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TOPSIM MODEL REQUIREMENTS
DOCUMENT

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LIST OF TERMS

Abbreviations, Acronyms, and Initialisms

ATR        Acceptance Test Report
BDGRE      buoyant displacement gas release event
CD         chemical dissolution
CFF        cross-flow filtration
CH-TRU     contact-handled transuranic
CNP        cesium nitric acid recovery process system
CRP        cesium resin addition process system
CsIX       cesium ion exchange
CSV        comma-separated values
CWC        Central Waste Complex
CXP        cesium ion-exchange process system
DFLAW      direct-feed low-activity waste
DOE        U.S. Department of Energy
DSA        Documented Safety Analysis
DST        double-shell tank
EMF        Effluent Management Facility
ERSS       Extended-Reach Sluicing System
ETF        Effluent Treatment Facility
FEP        waste feed evaporation process system
FR         functional requirement
FRP        waste feed receipt process system
GFR        glass formers reagent system
HDH        HLW canister decontamination handling system
HEME       high-efficiency mist eliminator
HEPA       high-efficiency particulate air
HFP        HLW melter feed process system
HIHTL  hose-in-hose transfer line
HLP    HLW lag storage and feed blending process system
HLW    high-level waste
HMP    HLW melter process system
HOP    HLW melter offgas treatment process system
HSM    Hanford Simulation Model
HTRH   hard-to-remove heel
HTWOS  Hanford Tank Waste Operations Simulator
IHLW   immobilized HLW
ILAW   immobilized LAW
IMUST  inactive miscellaneous underground storage tank
IX     ion exchange
LAW    low-activity waste
LAWPS  Low-Activity Waste Pretreatment System
LCP    LAW concentrate receipt process system
LERF   Liquid Effluent Retention Facility
LFP    LAW melter feed process system
LMP    LAW melter process system
LOP    LAW primary offgas process system
LVP    LAW secondary offgas/vessel vent process system
MARS-V Mobile Arm Retrieval Vacuum System
MR     model requirement
MRS    Mobile Retrieval System
ORP    Office of River Protection
PUREX  Plutonium Uranium Extraction (Plant)
PT (Facility) WTP Pretreatment Facility
PVP    pretreatment vessel vent process system
PWD    plant wash and disposal system
RCRA  
*Resource Conservation and Recovery Act of 1976*

RDP  
spent resin collection and dewatering process system

RLD  
radioactive liquid waste disposal system

RPP  
River Protection Project

RTM  
Requirement Traceability Matrix

RVIR  
retrieved volume impact ratio

S-ILAW  
supplemental immobilized LAW

SALDS  
State-Approved Land Disposal Site

SBS  
submerged bed scrubber

SLAW  
supplemental low-activity waste (treatment)

SLCP  
supplemental LAW concentrate receipt process system

SLFP  
SLAW melter feed process system

SLMP  
supplemental LAW melter process system

SLOP  
supplemental LAW primary offgas process system

SLVP  
supplemental LAW secondary offgas/vessel vent process system

SME  
subject-matter expert

SR  
software requirement

SST  
single-shell tank

STLP  
supplemental treated LAW evaporation process system

TCP  
treated LAW concentrate storage process system

TEDF  
Treated Effluent Disposal Facility

TLP  
treated LAW evaporation process system

TPA  
Tri-Party Agreement

TR  
technical requirement

TSCR  
tank-side cesium removal

TWCS  
tank waste characterization and staging

TWINS  
Tank Waste Information Network System

UFP  
ultrafiltration process system
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<th>Term</th>
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<td>WAC</td>
<td>Washington Administrative Code</td>
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<tr>
<td>WAC</td>
<td>waste acceptance criteria</td>
</tr>
<tr>
<td>WESP</td>
<td>wet electrostatic precipitator</td>
</tr>
<tr>
<td>WIPP</td>
<td>Waste Isolation Pilot Plant</td>
</tr>
<tr>
<td>WRF</td>
<td>Waste Receiving Facility</td>
</tr>
<tr>
<td>WTP</td>
<td>Hanford Tank Waste Treatment and Immobilization Plant</td>
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<tr>
<td>WVR</td>
<td>waste volume reduction</td>
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### Terms

**200-East Area**
A geographical area on the east end of the Hanford Central Plateau that includes A-, AN-, AP-, AW-, AX-, AY-, AZ-, B-, BX-, BY-, and C-Tank Farms.

**200-West Area**
A geographical area on the west end of the Hanford Central Plateau that includes S-, SX-, SY-, T-, TX-, TY-, and U-Tank Farms.

**242-A Evaporator**
An evaporator/crystallizer facility, located in the 200-East Area of the Hanford site, that receives dilute waste from throughout the Hanford tank farms complex and returns concentrated waste to the DST system.

**aluminate \[\text{Al(OH)}_4\]**
The chemical form of aluminum in the liquid phase of Hanford waste.

**available space**
The volume in a vessel that can be filled with a liquid or slurry; or, the maximum volume of the vessel minus the total volume of the vessel.

**B Complex**
The collective term for the B-, BX-, and BY-Tank Farms.

**B-Complex WRF**
A WRF that will be built in the 200-East Area near the B Complex.

**back-end caustic leaching**
Performing caustic leaching after ultrafiltration.

**boehmite \((\text{AlOOH})\)**
A solid form of aluminum which can be dissolved by leaching.

**caustic leaching**
The process of adding sodium hydroxide and heat to dissolve selected solid species.

**cesium product**
The cesium-rich stream discharged from the CNP evaporator.

**CH-TRU waste treatment system**
The potential CH-TRU waste treatment system uses a high-vacuum, low-temperature, rotary dryer to remove water from the retrieved sludge. The dried product, consisting of approximately 10 wt%
water, 10wt% sand, and 80wt% waste solids is packaged in 55-gal drums. The low-dosage CH-TRU waste product allows manual operation of the drum-filling equipment and movement of product drums without requiring remote manipulators.

**complexed concentrate**
A complexed concentrate is concentrated aqueous waste containing organic ligands which have complexed with normally insoluble radionuclides (e.g., strontium, transuranics).

**concentrated pretreated LAW**
Pretreated LAW that has been concentrated.

**DFLAW**
A processing period where the WTP LMP is fed by the LAWPS.

**dilute waste**
Liquid waste having a concentration below a user-defined threshold.

**Dual-Pumping Mode**
The "Dual-Pumping" mode is when the Treated LAW Evaporator (TLP-SEP-00001) is fed from both the Treated LAW Collection Vessels (CXP-VSL-00026A,B,C) and the LAW SBS Condensate Receipt Vessels (TLP-VSL-00009A/B).

**eluate**
An effluent stream containing a desorbed solute and the eluting solvent.

**elution**
Desorption of an adsorbed solute by a solvent.

**EMF Evaporator Feed Vessel**
(EMF-VSL-00002): The vessel within the WTP EMF that receives liquid effluent and routes it to EMF evaporator (EMF-SEP-00001).

**envelope C waste**
A contractual composition designation for Hanford waste containing organic complexing agents that bind with radioactive metals resulting in an increase in solubility of the metals in the liquid phase.

**equilibrium distribution curve**
A graph representing the ratio of the concentration of a solute in one phase to the concentration of the solute in a second phase at equilibrium conditions. Usually, concentrations are given as the mole fraction of the solute in each phase.

**evaporator campaign**
A transfer or grouping of transfers (in the case of multi-passes) through the 242-A Evaporator that are from one feed batch.

**evaporator offgas**
Gases and condensable vapors evaporated off the liquid feed.

**facility availability**
The total time to treat all tank wastes with no reduction in throughput divided by the total time to treat all tank wastes with reductions representing equipment reliability/ availability/ maintainability/ inspectability downtimes.

**Feed-Only Mode**
The "Feed-Only" mode is when the Treated LAW Evaporator (TLP-SEP-00001) is only fed from the Treated LAW Collection Vessels (CXP-VSL-00026A,B,C).
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<th>Definition</th>
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<tr>
<td>filtrate</td>
<td>Supernatant from which solids have been removed by filtration.</td>
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<tr>
<td>Fixed-Feed Vector</td>
<td>A list of HLW and LAW batches delivered to the WTP feed receipt systems, including the volumes and compositions of each batch.</td>
</tr>
<tr>
<td>flux rate</td>
<td>The flux rate is the flow rate in a cross-flow filtration system.</td>
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<tr>
<td>fresh resin</td>
<td>New ion-exchange media received from a vendor.</td>
</tr>
<tr>
<td>gaseous effluent</td>
<td>Gas-phase material that is discharged out of a treatment facility or process.</td>
</tr>
<tr>
<td>gibbsite [Al(OH)3]</td>
<td>Gibbsite [Al(OH)3] is a solid form of aluminum that can be dissolved with hydroxide (OH-).</td>
</tr>
<tr>
<td>glass formers</td>
<td>A mixture of solids that contain the necessary chemicals to convert pretreated LAW feed into glass when melted.</td>
</tr>
<tr>
<td>Group A waste</td>
<td>Waste in tanks that contains a large layer of settled salts with retained gas and a layer of saturated supernatant with a floating crust on the surface.</td>
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<td>HLW</td>
<td>Waste consisting primarily of sludge and saltcake, with the sludge fraction of the waste consisting of metal oxides and hydroxides, and the saltcake fraction consisting of the product of numerous acid-base reactions. The HLW in the tanks accounts for the bulk of the radioactivity.</td>
</tr>
<tr>
<td>hydrogen mitigation</td>
<td>Action taken that reduces the risk of hydrogen combustion. Such action may include purging the vapor space to reduce the build-up of hydrogen gas.</td>
</tr>
<tr>
<td>partition coefficient</td>
<td>A ratio of the concentration of a chemical component or radionuclide in a &quot;product&quot; stream to the concentration of that same item in an effluent stream.</td>
</tr>
<tr>
<td>inhibited water</td>
<td>Water containing dilute caustic and dilute sodium nitrite that is used for flushing transfer lines as well as for other purposes. The dilute chemicals are added to inhibit corrosion. The make-up is additionally defined in the Inhibited Water Make-Up requirement.</td>
</tr>
<tr>
<td>IX resin regeneration</td>
<td>A process to allow for re-use of IX resin.</td>
</tr>
<tr>
<td>lag storage</td>
<td>A vessel that receives a feed stream, holds it for a specified period or until specified criteria are met, and then transfers it to another vessel or unit operation.</td>
</tr>
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<td>LAW</td>
<td>Tank waste consisting primarily of the supernate (liquid) portion with most of the solids and radioactivity removed before vitrification. LAW will be the largest tank waste stream by volume (approximately</td>
</tr>
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</table>
90% of the volume), but the lowest in radioactivity content (approximately 10% of the Ci).

LAW supplemental treatment (or SLAW)

A second LAW processing facility that will vitrify the excess pretreated LAW produced while maximizing HLW throughput. It is anticipated to come online after the startup of the WTP PT Facility. The LAW supplemental treatment facility is presently assumed to be another vitrification facility with the same technical design, glass chemistry, melters, and similar feed and offgas equipment as the WTP LAW Vitrification Facility.

LAW vitrification hot commissioning

The time period starting with the transfer of pretreated feed from the LAWPS to the WTP LAW Vitrification Facility.

LFP batch size

The LFP vessel LFP-VSL-00001_3 receives batches of LAW concentrate from the LCP vessel LCP-VSL-00001_2 based on sample analysis of the LAW concentrate. These batch volumes are in proportion to the recipe of glass formers received from glass former mixers. The glass former solids volume and the concentrate slurry volume combine for a melter feed batch volume. Definition is taken from Section 3.1.3.3 of 24590-WTP-RPT-PT-02-005, Flowsheet Bases, Assumptions, and Requirements (Rev. 8).

liquid effluent

Wastewater that is discharged from a treatment facility or process, also referred to as secondary liquid waste.

maximum volume

The maximum volume of a specific piece of equipment.

melter offgas

The gases and steam released by reactions in the glass melt.

minimum volume

The minimum volume of a specific piece of equipment.

mixer

A unit operation having multiple feed streams that are combined within the mixing vessel into one exit stream.

northeast quadrant

The northeast portion of the tank farms, which contains, among other things, B-, BX-, and BY-Tank Farms.

northwest quadrant

The northwest portion of the tank farms, which contains, among other things, T-, TX-, and TY-Tank Farms.

oxidative leaching

The process of adding sodium permanganate (NaMnO$_4$) to dissolve solid chromium that limits waste loading in IHLW.

tanks farms

The 28 Hanford DSTs and the 149 Hanford SSTs.

permeate

Treated waste and wash solution from which most of the solids have been removed by the ultrafiltration process.

pretreated LAW

LAW feed that has been treated to remove cesium and filtered to remove solids.
pretreated HLW: The blended cesium product and the stream of pretreated process slurries sent from the WTP PT Facility to the WTP HLW Vitrification Facility.

pretreated process slurries: Slurries of washed HLW solids from the UFP.

pretreatment water lock: When the UFP cannot proceed because the recycle systems are full and unable to process. The PWD vessels (specifically, the acidic/alkaline effluent vessels [PWD-VSL-00015/00016] and the plant wash vessel [PWD-VSL-00044]) are full and ready to pump to the evaporator feed receipt vessels (FEP-VSL-00017A/B); however, the evaporator feed receipt vessels (FEP-VSL-00017A/B) are also full and ready to pump.

power flushed: Removing waste in the ultrafiltration loop using a sequence of pneumatically driven flushes and air purges.

process condensate: The liquid stream formed through condensation of a vapor stream, which may be recycled within a facility or process.

Recycle-Only Mode: The "Recycle-Only" mode is when the TLP evaporator (TLP-SEP-00001) is fed from only the LAW SBS condensate receipt vessels (TLP-VSL-00009A/B).

regeneration waste: The waste created during IX resin restoration. This includes rinses and solutions used for displacement, elution, and regeneration of the resin using 0.5M sodium hydroxide (NaOH).

residual waste: The waste remaining in the SSTs after retrieval is complete.

sawtooth: A term used to describe oscillating between an upper volume and a lower volume, by adding an increment of liquid or slurry, then transferring that incremental volume out again.

SLFP batch size: The LAW supplemental (or SLAW) treatment system is designed to mirror the LAW system. Therefore, the following statement is taken from the LAW requirements: SLAW melter feed preparation vessels SLFP-VSL-00001/00003 receives batches of SLAW concentrate from the SLAW concentrate receipt vessels SLCP-VSL-00001/00002 based on sample analysis of the SLAW concentrate. These batch volumes are in proportion to the recipe of glass formers received from glass former mixers. The glass former solids volume and the concentrate slurry volume combine for a melter feed batch volume. The definition is taken from Section 3.1.3.3 of 24590-WTP-RPT-PT-02-005.

solids washing: Using water or process condensate to dissolve soluble species from undissolved solids.
solubility application  Describes the selected solubility model (ISM or Standard) applied to a given set of components at a specified temperature to redistribute the solid and liquid components based on the predicted equilibrium.

southeast quadrant  The southeast portion of the tank farms, which contains, among other things, A-, AX-, and C-Tank Farms.

southwest quadrant  The southwest portion of the tank farms, which contains, among other things, S-, SX-, and U-Tank Farms.

spent resin IX media  IX media which no longer is removing the cesium to the desired level due to radiological and chemical degradation.

split factor  The mass fraction of a component that "splits" from the feed stream into one of two exit streams by way of a splitter unit operation. The remaining mass fraction splits into the second exit stream.

splitter  A unit operation receiving one feed stream that is split into two exit streams based on split factors.

status  A facility's or component's availability to interact with an outside entity.

strontium/TRU precipitation  The process of adding strontium nitrate \( \text{Sr(NO}_3\text{)}_2 \) and sodium permanganate \( \text{MnNaO}_4 \) to cause strontium and TRU species to precipitate.

T Complex  The collective term for the T-, TX-, and TY-Tank Farms.

T-Complex WRF  A WRF that will be built in the 200-West Area near the T Complex.

terminal volume  The residual volume that is permitted in a tank or vessel when it has completed normal operations and is no longer needed to receive or transfer waste.

total volume  The current volume (solid volume plus liquid volume) of a vessel.

up-front caustic leaching  Performing caustic leaching prior to filtration in the ultrafiltration preparation vessel (UFP-VSL-00001A/B).

vitrify  Convert into glass by heat and fusion.

wash forward  When the wash solution from \textit{UFP Feed Vessels (UFP-VSL-00002A/B)} is sent to one of the \textit{UFP Permeate Receipt Vessels (UFP-VSL-00062A/B/C)}.

wash recycle  When the wash solution from the \textit{UFP Feed Vessels (UFP-VSL-00002A/B)} is sent to one of the \textit{Acidic/Alkaline Effluent Vessels (PWD-VSL-00015/00016)}.

Units

atm            atmospheres
°C             degrees Celsius
CFM = cu ft/min = ft³/min      cubic feet per minute
cu ft = ft³      cubic feet
cu ft/min = ft³/min = CFM    cubic feet per minute
cv              column volume
cv/hr          column volume per hour
°F             degrees Fahrenheit
ft             foot
ft³ = cu ft    cubic foot, cubic feet
ft³/min = CFM = cu ft/min    cubic feet per minute
g              gram
gal           gallon(s)
gpm           gallons per minute
in             inch(es)
k             kilo
kg             kilogram
kgal          kilogallon(s)
L             liter
M             molar
Mgal          million gallon(s)
min           minute
psi           pounds per square inch
SpG           specific gravity
wt%  weight percent
1.0 INTRODUCTION

This document communicates the requirements for the Hanford Simulation Model (HSM) that are implemented in the TOPSim software application.

1.1 TOPSIM MODEL OVERVIEW

The TOPSim software application is used to host and simulate models of the Hanford tank farms and processing plant operations. TOPSim includes design elements (defined in the RPP-55533, TOPSim Software Design Document) that can be configured to model the physical plant, including tanks, process equipment, and transfer lines. The TOPSim environment also includes chemistry models to support calculations and tracking of chemical components through the process. The application is designed to allow extensions of the model elements to incorporate cost, reliability, and other constraints.

TOPSim was developed within the Gensym G2® platform. The fundamental operation of TOPSim involves the simulation environment paired with a model design and a database (developed with SQL Server®). The particular model design used in this case is referred to as the HSM. The simulation software is coupled with the model and the operation of specific subprocesses, while the database provides a repository to store configuration data and the generated simulation data. In addition, the database provides the basis for analysis of the simulation data generated by the process model.

1.2 PURPOSE

The purpose of the HSM is to provide a simulation aligned to the latest technical information for use as a starting point for scenario modeling. The intent of aligning the default HSM to the latest technical information is to improve the efficiency of configuring the HSM to create a requested scenario. The use of software tools for the development and documentation of requirements for the default model is intended to facilitate the maintenance of requirements to support the efficient specification and configuration of scenario requirements and their associated testing. A key part of this simulation environment is the ability to encode operational decision logic into the model. Incorporating decision logic into the simulation enables modeling of long-term, large-scale processes, as these require extensive decision logic in their execution.

The primary purpose of this requirements document is to communicate the requirements of the TOPSim application. A detailed and complete requirements set provides the foundation for software development. It gives developers clear goals thereby minimizing the development effort, provides an avenue for customer feedback, provides traceability, and provides a baseline for verification and validation.

1.3 SCOPE

The scope of the HSM includes the Hanford tanks containing wastes from nuclear fuel reprocessing that must be treated; the existing and planned facilities for retrieving wastes and staging them for delivery to treatment facilities; and the processes that are being built or are proposed for treating the tank wastes.
1.4 REQUIREMENTS TRACEABILITY

Requirements traceability is maintained in the Jama© software application and communicated in a Requirements Traceability Matrix (RTM) presented in the Acceptance Test Report (ATR; RPP-57461, TOPSim Acceptance Test Report) for a particular TOPSim version. Individual requirements are identified using a unique identifier consisting of the text string “BMR-” coupled with a requirement-level designator, a hyphen, and a number sequentially assigned by Jama© as requirements are entered. The requirement designators are “REQ” for system requirements, “FR” for functional requirements, “MR” for model requirements, and “TR” for technical requirements. The information for each system is presented in a separate section of the document. Systems are presented in sections under level 1 document headings. System, functional, model, and technical requirements are presented under level 2 document headings. Individual requirements are presented under level 3 document headings. Each level 3 heading contains the title of the requirement and its unique identifier enclosed in square brackets. The requirement statement is presented in the text under each level 3 heading. Each system’s section first provides a summary description of the system and then presents the different levels of requirements for each system, followed by any supporting figures or diagrams. Individual requirements of the same type are presented under the heading for that type of requirement.

1.5 REQUIREMENTS HIERARCHY

The HSM is defined using four levels of requirements - system requirements (SR), functional requirements (FR), model requirements (MR), and technical requirements (TR). An SR is a statement regarding what a system within the flowsheet does to support the mission. There can be multiple requirements for a system, but they should all be high-level descriptions of the system. These requirements can include stakeholder requirements (what the customer needs) and quality attributes such as availability. An FR is a statement identifying a particular function a system performs. These requirements define the logic of each process or operation within a system. They can include constraints (restrictions on the system) and interface requirements (with other systems/processes). An MR identifies what the model must do in support of a particular function. These requirements define the flowsheet items, objects, and associated logic. A TR defines the configuration of the flowsheet items/objects, such as volumes, data collection/manipulation, etc.

Figures are provided for some systems as separate sections within the requirements. These figures are not intended to convey requirements themselves and are intended to illustrate how requirements interface (i.e., fit together).

1.6 FORMATTING CONVENTIONS

This document is intended to create a record of the requirements housed in the Jama© software. It is created by directly exporting the information contained in Jama by means of an automated script. While every effort has been made to make the content of Jama comply with the formatting standards, due to the nature and size of the content, it is not practical to comply with all of the formatting standards typically applied to technical documents. The following formatting exceptions are noted so that the reader may better understand the document layout.

- Acronyms and references are not spelled out on first use but are provided in an acronyms table and references section, respectively.
• Tables and figures use the captions provided by Jama and do not contain unique numbers assigned by Word®.
• Units and significant figures vary by requirement and/or basis document; no standard units system or significant figures have been chosen.
2.0 TANK FARMS

2.1 SINGLE-SHELL TANKS

The purpose of the single-shell tanks (SST) is to store sludge and/or crystallized salts containing incidental amounts of liquids until they can be retrieved into the double-shell tanks (DST), Waste Receiving Facilities (WRF), or contact-handled transuranic (CH-TRU) waste treatment system. The SST system stores wastes until they are retrieved into the DST system or processed via other handling equipment. The SST farms and the SSTs within the farms are listed in Table "Distribution of Single-Shell Tanks at the Hanford Site." The SSTs are underground, reinforced-concrete structures (i.e., a concrete tank with a concrete dome) with an interior carbon-steel liner covering the concrete base and walls (see Figure "Typical Single-Shell Tank"). Of the 149 SSTs, 133 are large-capacity tanks with a 75-ft internal diameter (100-series tanks), and 16 are smaller-capacity tanks (200-series tanks) with a 20-ft internal diameter.

<table>
<thead>
<tr>
<th>Quadrant</th>
<th>Area</th>
<th>SST Farm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Southeast</td>
<td>200 East</td>
<td>A-, AX-, and C-Tank Farms; C-Tank Farm 200-series</td>
</tr>
<tr>
<td>Northeast</td>
<td>200 East</td>
<td>B-, BX-, and BY-Tank Farms; B-Tank Farm 200-series</td>
</tr>
<tr>
<td>Southwest</td>
<td>200 West</td>
<td>S-, SX-, and U-Tank Farms; U-Tank Farm 200-series</td>
</tr>
<tr>
<td>Northwest</td>
<td>200 West</td>
<td>T-, TX-, and TY-Tank Farms; T-Tank Farm 200-series</td>
</tr>
</tbody>
</table>

The SSTs are grouped into 12 tank farms containing between 4 and 18 tanks each. The SST waste retrieval can be viewed as occurring from two individual tank farms (C- and U-Tank
Farms) and from four tank farm groupings (A/AX-, B/BX/BY-, S/SX-, and T/TX/TY-Tank Farms). Waste from SSTs that is destined for DST storage is retrieved and transferred to the DST system through a pipeline system that services all tank farms and connects the 200-East and 200-West Areas.

The number and capacities of the SSTs are:

- 16 tanks, each of 55-kgal capacity (200-series tanks)
- 60 tanks, each of 530-kgal capacity
- 48 tanks, each of 758-kgal capacity
- 25 tanks, each of 1-Mgal capacity.

In the HSM, upon model initialization, the projected volume of retrieval water or chemicals are added to each SST, and wash factors are applied to determine the solid/liquid equilibrium. For each retrieval, the resulting contents are pumped to the DSTs at an average rate that achieves the projected retrieval duration. The sequence and timing of SST retrievals are specified by model input assumptions or automated logic that attempts to maintain sufficient waste feed to the WTP facilities. SST closure operations are not modeled.

2.1.1 System Requirements

2.1.1.1 SST - Waste Retrieval

Unique ID: BMR-SST_SR-1

The SST system shall store and support the retrieval of SST wastes to the DSTs, WRFs, and CH-TRU waste treatment system down to the minimum technically possible residual waste inventory or to the limits of waste retrieval technology, whichever is less.

Basis: N/A

2.1.2 Functional Requirements

2.1.2.1 SST - Store Waste

Unique ID: BMR-SST_FR-9

The SSTs shall have the capability to store radioactive waste until it can be retrieved.

Basis: This is the fundamental purpose of the SSTs.

2.1.2.2 SST - Adjust Waste Chemistry

Unique ID: BMR-SST_FR-1

The SSTs shall have the capability to receive chemical additives to adjust tank waste chemistry.

Basis: RPP-PLAN-40145 (and attached SS-1647) lists the caustic and/or oxalic acid chemical additions to be added to the SSTs for retrieval. In addition, caustic and/or nitrite may be added for corrosion mitigation in the receiver DSTs per OSD-T-151-00007, Operating Specifications for the Double-Shell Storage Tanks.
2.1.2.3 SST - Receive Waste Retrieval Liquids

**Unique ID:** BMR-SST_FR-2

The SSTs shall have the capability to receive water or DST supernatant to enable waste retrieval.

**Basis:** It is assumed that supernate can be used where practical for sluicing with a Mobile Arm Retrieval Vacuum System (MARS-V) in assumed leaking tanks. Supernate is preferred over water because sluicing with only water would put a significant load on the DST system for storage and on the evaporator for boil-off. An Extended-Reach Sluicing System (ERSS) with DST supernate is primarily used to retrieve sludge. The ERSS with water is used to retrieve salt cake.

2.1.2.4 SST - Transfer to 200-East-Area DSTs

**Unique ID:** BMR-SST_FR-3

The A-, AX-, and C-Tank Farm SSTs shall have the capability to transfer waste contents to the 200-East-Area DSTs.

**Basis:** A-, AX-, and C-Tank Farm SSTs are located in the 200-East Area as are AN-, AP-, AW-, AZ-, and AY-Tank Farm DSTs.

2.1.2.5 SST - Transfer to 200-West-Area DSTs

**Unique ID:** BMR-SST_FR-4

The S-, SX-, and U-Tank Farm SSTs shall have the capability to transfer waste contents to the 200-West-Area DSTs.

**Basis:** S-, SX-, and U-Tank Farm SSTs are located in the 200-West Area as are SY-Tank Farm DSTs.

2.1.2.6 SST - Transfer to CH-TRU Waste Treatment System

**Unique ID:** BMR-SST_FR-5

The B- and T-Tank Farm SSTs containing potential CH-TRU shall have the capability to transfer waste to the CH-TRU waste treatment system.

**Basis:** From RPP-PLAN-40145, Single-Shell Tank Waste Retrieval Plan, "For the B and T Farm tanks containing material to be treated as contact-handled transuranic (CH-TRU) waste, the retrieved solution is sent to the nearby CH-TRU facility, not a DST."

2.1.2.7 SST - Transfer to B-Complex WRF

**Unique ID:** BMR-SST_FR-6

The B-Complex SSTs, with the exception of those tanks containing potential CH-TRU, shall have the capability to transfer waste to the B-Complex WRF.

**Basis:** Per RPP-PLAN-40145, "The waste in the B/BX/BY tank farm grouping, except that handled as CH-TRU, will be retrieved and transferred via hose-in-hose transfer lines (HIHTLs) to new diversion boxes. From the new diversion boxes the waste will go via HIHTLs or double-encased stainless steel lines to a new WRF located nearby."
2.1.2.8  **SST - Transfer to T-Complex WRF**

**Unique ID:** BMR-SST_FR-7

The *T-Complex SSTs*, with the exception of those containing potential *CH-TRU*, shall have the capability to transfer waste to the *T-Complex WRF*.

**Basis:** Per *RPP-PLAN-40145*, "The waste in the T/TX/TY tank farm grouping, except that handled as CH-TRU, will be retrieved and transferred via HIHTLs to new diversion boxes. From the new diversion boxes the waste will go via new double-encased HIHTLs or stainless steel lines to a WRF located nearby."

2.1.2.9  **SST - Residual Inventory**

**Unique ID:** BMR-SST_FR-8

The *SSTs* shall have the capability to be retrieved to the minimum technically possible residual waste inventory or to the limits of waste retrieval technology, whichever is less.

**Basis:** The U.S. Department of Energy (DOE), Office of River Protection (ORP) provided SST retrieval planning direction to assume a residual waste volume of 300 ft$^3$ (2,244 gal) for 100-series tanks and 25 ft$^3$ (187 gal) for 200-series tanks (*09-TPD-014*, "Approval of Revision of River Protection Project (RPP) System Plan, Revision 4 Key Assumptions in Support of Contract Deliverable C.2.3.1-1, RPP System Plan").

2.1.3  **Model Requirements**

2.1.3.1  **200-East Area SST Waste Storage**

**Unique ID:** BMR-SST_MR-7

The 200-East Area SSTs shall include all tanks in C-Tank Farm, A-/AX-Tank Farms, and B Complex (B-/BX-/BY-Tank Farms).

**Basis:** The SSTs in the 200-East Area are C-101 through C-112, C-201 through C-204, A-101 through A-106, AX-101 through AX-104, B-101 through B-112, B-201 through B-204, BX-101 through BX-112, and BY-101 through BY-112.

2.1.3.2  **200-West Area SST Waste Storage**

**Unique ID:** BMR-SST_MR-39

The 200-West Area SSTs shall include all the tanks in S-/SX-Tank Farms, T Complex (T-/TX-/TY-Tank Farms), and U-Tank Farm.

**Basis:** The SSTs in the 200-West Area are S-101 through S-112, SX-101 through SX-115, T-101 through T-112, T-201 through T-204, TX-101 through TX-118, TY-101 through TY-106, U-101 through U-112, and U-201 through U-204.

2.1.3.3  **SST Waste Retrieval - Retrieval Preparation Sequence**

**Unique ID:** BMR-SST_MR-27

On the simulation start date, caustic and/or oxalic acid shall be added to SSTs AX-101/-103/-104 and A-101/-102/-103/-105/-106 to improve retrieval efficiency.
Nine days after the simulation start date, the following steps shall be performed in the order indicated.

1. Wash factors shall be applied.

2. Water shall be added according to the following iterative algorithm:
   - The water addition shall be calculated from the as-retrieved volume plus the residual volume*, less the current total volume, and added to the SST.
   - Solubility shall be applied.
   - Liquid phase reactions for CrOOH shall be applied.
   - Solubility shall be applied.
   - The new current total volume shall be calculated and, if it is equal to the as-retrieved volume plus residual volume*, corrosion chemicals shall be added (Step 4 below), otherwise another iteration of the water addition calculation is performed.

3. Corrosion chemicals shall be added according to the following steps, in the order indicated:
   - Corrosion chemicals shall be added according to the DST corrosion specifications (HNF-SD-WM-OCD-015), with a multiplier to ensure bringing [OH-] or [NO2-] within specification.
   - Liquid-phase reactions for CrOOH shall be applied.
   - Solubility shall be applied.
   - The above three steps shall be repeated until the DST corrosion specifications have been met.

4. The residual remaining in the SSTs after retrieval shall be calculated and designated as an immobile solid layer in the SST.

5. Adjust the SST pump rate such that the mobilized waste in the SST is retrieved at a rate sufficient to achieve the minimum retrieval duration.

* A residual volume of 2,244 gal for 100-series SSTs and 187 gal for 200-series SSTs is used in the iterative water calculations. There may be very infrequent times when the residual volume will be less than 2,244 gal for 100-series SSTs or less than 187 gal for 200-series SSTs, but the error introduced is acceptable and not perceivable over the mission duration.

**Basis:** The Retrieval Preparation Sequence is based on the water and chemical additions applied to the SSTs to prepare them for retrieval per SS-1647 from RPP-PLAN-40145. The iterative nature of the algorithm is due to the requirement to achieve the as-retrieved and residual volumes, while implementing solubility calculations (gCalc) which cause volume changes.

### 2.1.3.4 SST Waste Retrieval - Caustic and Oxalic Acid Additions

**Unique ID:** BMR-SST_MR-31

The A- and AX-Tank Farm SSTs shall receive caustic and oxalic acid additions to improve the efficiency of retrievals.
Basis: 1M oxalic acid and 19M caustic additions are used in SSTs A-105 and AX-101 through AX-104 to improve retrieval of hard-to-remove heels (HTRH) by chemical dissolution of sludge. The use of oxalic acid is followed by the use of a 3M caustic solution to neutralize any remaining oxalic acid in the heel. Oxalic acid is used to remove heels containing a significant fraction of iron oxide (Fe₂O₃) and a 19M caustic solution is used to remove aluminum hydroxide [Al(OH)₃] agglomerations.

2.1.3.5 SST Waste Retrieval - Application of Wash Factors

Unique ID: BMR-SST_MR-30

Wash factors shall be applied to the SST contents in order to dissolve soluble chemical components.

Basis: Wash factors are zero-order estimates of the fraction of each soluble component in the SSTs that will dissolve when water is added, and are used to estimate dissolution upon the addition of retrieval fluids to the SSTs. HNF-3157, Best-Basis Wash and Leach Factor Analysis, describes how the wash factors were determined from actual SST waste data.

2.1.3.6 SST Waste Retrieval - Water Addition

Unique ID: BMR-SST_MR-32

Water shall be added to the SSTs to facilitate retrieval of solid waste. If the water addition causes the SST to overfill, the maximum volume limits shall be overridden.

Basis: Water is added to the SSTs to mobilize the waste during retrieval to DSTs. The quantity of water needed is dependent on the selected retrieval method and composition of the waste to be retrieved. Water and chemical addition quantities are estimated in SS-1647 (attached to RPP-PLAN-40145). Since the SSTs are prepared for retrieval upon model initialization, and the as-retrieved volume of the waste often exceeds the volume of the SST being retrieved, the SSTs may overfill when prepared for retrieval. This issue does not exist in reality, because the SSTs will be retrieved as water is added.

2.1.3.7 SST Waste Retrieval - Application of Solubility Following Water Addition

Unique ID: BMR-SST_MR-33

Solubility in the SSTs shall be performed following the addition of water.

Basis: GCalc is a multicomponent liquid/solid solubility model based on the Pitzer equation. It is applied to select components with intermediate solubility in the waste (i.e., components that readily dissolve or precipitate with changes in composition). Strontium solubility is applied when gCalc solubility is applied.

2.1.3.8 SST Waste Retrieval - Liquid Chromium Reaction Following Water Addition

Unique ID: BMR-SST_MR-4

After the addition of water and after wash factors have been applied, CrOOH shall be converted to chromate (CrO₄²⁻).

Basis: Chromate (CrOOH) must be converted to the liquid-soluble form after wash factors are applied and it is transferred into the liquid phase.
2.1.3.9 SST Waste Retrieval - Application of Solubility after Chromium Reaction

**Unique ID:** BMR-SST_MR-45

Solubility in the SSTs shall be performed following the application of the chromium reaction.

**Basis:** GCalc is a multicomponent liquid/solid solubility model based on the Pitzer equation. It is applied to select components with intermediate solubility in the waste (i.e., components that readily dissolve or precipitate with changes in composition). Strontium solubility is applied when GCalc solubility is applied.

2.1.3.10 SST Waste Retrieval - Calculation of New Current Total SST Volume

**Unique ID:** BMR-SST_MR-41

The new current total volume in the SST shall be calculated at the end of each water addition iteration to determine if the as-retrieved SST volume has been achieved.

**Basis:** The volume calculation is iterative since there are volume changes caused by dissolution or precipitation when solubility calculations are applied. Those changes require adjustment of the amount of water added to meet the as-retrieved volume and solubility calculations to be re-run until the error in the volume is acceptable.

2.1.3.11 SST Waste Retrieval - DST Corrosion Mitigation Chemicals Addition after Retrieval Water Addition

**Unique ID:** BMR-SST_MR-35

Corrosion mitigation chemicals, sodium hydroxide (NaOH) or sodium nitrite (NaNO₂), shall be added to the SSTs after retrieval water is added, so that the receiving DSTs meet the DST corrosion control specification.

**Basis:** The DST corrosion mitigation chemical additions are added to the SSTs as they are prepared to be retrieved in order to prevent corrosion in the downstream receiving DSTs per OSD-T-151-00007.

2.1.3.12 SST Waste Retrieval - Application of Chromium Reaction Following DST Corrosion Mitigation Chemical Addition

**Unique ID:** BMR-SST_MR-42

After the corrosion mitigation chemicals have been added, the guyanaite (CrOOH(l)) reaction shall be performed to convert any guyanaite (CrOOH(l)) which may remain in the liquid chromate (CrO₄²⁻(l)).

**Basis:** Guyanaite (CrOOH(l)) must be converted to the liquid-soluble form after wash factors are applied and it is transferred into the liquid phase.

2.1.3.13 SST Waste Retrieval - Application of Solubility Following Addition of Corrosion Mitigation Chemicals

**Unique ID:** BMR-SST_MR-34

Solubility shall be applied in the SSTs following the addition of corrosion mitigation chemicals.
Basis: GCalc is a multicomponent liquid/solid solubility model based on the Pitzer equation. It is applied to select components with intermediate solubility in the waste (i.e., components that readily dissolve or precipitate with changes in composition). Solubility is applied after the addition of corrosion mitigation chemicals to address any dissolution or precipitation that may result from the addition of sodium hydroxide (NaOH) or sodium nitrite (NaNO₂).

2.1.3.14 SST Waste Retrieval - Residual Solids Layer

Unique ID: BMR-SST_MR-36

The residual waste remaining in the SSTs after retrieval shall be calculated and designated as an immobile solid layer in the SST. The volume of the residual waste shall be a function of the SST type (100 or 200 series).

Basis: Residual wastes are based on post-retrieval waste volume estimates for Tanks C-103, C-106, S-112, C-201, C-202, C-203, and C-204.

2.1.3.15 SST Waste Retrieval - SST Pump Rate Calculation

Unique ID: BMR-SST_MR-43

The SST pump rate is equal to the quotient of the as-retrieved volume and minimum retrieval duration.

Basis: The minimum retrieval duration for each SST is estimated in SS-1647 (attached to RPP-PLAN-40145), and is a function of the method used to retrieve the SST waste.

2.1.3.16 SST Farm Retrieval Order - A-/AX-Tank Farms

Unique ID: BMR-SST_MR-9

The tanks in A- and AX-Tank Farms shall be retrieved after the retrievals in the C-Tank Farm are complete.

Basis: Tank Farms A and AX will be the next farms retrieved because S-/SX-Tank Farms require Tank SY-101 and/or Tank SY-103 be cleaned out; there is not a RCRA-compliant transfer route from the B-/BX-/BY-Tank Farms. Additionally, a RCRA-compliant transfer route from T-/TX-/TY-Tank Farms or U-Tank Farm to the SY-Tank Farm does not currently exist (RPP-PLAN-40145).

2.1.3.17 SST Farm Retrieval Order - B-/BX-/BY-Tank Farms

Unique ID: BMR-SST_MR-10

The tanks in B-, BX-, and BY-Tank Farms, with the exception of those tanks in the B-Tank Farm containing potential CH-TRU, shall be retrieved no earlier than the SST 200-West Area Retrieval Start Date.

Basis: This is an enabling assumption. RPP-PLAN-40145 does not specify the next tank farm to be retrieved or the timing after retrievals of A-/AX-Tank Farms.
2.1.3.18 **SST Farm Retrieval Order - Tank SY-103**

**Unique ID:** BMR-SST_MR-11

Tank SY-103 shall be mitigated before SSTs in the 200-West Area are retrieved, with the exception of those tanks in T-Tank Farm containing potential CH-TRU for which the retrieval start time is not tied to the completion of SY-103 mitigation.

**Basis:** Retrievals in the S-/SX-Tank Farms require Tank SY-101 and/or Tank SY-103 be cleaned out. Additionally, a RCRA-compliant transfer route from Tank Farms T, TX, and TY or U-Tank Farm to SY-Tank Farm needs to be constructed (*RPP-PLAN-40145*).

2.1.3.19 **SST Farm Retrieval Order - S-/SX-Tank Farms**

**Unique ID:** BMR-SST_MR-12

Tanks in the S- and SX-Tank Farms shall be retrieved first in the 200-West Area, following the retrievals of the A- and AX-Tank Farms in the 200-East Area and the mitigation of Tank SY-103. The S- and SX-Tank Farms' retrieval order is as follows in the table "Early Retrieval Order of 241-S and 241-SX Tank Farms" until the SST 200-West Area Retrieval Start Date, at which time the remaining SST retrievals in the S- and SX-Tank Farms occur using the SST retrieval logic.

### Early Retrieval Order of 241-S and 241-SX Tank Farms

<table>
<thead>
<tr>
<th>Order</th>
<th>Tank</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>S-105</td>
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<td>S-109</td>
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Early Retrieval Order of 241-S and 241-SX Tank Farms

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**Basis:** Tank Farms S and SX were chosen as the next farms to be retrieved because a Resource Conservation and Recovery Act of 1976 (RCRA)-approved transfer line is already in place to the SY-Tank Farm, and the number of tanks retrieved can be maximized because of the lower as-retrieved volumes compared to those in the U-Tank Farm. In addition, the tanks in the S- and SX-Tank Farms have less solids than those in the U-Tank Farm, so Tank SY-103 does not reach the maximum solids limit of 200 in as early during retrievals. When SY-103 reaches 200 in of solids, retrievals must stop until a cross-site slurry line is available and the solids can be removed.

### 2.1.3.20 SST Farm Retrieval Order - T-/TX-/TY-Tank Farms

**Unique ID:** BMR-SST_MR-13

Tanks in the T-, TX-, and TY-Tank Farms in the 200-West Area, except those designated as containing potential CH-TRU waste, shall start being retrieved after the last SSTs retrievals in the S- and SX-Tank Farms have been initiated.

**Basis:** This is an enabling assumption. *RPP-PLAN-40145* does not specify the next tank farm to be retrieved or the timing of those retrievals after retrievals in the S- and SX-Tank Farm.

### 2.1.3.21 SST Farm Retrieval Order - U-Tank Farm

**Unique ID:** BMR-SST_MR-14

Tanks in the U-Tank Farm shall be retrieved after the last retrievals in the T-, TX-, and TY- Tank Farms have been initiated.

**Basis:** *RPP-PLAN-40145* states that the tanks in U-Tank Farm are retrieved after retrieval of tanks in the T-, TX-, and TY Tank Farms.

### 2.1.3.22 SST Routing to DSTs/WRFs - A-Tank Farm

**Unique ID:** BMR-SST_MR-15

Retrievals of SSTs from A-Tank Farm shall be routed to the A-Tank Farm Waste Receipt Tank (RPP-RPT-59942, *A-Farm Receipt Tank Evaluation*).

**Basis:** There are advantages to using AP-101 as the SST receipt tank for A-Tank Farm, including easier access and shorter routes for retrievals in the A-Tank Farm.
2.1.3.23   SST Routing to DSTs/WRFs - AX-Tank Farm

**Unique ID:** BMR-SST_MR-16

Retrievals of SSTs from AX-Tank Farm shall be routed to Tank AZ-102.

**Basis:** The decision to route retrievals from the AX-Tank Farm to Tank AZ-102 was made based on its proximity to the AX-Tank Farm and an evaluation of supernatant concentrations and sludge volumes.

2.1.3.24   SST Routing to DSTs/WRFs - S-, SX-, and U-Tank Farms

**Unique ID:** BMR-SST_MR-17

Retrievals from SST in S-, SX-, and U-Tank Farms shall be routed to Tank SY-102 or Tank SY-103.

**Basis:** Tank Farms S, SX, and U are in close proximity to SY-Tank Farm. In addition, there is a RCRA-compliant transfer line available between S- and SX-Tank Farms and SY-Tank Farm.

2.1.3.25   SST Routing to DSTs/WRFs - T-, TX-, and TY-Tank Farms

**Unique ID:** BMR-SST_MR-18

Retrievals from SSTs in T-, TX-, and TY-Tank Farms shall be routed to the T-Complex WRF, except for those from Tanks T-201, T-202, T-203, T-204, T-104, T-110, and T-111, which are routed to the CH-TRU waste treatment system.

**Basis:** Because of their distances from the SY-Tank Farm, retrievals from T-, TX-, and TY-Tank Farms will be transferred to a WRF (except for tanks containing potential CH-TRU [T-201, T-202, T-203, T-204, T-104, T-110, and T-111]), which will then be used to route the retrieved waste to the SY-Tank Farm.

2.1.3.26   WRF Routing to DSTs - T-Complex WRF

**Unique ID:** BMR-SST_MR-20

Waste from SSTs retrieved to the T-Complex WRF shall be routed to Tanks SY-102 and SY-103.

**Basis:** The only DSTs in the 200-West Area are those in the SY-Tank Farm.

2.1.3.27   SST Routing to DSTs/WRFs - B-, BX-, and BY-Tank Farms

**Unique ID:** BMR-SST_MR-19

Retrievals from SSTs in B-, BX-, and BY-Tank Farms shall be routed to the B-Complex WRF, except for those from Tanks B-201, B-202, B-203, and B-204, which are routed to the CH-TRU waste treatment system.

**Basis:** Because of their distance from AN-Tank Farm, retrievals from the B-, BX-, and BY-Tank Farms will be transferred to a WRF (except for tanks containing potential CH-TRU [B-201, B-202, B-203, and B-204]), which will then be used to route the retrieved waste to the AN-Tank Farm.
2.1.3.28 WRF Routing to DSTs - B-Complex WRF

Unique ID: BMR-SST_MR-21

Waste from SSTs retrieved to the *B-Complex WRF* shall be routed to the AN-Tank Farm.

*Basis:* The B-Complex WRF is retrieved to the AN-Tank Farm because it is the closest DST farm.

2.1.3.29 SST Routing to CH-TRU Waste Treatment System

Unique ID: BMR-SST_MR-6

Tanks B-201, B-202, B-203, and B-204 and T-201, T-202, T-203, T-204, T-104, T-110, and T-111 shall be retrieved to the *CH-TRU waste treatment system*.

*Basis:* RPP-21970, *CH-TRUM WPU&SE 11-Tank Material Balance*, provides the list of the 11 potential CH-TRU tanks that will be routed to the CH-TRU waste treatment system.

2.1.3.30 SST Waste Retrieval - SST Retrieval Volumes

Unique ID: BMR-SST_MR-28

The volumes retrieved from the SSTs shall be the as-retrieved volumes.

*Basis:* The as-retrieved volumes include all chemical and water additions to the SSTs for retrieval, in addition to the waste already present in each SST less the residual waste that is not retrievable. If supernatant is also used to retrieve the waste in an SST, it is not included in the as-retrieved volume, since it does not result in an increase in the DST waste volume.

2.1.3.31 SST Waste Retrieval - SST Retrieval Durations

Unique ID: BMR-SST_MR-29

The durations for the retrieval of the waste from the SSTs, with the exception of the tanks containing potential CH-TRU waste, shall be no less than the minimum retrieval duration.

*Basis:* The minimum retrieval durations are provided in *RPP-PLAN-40145* (attached SS-1647). Actual retrieval durations will be longer due to the need to work off waste in the DST system when it becomes full, which may cause retrievals to pause.

2.1.3.32 SST Farm 200-East Area Retrieval Constraints - Retrieval Operations

Unique ID: BMR-SST_MR-1

Retrieval operations shall concentrate within one tank farm or group of adjacent farms at a time in the 200-East Area.

*Basis:* Limiting waste retrieval to one SST tank farm or group of adjacent tank farms at a time reduces the resources needed for and costs of performing retrievals.

2.1.3.33 SST Farm 200-West Area Retrieval Constraints - Retrieval Operations

Unique ID: BMR-SST_MR-8

Retrieval operations shall concentrate within one tank farm or group of adjacent farms at a time in the 200-West Area.
Basis: Limiting waste retrieval to one SST tank farm or group of adjacent tank farms at a time reduces the resources needed for and costs of performing retrievals.

2.1.3.34 SST Retrieval Selection Criteria Application Order - After SST 200-East and 200-West Areas' Retrieval Start Dates

Unique ID: BMR-SST_MR-5

After the SST 200-East Area Retrieval Start Date and the SST 200-West Area Retrieval Start Date, SSTs shall be selected for retrieval according to the following logic:

1. If a maximum of two simultaneous retrievals are in progress in the 200-East Area, then no additional SSTs need to be evaluated in the 200-East Area for retrieval.
2. If a maximum of two simultaneous retrievals are in progress in the 200-West Area, then no additional SSTs need to be evaluated in the 200-West Area for retrieval.
3. If the 200-East or 200-West Area do not meet the simultaneous retrieval limits, then the criteria below are applied to that area:
   - Leaking SSTs adjacent to non-leaking SSTs shall be removed from the list of SSTs available for retrieval.
   - SSTs adjacent to tanks in the process of being retrieved shall be removed from the list of SSTs available for retrieval.
   - If a 200-series SST is already undergoing retrieval in a given farm complex, other 200-series SSTs are removed from the list of SSTs available for retrieval.
   - If there are still multiple SSTs to select from after the preceding three criteria have been applied, the SST with the lowest calculated RVIR shall be selected as the next SST for retrieval after the final two SSTs in the S- and SX-Tank Farms are chosen for retrieval on the SST 200-East and 200-West Areas' Retrieval Start Dates, and when retrieval of the first of those two S-/SX-Tank-Farm SSTs has been retrieved.

Basis: This is an enabling assumption. The algorithm was developed based on satisfying the SST retrieval criteria presented in RPP-PLAN-40145 and the implementation of the RVIR calculation, which was developed for use in the model to select, when all other criteria have been satisfied, the SST that will have the least impact on available DST space.

2.1.3.35 SST 200-East Area Retrieval Constraints - 200-Series Retrieval Limit

Unique ID: BMR-SST_MR-23

Only one 200-series SST shall be retrieved at a time in the 200-East Area.

Basis: There is only one VR-200 or Mobile Retrieval System (MRS) in operation at a time in the 200-East Area.

2.1.3.36 SST 200-West Area Retrieval Constraints - 200-Series Retrieval Limit

Unique ID: BMR-SST_MR-22

Only one 200-series SST shall be retrieved at a time in the 200-West Area.

Basis: This requirement has an undocumented basis.
2.1.3.37 SST 200-East Area Retrieval Constraints - Simultaneous Retrieval Limit

**Unique ID:** BMR-SST_MR-24

No more than two non-CH-TRU SSTs shall be retrieved from the 200-East Area at a time.

**Basis:** This is an enabling assumption from *RPP-PLAN-40145*, "For planning purposes assume a maximum of two tanks undergoing retrieval in a farm or farm group at one time until [Hanford Tank Waste Treatment and Immobilization Plant] WTP operations are close to starting. After WTP startup, the needed infrastructure, DST tank space, and experience are assumed to be in place for up to three simultaneous transfers in East and West area [sic]. Additionally, the number of transfers occurring in a year should be constrained to eight." This logic was extended to the area as well for modeling purposes.

2.1.3.38 SST 200-West Area Retrieval Constraints - Simultaneous Retrieval Limit

**Unique ID:** BMR-SST_MR-25

No more than two non-CH-TRU SSTs shall be retrieved from the 200-West Area at a time.

**Basis:** This is an enabling assumption from *RPP-PLAN-40145*, "For planning purposes assume a maximum of two tanks undergoing retrieval in a farm or farm group at one time until WTP operations are close to starting. After WTP startup, the needed infrastructure, DST tank space, and experience are assumed to be in place for up to three simultaneous transfers in East and West area [sic]. Additionally, the number of transfers occurring in a year should be constrained to eight." This logic was extended to the area as well for modeling purposes.

2.1.3.39 SST Retrieval Constraints - Adjacent SSTs after SST 200-East and 200-West Areas' Retrieval Start Dates

**Unique ID:** BMR-SST_MR-2

After the SST 200-East and 200-West Areas' Retrieval Start Dates, adjacent SSTs shall no longer be retrieved simultaneously.

**Basis:** Per *RPP-PLAN-40145*, "Where practical, the waste should be retrieved from non-leaking tank(s) before beginning waste retrieval from an adjacent assumed leaking tank(s)."

2.1.3.40 SST Retrieval Constraints - Leaking/Non-Leaking SSTs after SST 200-East and 200-West Areas' Retrieval Start Dates

**Unique ID:** BMR-SST_MR-26

After the SST 200-East and 200-West Areas' Retrieval Start Dates, non-leaking SSTs adjacent to leaking tank(s) shall be retrieved prior to the leaking tank(s).

**Basis:** Per *RPP-PLAN-40145*, "Where practical, the waste should be retrieved from non-leaking tank(s) before beginning waste retrieval from an adjacent assumed leaking tank(s)."
2.1.3.41 SST Retrieval Selection - RVIR Application for 200-East and 200-West Areas' Tank Farms

Unique ID: BMR-SST_MR-38

The RVIR shall be applied separately for both 200-East and 200-West Areas' tank farms.

Basis: The RVIR was created as the final criteria for selecting an SST for retrieval. Its purpose is to minimize the impact on available DST space.

2.1.3.42 SST Retrieval Selection - Application of RVIR for Final SST Selection

Unique ID: BMR-SST_MR-37

After the adjacent and leaking/non-leaking criteria for SST selection have been applied, if there are still multiple SSTs to choose from for the next retrieval, the RVIR shall be calculated to determine which of the remaining SSTs should be retrieved next.

Basis: The RVIR was created as the final criteria for selecting an SST for retrieval. Its purpose is to minimize the impact on available DST space.

2.1.3.43 SST Retrieval Constraints - DST/WRF Receipt Limitations

Unique ID: BMR-SST_MR-3

A DST or a WRF tank shall receive waste from only one SST at a time.

Basis: This requirement is an extrapolation of the following from RPP-PLAN-40145, "A DST or WRF tank should receive waste from only one sludge SST at a time. Several tanks containing only saltcake or utilizing water sluicing could be transferred concurrently to a single DST/WRF."

2.1.3.44 SST Routing to DSTs/WRFs - Tank C-105

Unique ID: BMR-SST_MR-44

Retrievals from SST C-105 shall be routed to Tank AN-106.

Basis: The decision to retrieve waste from SST C-105 to Tank AN-106 was made as a result of the planning efforts for disposition of the waste from Tank AY-102 after waste material was found between the primary and secondary tank walls.

2.1.4 Technical Requirements

2.1.4.1 SST Tank Attributes

Unique ID: BMR-SST_TR-6

The minimum and maximum SST volumes and the as-designed SST pump rates are provided in the tables below, titled "200-East Area SST Volumes and Identification" and "200-West Area SST Volumes and Identification."
## 200-East Area SST Volumes and Identification

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<th>Vessel/Unit Operation/ Model Identification</th>
<th>Maximum Volume (gal)</th>
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<th>Flowrate (gal/min)</th>
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### 200-East Area SST Volumes and Identification

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* Minimum volumes listed are those defined by the equipment class; model procedure overwrites these values based on the residual waste volume.

* The value listed is the as-designed pump rate for the equipment class. SSTs are pumped at the capacity of the retrieval system defined by the minimum retrieval duration.

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\(^a\) Minimum volumes listed are those defined by the equipment class; model procedure overwrites these values based on the residual waste volume.

\(^b\) The value listed is the as-designed pump rate for the equipment class. SSTs are pumped at the capacity of the retrieval system defined by the minimum retrieval duration.

**Basis:** Applies to SSTs present in the tank farms.

1. Minimum volumes listed are those defined by the equipment class; model procedure overwrites these values based on the residual waste volume.

2. The value listed is the design pump rate for the equipment class. SSTs are pumped at the capacity of the retrieval system defined by the minimum retrieval duration.

### 2.1.4.2 SST Waste Retrieval - SST Additions, As-Retrieved Volumes, and Minimum Retrieval Durations

#### Unique ID: BMR-SST_TR-10

For all SSTs except for those in Tank Farms C, AX, and A, the source of the SSTs' minimum retrieval durations, chemical uses, and as-retrieved volumes are from SS-1647, Rev. 0, and its parent documents, RPP-40545, Rev. 5, *Quantitative Assumptions for Single-Shell Tank Waste Retrieval Planning*, and RPP-PLAN-40145, Rev. 6.

**Basis:** RPP-40545, RPP-PLAN-40145, and associated SS-1647 provide the bases for SST retrieval durations, chemical additions, and as-retrieved volumes.

### 2.1.4.3 SST Waste Retrieval - A-/AX-Tank Farm Retrieval

#### Unique ID: BMR-SST_TR-17

For Tank Farms A and AX, the source of the SSTs' minimum retrieval durations, chemical uses, and as-retrieved volumes are from WRPS-1801547 as outlined in Table "Tank Farms A and AX Minimum Retrieval Durations, Chemical Uses, and As-Retrieved Volumes."
Tank Farms A and AX Minimum Retrieval Durations, Chemical Uses, and As-Retrieved Volumes

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**Basis:** Email from Ashley Ansolabehere to Paul Certa, 10/6/2017, "MYOP Rev3 Tracking.xlsx" provides the input for the A-/AX-Tank Farm retrievals.

### 2.1.4.4 SST Waste Retrieval - Tank C-105

**Unique ID:** BMR-SST_TR-18

The remainder of the retrieval from Tank C-105 to Tank AN-106 shall begin on 8/25/2017 and complete on 2/25/2018. Prior to retrieval, 50,000 gal of 19M NaOH shall be added and enough water to achieve an as-retrieved volume of 184,030 gal.


### 2.1.4.5 SST Waste Retrieval - Application of Wash Factors

**Unique ID:** BMR-SST_TR-11

The wash factors to be applied to the contents of the SSTs shall be per *Tank Waste Information Network System (TWINS) (SVF-1888, "Wash and Leach Factor CSV File Generator Worksheet 2010-05-05").*

**Basis:** Wash factors are zero order estimates of the fraction of each soluble component in the SSTs that will dissolve when water is added, and are used to estimate dissolution upon the addition of retrieval fluids to the SSTs. *HNF-3157* describes how the wash factors were determined from actual SST waste data. The wash and leach factors are available for TOPSim use in *SVF-1888*. 
2.1.4.6 SST Waste Retrieval - Water Additions

Unique ID: BMR-SST_TR-13

Retrieval water is added 9 days after caustic and/or oxalic acid additions to Tanks AX-101, AX-103, and AX-104, and to Tanks A-101, A-102, A-103, A-105, and A-106 per WRPS-1702462, and is calculated from the as-retrieved volume plus the residual volume less the current total volume of the SST.

Basis: Water is added to the SSTs after caustic and/or oxalic acid to mobilize the waste during retrievals to DSTs. The quantity of water needed is dependent on the selected retrieval method and composition of the waste to be retrieved. Water and chemical addition quantities are estimated in \textit{RPP-PLAN-40145 and associate spreadsheet SS-1647}.

2.1.4.7 SST Waste Retrieval - Liquid Chromium Reaction

Unique ID: BMR-SST_TR-12

Liquid guyanaite (CrOOH) is converted to chromate (CrO$_4^{2-}$)(l) according to the following reaction with a conversion of 100\% of the limiting component:

\[
2.0 \text{CrOOH(l)} + 3.0 \text{NO}_3^-(l) + 4.0 \text{OH}^-(l) \rightarrow 2.0 \text{CrO}_4^{2-}(l) + 3.0 \text{NO}_2^-(l) + 3.0 \text{H}_2\text{O(l)}.
\]

Basis: Guyanaite (CrOOH) must be converted to the liquid-soluble form after wash factors are applied and it is transferred into the liquid phase.

2.1.4.8 SST Waste Retrieval - DST Chemical Addition for Corrosion Mitigation

Unique ID: BMR-SST_TR-14

Corrosion mitigation chemicals, NaOH or NaNO$_2$, are added to the SSTs according to technical requirements, \textit{DST Supernatant Waste Chemistry Limits}.

Basis: The chemical additions for DST corrosion mitigation are added to the SSTs as they are prepared for retrieval in order to prevent corrosion in the downstream receiving DSTs per \textit{OSD-T-151-00007}.

2.1.4.9 SST Waste Retrieval - SST Residual Solids Composition

Unique ID: BMR-SST_TR-15

The composition of the residual solids in the SSTs (excluding historical retrievals) shall be the composition of the waste remaining after the retrieval preparation steps have been performed (caustic and oxalic additions, wash factor application, water addition, corrosion chemical addition, and solubility application).

Basis: This is an enabling assumption. \textit{RPP-40545} assumes that if a 100-series tank has more than 2,244 gal of sludge before retrieval, the remaining heel will be the composition of the sludge, and that if the tank has less than 2,244 gal of sludge, the residual will be sludge plus salt cake to create 2,244 gal. If the tank has no sludge, the residual is assumed to be entirely salt cake. The residual in the 200-series tanks is assumed to be all sludge.

2.1.4.10 SST Waste Retrieval - SST 100-Series Residual Volumes

Unique ID: BMR-SST_TR-2

The residual volume after retrieval is complete is 2,244 gal for 100-series SSTs.
**Basis:** The DOE-ORP in letter 09-TPD-014, "Approval of Revision of River Protection Project (RPP) System Plan, Revision 4 Key Assumptions in Support of Contract Deliverable C.2.3.1-1, RPP System Plan," provided SST retrieval planning direction to assume a residual waste volume of 300 ft$^3$ (2,244 gal) for 100-series tanks and 25 ft$^3$ (187 gal) for 200-series tanks.

### 2.1.4.11 SST Waste Retrieval - 100- and 200-Series Residual Solids Volume

**Unique ID:** BMR-SST_TR-16

If there are not enough solids to be 83wt% of the residual volume, then the total amount of solids is used, and the liquid volume is calculated so that the solids mass will still be 83wt% of the total mass.

**Basis:** This is an enabling assumption. RPP-40545 assumes that if a 100-series tank has more than 2,244 gal of sludge before retrieval, the remaining heel will be the composition of the sludge, and that if the tank has less than 2,244 gal of sludge, the residual will be sludge plus salt cake to create 2,244 gal. If the tank has no sludge, the residual waste is assumed to be entirely salt cake. The residual in the 200-series tanks is assumed to be all sludge.

### 2.1.4.12 SST Waste Retrieval - SST 200-Series Residual Volumes

**Unique ID:** BMR-SST_TR-4

The residual volume after retrieval is complete is 187 gal for 200-series SSTs.

**Basis:** The DOE-ORP in letter 09-TPD-014 provided SST retrieval planning direction to assume a residual waste volume of 300 ft$^3$ (2,244 gal) for 100-series tanks and 25 ft$^3$ (187 gal) for 200-series tanks.

### 2.1.4.13 SST Waste Retrieval - SST 100- and 200-Series Residual Compositions

**Unique ID:** BMR-SST_TR-9

The residual composition for the SSTs (except SST historical retrievals) is 83wt% solids with liquids at 5E-04 times the concentration of the bulk as-retrieved supernatant.

**Basis:** Residual wastes composed of 83wt% solids and 17wt% liquids are based on post-retrieval waste volume estimates for Tanks C-103, C-106, S-112, C-201, C-202, C-203, and C-204. The final liquid concentration is based on calculations from the 100-series SSTs, which was 5.4E-04 times the pre-rinse concentration.

### 2.1.4.14 SST Waste Retrieval - B-/BX-/BY-Tank Farms Retrieval Start Dates

**Unique ID:** BMR-SST_TR-1

Tank Farms B, BX, and BY will begin retrievals on the SST 200-East Area Retrieval Start Date.

**Basis:** This is an enabling assumption. The SST 200-East and 200-West Areas' Retrieval Start Dates are the start dates for logic-driven SST retrievals, which begins after DFLAW on the DST Limited Space Operations End Date.
2.1.4.15  **SST Retrieval Constraints - SST 200-East and 200-West Areas' Retrieval Start Dates**

**Unique ID:** BMR-SST_TR-8

The SST 200-East Area Retrieval Start Date is the date that the *Receive SST/WRF Waste - 200-East Area* become available. The SST 200-West Area Retrieval Start Date is the date that SST retrievals complete in the S- and SX-Tank Farms.

**Basis:** This is an enabling assumption. The SST 200-East and 200-West Areas' Retrieval Start Dates are TOPSim parameters used to define the start of logic-driven SST retrievals.

2.1.4.16  **SST Retrieval Constraints - Adjacent SSTs**

**Unique ID:** BMR-SST_TR-7

From RPP-17152, Rev. 12, *Hanford Tank Waste Operations Simulator (HTWOS) Version 8.1 Model Design Document*, Table "Adjacent Tanks" lists the SSTs adjacent to each other.

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**Basis:** This is an enabling assumption. The adjacent tank list is used in conjunction with the list of leaking SSTs from HNF-EP-0182 to enable the model to select non-leaking SSTs adjacent to assumed leaking SSTs for retrieval prior to retrieval of the assumed leakers, if possible. This list is only used for logic-driven SST retrievals.

### 2.1.4.17 SST Retrieval Constraints - Sound/Leaking SSTs

**Unique ID:** BMR-SST_TR-5

From HNF-EP-0182, Rev. 342, Table "Inventory and Status by Tanks - Single-Shell Tanks" lists the SST tanks with inventory and status.

### Inventory and Status by Tanks - Single-Shell Tanks

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<th>Total Waste (kgal)</th>
<th>Drainable</th>
<th>Waste Volumes&lt;sup&gt;(26)&lt;/sup&gt;</th>
<th>Solids Volume Update&lt;sup&gt;(89)&lt;/sup&gt;</th>
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**NOTE:** All volume data obtained from TWINS.
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### 12 Tanks – Total

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**16 tanks – Total**: 137.4  8  128  0

**S Farm Status**

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2-32
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### SX Farm Status

| SX-101 | Sound | 420 | 44 | 0  | 144 | 276 | 4/1/2005 |
| SX-102 | Sound | 342 | 37 | 0  | 55  | 287 | 4/1/2015 |
| SX-103 | Sound | 509 | 40 | 0  | 78  | 431 | 4/1/2005 |
| SX-104(34) | Sound | 446 | 48 | 0  | 136 | 310 | 10/1/2006 |
| SX-105 | Sound | 375 | 39 | 0  | 63  | 312 | 4/1/2005 |
| SX-106 | Sound | 399 | 37 | 0  | 0   | 399 | 4/1/2016 |
| SX-107 | Assumed leaker | 96  | 7  | 0  | 96  | 0   | 7/1/2015 |
| SX-108 | Assumed leaker | 74  | 0  | 0  | 74  | 0   | 10/1/2004 |
| SX-109 | Assumed leaker | 241 | 0  | 0  | 66  | 175 | 7/1/2015 |
| SX-110(35) | Sound | 58  | 0  | 0  | 49  | 9   | 7/1/2015 |
| SX-111 | Assumed leaker | 117 | 11 | 0  | 97  | 20  | 10/1/2015 |
| SX-112 | Assumed leaker | 77  | 6  | 0  | 77  | 0   | 10/1/2015 |
| SX-113 | Assumed leaker | 22  | 0  | 0  | 22  | 0   | 10/1/2015 |
| SX-114 | Assumed leaker | 158 | 30 | 0  | 127 | 31  | 7/1/2015 |
| SX-115 | Assumed leaker | 4   | 0  | 0  | 4   | 0   | 7/1/2015 |
| **15 tanks – Total** |     |     | 3,338 | 0  | 1,088 | 2,250 |

### T Farm Status

<p>| T-101 | Assumed leaker | WI | 94 | 16 | 2  | 37  | 55  | 6/1/2016 |
| T-102 | Sound | FLA | 32 | 3  | 13 | 19  | 0   | 4/1/2005 |</p>
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### 2.1.4.18 SST Waste Retrieval - SST Retrieval Selection

**Unique ID:** BMR-SST_TR-3

The RVIR is calculated as follows:

\[
RVIR = ((S_{ratio} \times L_{ratio}) + a)^b \times \left[ (1 - S_{ratio})^2 + (1 - L_{ratio})^2 \right]^{1/2}
\]

Where \(a, b\) are empirically derived values to shape the RVIR space to optimize the next SST selection.

- \(a = 0.03\)
- \(b = 0.5\)

Solids ratio – Indicates how the overall DST system solids will change due to the retrieval of the evaluation tank.

---

**Basis:** The list of sound and leaker/assumed leaker SSTs is obtained from HNF-EP-0182. The Table "Adjacent Tanks" (BMR-SST_TR-7) is used in conjunction with the list of leaking SSTs from HNF-EP-0182 to enable the model to select non-leaking SSTs adjacent to assumed leaking SSTs for retrieval prior to retrieval of the assumed leakers, if possible. This list is only used for logic-driven SST retrievals.
\[ S_{ratio} = \frac{(S_{in} + S_{current} - S_{out})}{S_{capacity}} \]

Liquids ratio – Indicates how the overall DST system liquids will change due to the retrieval of the evaluation tank.

\[ L_{ratio} = \frac{(L_{in} + L_{current} - L_{out})}{L_{capacity}} \]

Elements of the solids and liquids ratios are defined as follows:

- **S\text{capacity}** = The combined target operating solids volume for the HLW feed, HLW feed preparation, HLW feed staging tanks, and deep sludge tanks. \( S_{capacity} \) is calculated as the dst-solids-height-target of 69 in converted to gallons for tanks in the following planning groups: tf-hlw-feed-tanks, tf-hlw-feed-preparation-tanks, tf-hlw-feed-staging-tanks, tf-deep-sludge-tanks.

- **L\text{capacity}** = The combined target operating liquids volume for the LAW feed, LAW feed preparation, LAW feed staging, HLW feed, HLW feed preparation, HLW feed staging tanks, and deep sludge tanks. \( L_{capacity} \) is calculated as the sum of the liquid capacity for HLW and LAW tanks. For HLW tanks the liquid capacity is calculated as the maximum volume of the tank minus the solids height target converted to gal/in, i.e. \( \text{maximumVolume} - (\text{heightLimit} \times \text{gallonsPerInch}) \). The HLW tanks are those in the following planning groups: tf-hlw-feed-tanks, tf-hlw-feed-preparation-tanks, tf-hlw-feed-staging-tanks, tf-deep-sludge-tanks. For LAW tanks the liquid capacity is calculated as the maximum volume of the tank minus the slurry volume of the tank. The LAW tanks are those in the following planning groups: tf-law-feed-tanks, tf-law-feed-preparation-tanks, tf-law-feed-staging-tanks.

- **S\text{in}** = The projected increase in the solids volume based on the currently active SST retrievals and the SST being evaluated for retrieval. Solids input of the currently active SST retrievals is calculated based on the retrieval duration of the SST being evaluated.

- **L\text{in}** = The projected increase in liquid volume based on the currently active SST retrievals and the SST being evaluated for retrieval.

- **S\text{current}** = The combined solids volume of the HLW feed, HLW feed preparation, HLW feed staging, and deep sludge tanks.

- **L\text{current}** = The combined liquids volume for the LAW feed, LAW feed preparation, LAW feed staging, HLW feed, HLW feed preparation, HLW feed staging tanks, and deep sludge tanks.

- **S\text{out}** = The projected decrease in solids volume based on the prior year net rate of solids exiting the DST System. Duration for the projected output is the retrieval duration of the SST being evaluated.

- **L\text{out}** = The projected decrease in liquids volume based on the prior year net rate of liquids exiting the DST system. Duration for the projected output is the retrieval duration of the SST being evaluated.

**Basis:** This is an enabling assumption. The RVIR was created as the final criteria for selecting an SST for retrieval. Its purpose is to minimize the impact on available DST space.
2.2 WASTE RECEIVING FACILITIES

Single-shell tanks in the B Complex (B, BX and BY Tank Farms) and T Complex (T, TX, and TY Tank Farms) require additional facilities to support timely and efficient waste retrievals because of the distance of these SSTs from the nearest DST farm. Waste from these locations will be retrieved into a Waste Retrieval Facility (WRF) before being transferred to the DST system per RPP-PLAN-40145, Single-Shell Tank Waste Retrieval Plan. The tank farms' baseline currently includes the design, construction, and operation of two aboveground WRFs, one in the 200-East Area near B Complex, and one in the 200-West Area near T Complex. Other SSTs are retrieved directly into the DST system except for those handled as CH-TRU waste; waste to be designated as CH-TRU will be retrieved directly to that system (see Section 6.0). Each WRF provides the following:

- Waste receipt tanks with pumps, transfer lines to the SSTs, and other ancillary equipment to allow recycle of supernatant during waste retrieval, thereby minimizing the volume of waste generated by retrieval operations.
- Space for the temporary staging of the retrieved waste, to decouple SST retrievals from the near-term limits of DST storage space.
- Compliant transfer lines to support retrievals from the B and T Complexes (one line for each complex) before the WRFs are placed in service. U Farm retrieval will be supported by use of the T Complex-compliant transfer line and installation of a diversion box.
- Pumping capacity to transfer the retrieved waste slurries at high solids loadings over a considerable distance to the nearest DST storage tanks, without exceeding the allowable pressure ratings for transfer system components.

In the HSM, each WRF is modeled as a set of tanks that receives waste from SSTs and transfer it to DSTs. Supernatant recycling for SST retrievals is not modeled.

2.2.1 System Requirements

2.2.1.1 Receive SST Waste

**Unique ID:** BMR-WRF_SR-1

The *WRF* system shall receive waste from *SSTs* that are outside the effective transfer distance of retrieval and transfer equipment.

**Basis:** N/A.

2.2.1.2 Transfer Waste

**Unique ID:** BMR-WRF_SR-2

The *WRF* system shall mobilize and transfer received *SST* waste to the primary transfer equipment.

**Basis:** N/A
2.2.2 Functional Requirements

2.2.2.1 B-Complex WRF Receipt

Unique ID: BMR-WRF_FR-1

The B-Complex WRF shall have the capability of receiving waste from the 200-East Area SSTs that are outside the effective transfer distance of retrieval and transfer equipment.

Basis: N/A

2.2.2.2 T-Complex WRF Receipt

Unique ID: BMR-WRF_FR-4

The T-Complex WRF shall have the capability of receiving waste from the 200-West Area SSTs that are outside the effective transfer distance of retrieval and transfer equipment.

Basis: N/A

2.2.2.3 WRF Waste Mobilization

Unique ID: BMR-WRF_FR-6

Each WRF shall have the capability to mix/mobilize received slurries.

Basis: N/A

2.2.2.4 B-Complex WRF Routing

Unique ID: BMR-WRF_FR-3

The B-Complex WRF shall have the capability to route mobilized waste to available DSTs in the 200-East Area.

Basis: N/A

2.2.2.5 T-Complex WRF Routing

Unique ID: BMR-WRF_FR-5

The T-Complex WRF shall have the capability to route mobilized waste to available DSTs in the 200-West Area.

Basis: N/A

2.2.3 Model Requirements

2.2.3.1 B-Complex WRF - Tanks Identification

Unique ID: BMR-WRF_MR-1

The B-Complex WRF shall consist of six tanks identified as BA-1, BA-2, BA-3, BA-4, BA-5, and BA-6.

Basis: HNF-3511, Single-Shell Tank Retrieval Infrastructure, (82400-99-076) specifies 6 x 150,000-gal (operating capacity) tanks for Tank Farms B, BX, and BY and 6 x 150,000-gal capacity tanks for Tank Farms T, TX, and TY.
2.2.3.2 T-Complex WRF - Tanks Identification

**Unique ID:** BMR-WRF_MR-2

The *T-Complex WRF* shall consist of six tanks identified as TA-1, TA-2, TA-3, TA-4, TA-5, and TA-6.

**Basis:** *HNF-3511* (82400-99-076) specifies 6 x 150,000-gal (operating capacity) tanks for Tank Farms B, BX, and BY and 6 x 150,000-gal capacity tanks for Tank Farms T, TX, and TY.

2.2.3.3 B-Complex WRF - Tanks Trigger Receipt of Waste

**Unique ID:** BMR-WRF_MR-4

A *B-Complex WRF* tank shall receive waste from a *B-Complex SST* when a *B-Complex WRF* tank is at or below its minimum volume, or the waste in the tank is less than the *minimum transfer volume* plus the tank minimum volume.

**Basis:** This is an enabling assumption. The logic was developed for modeling purposes. There is no documented basis.

2.2.3.4 T-Complex WRF - Tanks Trigger Receipt of Waste

**Unique ID:** BMR-WRF_MR-5

A *T-Complex WRF* tank shall receive waste from a *T-Complex SST* when a *T-WRF* tank is at or below its minimum volume, or the waste in the tank is less than the *minimum transfer volume* plus the tank minimum volume.

**Basis:** This is an enabling assumption. The logic was developed for modeling purposes. There is no documented basis.

2.2.3.5 WRF - Receipt Source Constraint

**Unique ID:** BMR-WRF_MR-19

A *WRF* tank shall not receive waste from more than one *SST* at a time.

**Basis:** This is an enabling assumption. The logic was developed for modeling purposes. There is no documented basis.

2.2.3.6 WRF - Filling Complete

**Unique ID:** BMR-WRF_MR-6

A single *WRF* tank shall complete filling when one of the following constraints has been met:

- The tank has reached its set volume, or
- The full waste content of a single *SST* has been received.

**Basis:** This is an enabling assumption. The logic was developed for modeling purposes. There is no documented basis.

2.2.3.7 WRF - Solubility

**Unique ID:** BMR-WRF_MR-3

Solubility shall be applied to a *WRF* tank when it has completed filling.
Basis: This is an enabling assumption. The logic was developed for modeling purposes. There is no documented basis.

2.2.3.8  WRF - Mixing for Transfers

Unique ID: BMR-WRF_MR-9

The contents of a WRF tank shall be mixed after sampling and prior to transferring to the designated destination.

Basis: N/A

2.2.3.9  WRF - Transfer Trigger

Unique ID: BMR-WRF_MR-10

A WRF tank shall initiate the transfer of its mixed contents (down to its minimum volume, if possible) to a designated receiver when the space available in the receiver is greater than the minimum transfer volume.

Basis: This is an enabling assumption. The logic was developed for modeling purposes. There is no documented basis.

2.2.3.10  B-Complex WRF - Transfer Routing

Unique ID: BMR-WRF_MR-11

The B-Complex WRF tanks shall transfer waste to DSTs in the AN-Tank Farm.

Basis: The AN-Tank Farm is the DST farm closest to the B Complex; the 200-East Area SST/WRF Waste Receipt Tanks will receive retrievals from the B Complex.

2.2.3.11  T-Complex - WRF Transfer Routing

Unique ID: BMR-WRF_MR-12

The T-Complex WRF tanks shall transfer waste to DSTs in the SY-Tank Farm.

Basis: The only DSTs in the 200-West Area are those in the SY-Tank Farm.

2.2.3.12  WRF - Clean-Out Trigger

Unique ID: BMR-WRF_MR-13

Each WRF shall initiate being cleaned out when there is no other SST waste from its respective retrieving tank complex to be received and all received waste has been transferred out to the WRF tank minimum volume.

Basis: This is an enabling assumption. The logic was developed for modeling purposes. There is no documented basis.

2.2.3.13  WRF - Clean-Out Rinse Receipt

Unique ID: BMR-WRF_MR-14

A WRF tank shall receive a designated number of water flushes to rinse the remaining tank waste when the tank's clean-out is triggered.

Basis: This is an enabling assumption based on DST clean-out logic.
2.2.3.14  B-Complex WRF - Rinse Routing

**Unique ID:** BMR-WRF_MR-15

After receiving each individual water rinse, the *B-Complex WRF* tank contents shall be transferred, down to the *terminal volume*, to a *DST* in the AN-Tank Farm prior to receiving the next rinse.

**Basis:** This is an enabling assumption based on DST clean-out logic.

2.2.3.15  T-Complex WRF - Rinse Routing

**Unique ID:** BMR-WRF_MR-16

After receiving each individual water rinse, the *T-Complex WRF* tank contents shall be transferred, down to the *terminal volume*, to a *DST* in the SY-Tank Farm prior to receiving the next rinse.

**Basis:** This is an enabling assumption based on DST clean-out logic.

2.2.3.16  WRF - Tank Closure

**Unique ID:** BMR-WRF_MR-17

A WRF tank shall not receive waste after clean-out rinses have been completed.

**Basis:** N/A

2.2.3.17  WRF-to-DST Flush

**Unique ID:** BMR-WRF_MR-20

In DRAFT status.

**Basis:** In DRAFT status.

2.2.4  Technical Requirements

2.2.4.1  B-Complex WRF - Operational Parameters

**Unique ID:** BMR-WRF_TR-3

<table>
<thead>
<tr>
<th>WRF Tank</th>
<th>Maximum Volume (gal)</th>
<th>Minimum Volume (gal)</th>
<th>Terminal Volume (gal)</th>
<th>Pump-Out Rate (gpm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>BA-1</td>
<td>150,000</td>
<td>1,000</td>
<td>500</td>
<td>140</td>
</tr>
<tr>
<td>BA-2</td>
<td>150,000</td>
<td>1,000</td>
<td>500</td>
<td>140</td>
</tr>
<tr>
<td>BA-3</td>
<td>150,000</td>
<td>1,000</td>
<td>500</td>
<td>140</td>
</tr>
<tr>
<td>BA-4</td>
<td>150,000</td>
<td>1,000</td>
<td>500</td>
<td>140</td>
</tr>
<tr>
<td>BA-5</td>
<td>150,000</td>
<td>1,000</td>
<td>500</td>
<td>140</td>
</tr>
<tr>
<td>BA-6</td>
<td>150,000</td>
<td>1,000</td>
<td>500</td>
<td>140</td>
</tr>
</tbody>
</table>

**Basis:** *HNF-3511 (82400-99-076)* specifies 6 x 150,000-gall (operating capacity) tanks for tank farms B, BX, and BY and 6 x 150,000-gal capacity tanks for tank farms T, TX, and TY. The pump rate traces to 3.2.1.7.a of *HNF-4162, Double-Shell Tank Transfer Pump Subsystem Specification, TFC-ENG-STD-26*, “Waste Transfer Dilution and Flushing Requirements,” and
24590-WTP-ICD-MG-01-019, *ICD 19 – Interface Control Document for Waste Feed*. The minimum and terminal volumes are enabling assumptions developed for modeling purposes.

### 2.2.4.2 T-Complex WRF - Operational Parameters

**Unique ID:** BMR-WRF_TR-7

<table>
<thead>
<tr>
<th>WRF Tank</th>
<th>Maximum Volume (gal)</th>
<th>Minimum Volume (gal)</th>
<th>Terminal Volume (gal)</th>
<th>Pump-Out Rate (gpm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>TA-1</td>
<td>150,000</td>
<td>1,000</td>
<td>500</td>
<td>140</td>
</tr>
<tr>
<td>TA-2</td>
<td>150,000</td>
<td>1,000</td>
<td>500</td>
<td>140</td>
</tr>
<tr>
<td>TA-3</td>
<td>150,000</td>
<td>1,000</td>
<td>500</td>
<td>140</td>
</tr>
<tr>
<td>TA-4</td>
<td>150,000</td>
<td>1,000</td>
<td>500</td>
<td>140</td>
</tr>
<tr>
<td>TA-5</td>
<td>150,000</td>
<td>1,000</td>
<td>500</td>
<td>140</td>
</tr>
<tr>
<td>TA-6</td>
<td>150,000</td>
<td>1,000</td>
<td>500</td>
<td>140</td>
</tr>
</tbody>
</table>

**Basis:** *HNF-3511 (82400-99-076)* specifies 6 x 150,000-gall (operating capacity) tanks for tank farms B, BX, and BY and 6 x 150,000-gal capacity tanks for tank farms T, TX, and TY. The pump rate traces to 3.2.1.7.a of *HNF-4162, TFC-ENG-STD-26*, and 24590-WTP-ICD-MG-01-019. The minimum and terminal volumes are enabling assumptions developed for modeling purposes.

### 2.2.4.3 B-Complex WRF - Start

**Unique ID:** BMR-WRF_TR-2

The *B-Complex WRF* shall be available to begin operations when the first *B-Complex* retrieval begins.

**Basis:** This is an enabling assumption. The logic was developed for modeling purposes. There is no documented basis.

### 2.2.4.4 T-Complex WRF - Start

**Unique ID:** BMR-WRF_TR-1

The *T-Complex WRF* shall be available to begin operations when the first *T-Complex* retrieval begins.

**Basis:** This is an enabling assumption. The logic was developed for modeling purposes. There is no documented basis.

### 2.2.4.5 WRF - Number of Clean-Out Rinses

**Unique ID:** BMR-WRF_TR-5

After a *WRF* clean-out is triggered, each *WRF* tank shall receive three water rinses.

**Basis:** This is an enabling assumption based on DST logic.
2.2.4.6 **WRF - Rinse Volume**

**Unique ID:** BMR-WRF_TR-6

Each clean-out rinse shall consist of 10,000 gal of water.

**Basis:** This is an enabling assumption. Volume is based on the amount used in the DSTs.

2.2.4.7 **WRF - Minimum Transfer Volume**

**Unique ID:** BMR-WRF_TR-8

The minimum transfer volume from a *WRF* tank to a *DST* shall be 10,000 gal.

**Basis:** This is an enabling assumption. The minimum transfer volume is based on the amount used for the DSTs.

2.2.4.8 **WRF-to-DST Flush Volume**

**Unique ID:** BMR-WRF_TR-9

Transfers from a WRF to a DST will be followed by a 6000-gal flush.

**Basis:** N/A

2.3 **OTHER WASTE SOURCES**

Additional minor waste sources exist at the Hanford Site in active and inactive miscellaneous underground storage tanks (collectively referred to as IMUSTs), as well as newly generated wastes that are projected to be created and, subsequently, treated. New wastes are anticipated to be received into the 200-East Area DSTs from the deactivation of the PUREX plant and T Plant. Additionally, the 222-S Laboratory produces waste to be received periodically into the DST system.

Dozens of IMUSTs previously supported SST operations. This IMUST waste must be retrieved into the DST system, treated, and the IMUSTs closed under the Resource Conservation and Recovery Act of 1976 provisions, in accordance with the Hanford Federal Facility Agreement and Consent Order - Tri Party Agreement (TPA) (Ecology et al. 1989). The estimated volume of waste in the IMUSTs comprises only a small fraction of the total tank waste.

The generation of waste from the deactivation of the PUREX plant and the T Plant will be received in designated East-Area DSTs on a projected schedule. Additionally, the 222-S Laboratory produces waste from laboratory operations needed to support tank farm operations and supporting processing facilities. The volume received will be based on the amount of laboratory operations needed but is currently estimated as a fixed volume. The 222-S Laboratory is expected to remain in operation until all Hanford tank wastes are treated and immobilized. The waste from the 222-S Laboratory will either be piped to a West-Area DST or trucked to an East-Area DST.

In the HSM, this additional waste is modeled as periodic transfers of a defined volume and composition of waste to select DSTs.
2.3.1 System Requirements

2.3.1.1 Transfer Waste

**Unique ID:** BMR-OWS_SR-1

Other waste sources shall transfer waste to the DST system.

**Basis:** N/A

2.3.2 Functional Requirements

2.3.2.1 Waste Source - 222-S Laboratory

**Unique ID:** BMR-OWS.FR-1

The 222-S Laboratory shall have the capability to transfer compliant waste to both the 200-East and 200-West Area DSTs.

**Basis:** N/A

2.3.2.2 Waste Source - T Plant

**Unique ID:** BMR-OWS.FR-2

The T Plant shall have the capability to transfer compliant waste to 200-East Area DSTs.

**Basis:** N/A

2.3.2.3 Waste Source - IMUSTs

**Unique ID:** BMR-OWS.FR-3

The IMUSTs shall have the capability to deliver compliant waste to the 200-East and 200-West Area DSTs.

**Basis:** N/A

2.3.3 Model Requirements

2.3.3.1 222-S Laboratory (SPN87)

**Unique ID:** BMR-OWS_MR-16

The 222-S Laboratory waste source shall be identified as SPN87.

**Basis:** SPN87, as a developer's choice, was originally set during Hanford Tank Waste Operations Simulator (HTWOS) development, and naming convention carried over to TOPSim.

2.3.3.2 222-S Laboratory (SPN87) - Transfer Frequency

**Unique ID:** BMR-OWS_MR-1

SPN87 shall transfer waste to the DSTs four times annually (January 1, April 1, July 1, and October 1).

**Basis:** This is a simplification determined by knowledgeable personnel. The purpose of the assumption is to reflect DST space demand, not exactly simulate lab waste receipts.
2.3.3.3  222-S Laboratory (SPN87) - Transfer Destination (Prior to 200-West Area Closure)

**Unique ID:** BMR-OWS_MR-2

SPN87 shall transfer to Tank SY-101 (regardless of construction-related tank lock-outs) beginning after the completion of historical transfers and continuing until the final clean-out processes for Tank SY-101 are initiated.

**Basis:** This is a simplification determined by knowledgeable personnel. Labs are in the 200-West Area and can send waste to Tank SY-101 as long as there is available space.

2.3.3.4  222-S Laboratory (SPN87) - Transfer Destination (After Closure of 200-West Area)

**Unique ID:** BMR-OWS_MR-8

SPN87 shall transfer to the 200-East Area DSTs after the final clean-out processes for Tank SY-101 are initiated until final clean-out processes have been initiated for all 200-East Area DSTs.

**Basis:** This is a simplification determined by knowledgeable personnel. After final clean-out of the 200-West Area DSTs, the 222-S Laboratory still operates, and waste is transferred cross-site.

2.3.3.5  222-S Laboratory (SPN87) - Wait Constraint

**Unique ID:** BMR-OWS_MR-10

If space is not available in an eligible DST for the entire transfer volume and associated flush, SPN87 shall wait for space to become available before transferring without necessarily delaying subsequently scheduled transfers from SPN87.

**Basis:** This is a simplification determined by knowledgeable personnel. Laboratories cannot be shut down and do not skip waste receipts if no DST room is available.

2.3.3.6  T Plant (TAL88) - Liquid

**Unique ID:** BMR-OWS_MR-15

The T-Plant waste source which transfers liquid waste to the DST system shall be identified as TAL88.

**Basis:** The name TAL88 was initially set during development.

2.3.3.7  T Plant (TAL88) - Liquid Transfer Frequency

**Unique ID:** BMR-OWS_MR-3

TAL88 shall make a one-time transfer of waste to the DSTs after the start-up of the WTP HLW Vitrification Facility.

**Basis:** This assumption was simplified by a subject-matter expert (SME) at the time of establishment.

2.3.3.8  T Plant (TAL88) - Liquid Transfer Destination

**Unique ID:** BMR-OWS_MR-5

TAL88 shall transfer to a DST in the 200-East Area.
Basis: This is a simplification determined by knowledgeable personnel. There is no connection from T Plant to the 200-West Area DSTs.

2.3.3.9 T Plant (TAL88) - Liquid Wait Constraint

Unique ID: BMR-OWS_MR-11

If space is not available in an eligible DST for the entire transfer volume, TAL88 shall wait for space to become available before transferring.

Basis: This is a simplification determined by knowledgeable personnel based on a choice regarding priority for DST space and on previous "errors" where a receipt was skipped when no DST space was available.

2.3.3.10 T Plant (TNS88) - Slurry

Unique ID: BMR-OWS_MR-17

The T Plant waste source which transfers slurry waste to the DST system shall be identified as TNS88.

Basis: The name TNS88 was initially set during development.

2.3.3.11 T Plant (TNS88) - Slurry Transfer Frequency

Unique ID: BMR-OWS_MR-4

TNS88 shall make a one-time transfer of waste to the DSTs after the start-up of the WTP HLW Vitrification Facility.

Basis: This assumption was simplified by an SME at the time of establishment.

2.3.3.12 T Plant (TNS88) - Slurry Transfer Destination

Unique ID: BMR-OWS_MR-6

TNS88 shall transfer to a DST in the 200-East Area designated for receiving solids.

Basis: The transfer is based on the nature of the waste.

2.3.3.13 T Plant (TNS88) - Slurry Wait Constraint

Unique ID: BMR-OWS_MR-12

If every otherwise eligible DST either does not have space for the entire transfer or the transfer would put that DST over its solids limit, TNS88 shall wait for space to become available before transferring.

Basis: This assumption was simplified by knowledgeable personnel. Transfers will only be performed to tanks with available space to do so in full-volume.

2.3.3.14 IMUSTs (WNE88)

Unique ID: BMR-OWS_MR-18

The IMUSTs waste source shall be identified as WNE88.

Basis: The name WNE88 was initially set during development.
2.3.3.15  **IMUSTs (WNE88) - Transfer Frequency**

**Unique ID:** BMR-OWS_MR-7

WNE88 shall transfer waste to the DSTs in 10 scheduled biennial transfers beginning after the start-up of the WTP HLW Vitrification Facility.

**Basis:** Originally, this assumption was established and simplified by an SME.

2.3.3.16  **IMUSTs (WNE88) - Transfer Destination**

**Unique ID:** BMR-OWS_MR-9

WNE88 shall transfer to a DST in the 200-East Area that is designated for receiving solids provided that the DST was not the last DST to receive waste from WNE88.

**Basis:** It was a general choice to spread WNE88 over several DSTs. This assumption was simplified by knowledgeable personnel.

2.3.3.17  **IMUSTs (WNE88) - Wait Constraint**

**Unique ID:** BMR-OWS_MR-13

If every otherwise eligible DST either does not have space for the entire transfer or the transfer would put that DST over its solids limit, WNE88 shall wait for space to become available before transferring without necessarily delaying subsequently scheduled transfers from WNE88.

**Basis:** Transfers can only be made when not exceeding the solid limits of the receiving tanks. Originally, this assumption was established and simplified by an SME.

2.3.3.18  **IMUSTs (WNE88) - Maximum Transfer Frequency**

**Unique ID:** BMR-OWS_MR-14

No two transfers from WNE88 shall be delivered within a year of each other regardless of DST space/solids space availability or scheduled delivery date.

**Basis:** This is a simplification determined by knowledgeable personnel in order to mimic the retrieval of multiple IMUSTs.

2.3.4  **Technical Requirements**

2.3.4.1  **222-S Laboratory (SPN87) - Early Mission Transfer Volume**

**Unique ID:** BMR-OWS_TR-1

Each transfer from SPN87 shall be 1,900 gal of liquid prior to the start-up of the WTP HLW Vitrification Facility.

**Basis:** This is a simplification determined by knowledgeable personnel based on the analytical load of the laboratory.

2.3.4.2  **222-S Laboratory (SPN87) - Balance of Mission Transfer Volume**

**Unique ID:** BMR-OWS_TR-5

Annual transfers from SPN87 shall be 10,000 gal of liquid after the startup of the WTP HLW Vitrification Facility.
**Basis:** This is a simplification determined by knowledgeable personnel based on the analytical load of the laboratory when the WTP is operating.

2.3.4.3 **T-Plant (TNS88) - Slurry Transfer Volume**

Unique ID: BMR-OWS_TR-3

The transfer from TNS88 shall have a volume of 700 gal of slurry.

**Basis:** This is a simplification determined by knowledgeable personnel (the transfer volume was set by the original SME).

2.3.4.4 **T-Plant (TAL88) - Liquid Transfer Volume**

Unique ID: BMR-OWS_TR-2

The transfer from TAL88 shall have a volume of 14,300 gal of liquid.

**Basis:** This is a simplification determined by knowledgeable personnel (the transfer volume was set by the original SME).

2.3.4.5 **IMUSTs (WNE88) - Transfer Volume**

Unique ID: BMR-OWS_TR-4

Each of the 10 transfers from WNE88 shall have a volume of 55,000 gal of slurry.

**Basis:** This is a simplification determined by knowledgeable personnel (the transfer volume was set by the original SME), and is a simplifying assumption made in the absence of details regarding IMUST retrievals.

2.4 **SUPPLEMENTAL CONTACT-HANDLED TRANSURANIC WASTE TREATMENT**

The CH-TRU waste treatment and packaging process uses a modular approach that features mobile, skid-mounted process equipment. A single modular system, designed for relocation, has the advantage of cost-effectively handling and producing a CH-TRU waste product that meets waste acceptance criteria. The SSTs containing potential CH-TRU sludge are Tanks B-201, B-202, B-203, B-204, T-201, T-202, T-203, T-204, T-111, T-110, and T-104.

The projected waste volumes generated during the retrieval of the potential CH-TRU waste are based on the retrieval technology selected for each SST. Retrieval of waste does not affect the available DST space, as no liquids are returned to the DST system. The CH-TRU waste dewatering system removes water from the sludge. The dried product is packaged in drums for storage and disposal. The packaged potential CH-TRU waste is stored at the Central Waste Complex at Hanford pending a determination of final disposition.

Water removed from the waste is filtered and then discharged to LERF/ETF. Offgas from the modular CH-TRU waste processing unit is filtered and discharged to the atmosphere.

The CH-TRU packaging process described above is modeled in the HSM, and estimates of the secondary liquid waste generated and the quantity of packaged CH-TRU drums are estimated as well.
### 2.4.1 System Requirements

#### 2.4.1.1 CH-TRU - Dry Waste

**Unique ID:** BMR-CHTRU_SR-1

The *CH-TRU waste treatment system* shall receive and dry potential *CH-TRU* waste, package it into an acceptable final waste form, and transfer it to the *WIPP*.

**Basis:** If it is determined that the packaged potential *CH-TRU* tank waste is to be disposed at *WIPP*, permitting and operational requirements to accept Hanford potential *CH-TRU* tank waste at *WIPP* will not impact the schedule's critical path.

### 2.4.2 Functional Requirements

#### 2.4.2.1 CH-TRU - Waste Receipt

**Unique ID:** BMR-CHTRU_FR-1

The *CH-TRU waste treatment system* shall have the capability to receive potential *CH-TRU* waste from the *SST* system.

**Basis:** N/A

#### 2.4.2.2 CH-TRU - Waste Concentration

**Unique ID:** BMR-CHTRU_FR-2

The *CH-TRU waste treatment system* shall have the capability to concentrate the *CH-TRU* waste to a specific waste loading.

**Basis:** N/A

#### 2.4.2.3 CH-TRU - Filler Addition

**Unique ID:** BMR-CHTRU_FR-7

The *CH-TRU waste treatment system* shall have the capability to add and blend filler (flowability agent upon start-up and scouring agent throughout the process) with the waste during concentration.

**Basis:** N/A

#### 2.4.2.4 CH-TRU - Product Packaging

**Unique ID:** BMR-CHTRU_FR-3

The *CH-TRU waste treatment system* shall have the capability to transfer the dry product generated from concentration into *WIPP*-compliant containers.

**Basis:** N/A

#### 2.4.2.5 CH-TRU - Offgas Generation

**Unique ID:** BMR-CHTRU_FR-4

The *CH-TRU waste treatment system* shall have the capability of condensing vapors contained in the offgas into *liquid effluent*. 

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Basis: N/A

2.4.2.6 CH-TRU - Liquid Effluent Routing

Unique ID: BMR-CHTRU_FR-5
The CH-TRU waste treatment system shall have the capability to route condensed liquid effluent to LERF.

Basis: N/A

2.4.2.7 CH-TRU - Gaseous Effluent Routing

Unique ID: BMR-CHTRU_FR-6
The CH-TRU waste treatment system shall have the capability to route non-condensable gaseous effluent for offgas treatment and atmospheric release.

Basis: N/A

2.4.3 Model Requirements

2.4.3.1 CH-TRU Receipt Vessels - Identification

Unique ID: BMR-CHTRU_MR-1
The CH-TRU receipt vessels shall consist of five vessels identified as SUP-TRU-FEED1, SUP-TRU-FEED2, SUP-TRU-FEED3, SUP-TRU-FEED4, and SUP-TRU-FEED5.

Basis: There are a total of five feed receipt process system (FRP) tanks that make up CH-TRU receipt vessels.

2.4.3.2 CH-TRU Dryer - Identification

Unique ID: BMR-CHTRU_MR-2
The CH-TRU dryer shall consist of one dryer identified as SUP-TRU-DRYER with a capacity of two identical dryers.

Basis: Each dryer is sized to handle the same volume of waste (7,200 gal). Modeling as 1 dryer with equivalent treatment capacity was used to reduce modeling time.

2.4.3.3 CH-TRU Demister - Identification

Unique ID: BMR-CHTRU_MR-3
The CH-TRU demister shall be identified as SUP-TRU-DRYER-CONDENSER.

Basis: Two DMS condensers are assigned as CH-TRU demister.

2.4.3.4 CH-TRU Stack - Identification

Unique ID: BMR-CHTRU_MR-4
The CH-TRU stack shall be identified as SUP-TRU-STACK.

Basis: A single stack for CH-TRU is available.
2.4.3.5 CH-TRU Receipt Vessels - Trigger Waste Receipt

**Unique ID:** BMR-CHTRU_MR-5

The *CH-TRU receipt vessels* shall receive waste from potential *CH-TRU*-containing SSTs when one or more of the *CH-TRU receipt vessels* are at or below the set volume and the chosen vessel is not currently filling or emptying.

**Basis:** This was determined by past modeler and SME decisions on how to operate the feed receipt tanks consistent with other CH-TRU requirements and with the modeling of other receipt tanks within TOPSim.

2.4.3.6 CH-TRU Receipt Vessels - Filling

**Unique ID:** BMR-CHTRU_MR-8

The *CH-TRU receipt vessels* shall receive CH-TRU waste sequentially (i.e., only one *CH-TRU receipt vessel* is filled at a time) from one SST at a time, in the specified retrieval order.

**Basis:** A single SST retrieval at a time is designated to receipt vessels. The retrieval process is followed based on the preset retrieval segment.

2.4.3.7 CH-TRU Receipt Vessels - Continued Filling

**Unique ID:** BMR-CHTRU_MR-9

When a *CH-TRU receipt vessel* has received the final contents of an SST but the vessel is not yet at its set volume, the *CH-TRU receipt vessel* shall receive from the next SST to be retrieved (within the same tank farm) unless all CH-TRU waste has been retrieved in the given tank farm.

**Basis:** This requirement is derived from other requirements, such as the processing of all the waste from one SST before processing the waste from the next SST.

2.4.3.8 CH-TRU Receipt Vessels - Complete Filling

**Unique ID:** BMR-CHTRU_MR-6

A single *CH-TRU receipt vessel* shall complete filling when it has reached its set volume, when the last of the *CH-TRU* waste in the first treatment area has been retrieved, or when the last of all the *CH-TRU* waste has been retrieved.

**Basis:** This was determined by past modeler and SME decisions on how to operate the feed receipt tanks consistent with other CH-TRU requirements and with the modeling of other receipt tanks within TOPSim.

2.4.3.9 CH-TRU Receipt Vessels - Discharge

**Unique ID:** BMR-CHTRU_MR-7

When a *CH-TRU receipt vessel* has completed filling, it shall transfer to the *CH-TRU dryer* at the maximum flow rate down to the minimum volume of the vessel.

**Basis:** This was determined by past modeler and SME decisions on how to operate the feed receipt tanks consistent with other CH-TRU requirements and with the modeling of other receipt tanks within TOPSim.
2.4.3.10  CH-TRU Receipt Vessels - Discharge Order

Unique ID: BMR-CHTRU_MR-10

The CH-TRU receipt vessels shall transfer, one vessel at a time, to the CH-TRU dryer in the order in which they are filled.

Basis: This was determined by past modeler and SME decisions on how to operate the feed receipt tanks consistent with other CH-TRU requirements and with the modeling of other receipt tanks within TOPSim.

2.4.3.11  CH-TRU Dryer - Waste Receipt

Unique ID: BMR-CHTRU_MR-11

The CH-TRU dryer shall receive waste on a continual basis from the CH-TRU receipt vessels when there is feed available to be transferred.

Basis: It is assumed that the dryer continues to receive from receipt vessels as long as dryer space is available to do so.

2.4.3.12  CH-TRU Dryer - Apply Splits

Unique ID: BMR-CHTRU_MR-13

The amount of contaminants carried into the vapor stream from the CH-TRU dryer shall be calculated and applied, based on partition coefficients, when feed is transferred to the dryer.

Basis: RPP-21970 specifies release factors to predict the amount of species entrained in the offgas of vessels other than the dryer.

2.4.3.13  CH-TRU Dryer - Concentrate Waste

Unique ID: BMR-CHTRU_MR-14

Waste shall be concentrated in the CH-TRU dryer through water removal when feed is transferred to the dryer.

Basis: This is derived from the CH-TRU process description and process flow diagram.

2.4.3.14  CH-TRU Dryer - Vapor Routing

Unique ID: BMR-CHTRU_MR-15

The vapor stream generated and the water removed from the CH-TRU dryer shall be transferred to the CH-TRU demister during drying operations.

Basis: This is derived from the CH-TRU process description and process flow diagram.

2.4.3.15  CH-TRU Dryer - Product Routing

Unique ID: BMR-CHTRU_MR-16

The concentrated product generated from the CH-TRU dryer shall be transferred to the CH-TRU product accumulator after concentration.

Basis: This is derived from the CH-TRU process description and process flow diagram.
2.4.3.16 CH-TRU Demister - Add Air

Unique ID: BMR-CHTRU_MR-21

Air shall be added to the CH-TRU demister when vapor is received.

Basis: This is derived from the CH-TRU process description and process flow diagram.

2.4.3.17 CH-TRU Demister - Apply Splits

Unique ID: BMR-CHTRU_MR-17

Partition coefficients shall be calculated and applied to the vapor stream upon entering the CH-TRU demister.

Basis: This statement is derived from stream 15 of RPP-21970, Rev.1, that partitioning from the waste to the offgas will be modeled after the 242-A Evaporator.

2.4.3.18 CH-TRU Demister - Condense Vapor

Unique ID: BMR-CHTRU_MR-18

The CH-TRU demister shall condense the condensable vapor after partition coefficients are applied.

Basis: This is derived from the CH-TRU process description and process flow diagram.

2.4.3.19 CH-TRU Demister - Condensate Routing

Unique ID: BMR-CHTRU_MR-19

The condensate generated in the CH-TRU demister shall be transferred to the LERF basins when the CH-TRU demister reaches its maximum volume.

Basis: This is derived from the CH-TRU process description and process flow diagram, and includes a simplifying assumption that the DWS Liquid Effluent Tanks and the LES Storage do not need to be modeled.

2.4.3.20 CH-TRU Demister - Gaseous Effluent Routing

Unique ID: BMR-CHTRU_MR-20

The gaseous effluent (liquids and solids from the splits application and constituents already in the gas phase) and air shall be transferred to the CH-TRU stack at the saturation conditions of the demister outlet which is calculated using the Mole Fraction of Water at Saturation calculation (BMR-WASTE_TR-343) at the demister outlet conditions.

Basis: Routing to the stack is derived from the CH-TRU process description and process flow diagram in RPP-21970, Rev.1. Condenser exit conditions can be found for stream 17 in the process flow diagram.

2.4.3.21 CH-TRU Receipt Vessels - Cleanout

Unique ID: BMR-CHTRU_MR-23

When the last of the CH-TRU waste from the SSTs has been received into the CH-TRU receipt vessels, all the CH-TRU receipt vessels will transfer remaining waste to the CH-TRU dryer (in the order they received) until all have been emptied to the vessel's minimum volume.
Basis: This is derived from other requirements, such as the processing of all the waste from one SST before processing the waste from the next SST.

2.4.3.22 CH-TRU Dryer and Demister - Cleanout

Unique ID: BMR-CHTRU_MR-24

When the last of the CH-TRU waste has been processed through the CH-TRU dryer and CH-TRU demister, the CH-TRU demister shall transfer any remaining accumulated liquid effluent to the LERF basins down to the vessel minimum volume.

Basis: This was determined by past modeler and SME decisions on how to operate the condensers consistent with other CH-TRU requirements and with the modeling of other condensers within TOPSim.

2.4.3.23 CH-TRU Product - Tracking

Unique ID: BMR-CHTRU_MR-25

The volume and composition of the product accumulated in the CH-TRU product accumulator shall be tracked in order to calculate and determine the number of WIPP-approved containers.

Basis: This requirement is based on the internal volume of a 55-gal WIPP standard drum and bulk density of the waste of 1.60 kg/L; and, a maximum fill volume limit of 85% is given.

2.4.3.24 CH-TRU Retrieval - Constraint

Unique ID: BMR-CHTRU_MR-26

After a CH-TRU receipt vessel has received all the waste from one SST, a delay shall be implemented before starting the next SST retrieval to simulate the time needed for retrieval equipment relocation and setup.

Basis: This requirement is derived from the CH-TRU process description and process flow diagram.

2.4.3.25 Relocation of CH-TRU System

Unique ID: BMR-CHTRU_MR-27

After processing all CH-TRU in the B Complex, a delay shall be implemented before processing the CH-TRU in T Complex to simulate the time needed for equipment relocation.

Basis: Delays between retrievals are preset to ensure proper equipment relocation and preparation are in place for the next retrieval.

2.4.4 Technical Requirements

2.4.4.1 CH-TRU Receipt Vessels - Parameters

Unique ID: BMR-CHTRU_TR-6

The CH-TRU receipt vessels shall each have the following parameters.

<table>
<thead>
<tr>
<th>Vessel #</th>
<th>Overflow Volume (gal)</th>
<th>Maximum Volume (gal)</th>
<th>Set Volume (gal)</th>
<th>Minimum Volume (gal)</th>
<th>Maximum Flow</th>
<th>Temperature (°C)</th>
</tr>
</thead>
</table>

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Basis: Based on an engineering decision by an SME, parameters were defined for a set volume of 90% of 8,000-gal maximum volume and minimum volume of 100 gal.

### 2.4.4.2 CH-TRU Dryer - Parameters

**Unique ID:** BMR-CHTRU_TR-7

The *CH-TRU dryer* shall have the following parameters.

<table>
<thead>
<tr>
<th>Vessel #</th>
<th>Overflow Volume (gal)</th>
<th>Maximum Volume (gal)</th>
<th>Set Volume (gal)</th>
<th>Minimum Volume (gal)</th>
<th>Maximum Flow Rate (gpm)</th>
<th>Temperature (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SUP-TRU-DRYER</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>5.58</td>
<td>N/A</td>
</tr>
</tbody>
</table>

Basis: *RPP-21970, Rev. 1,* states daily volume of slurry processed is 8,040 gal (8,040 gal/day is equivalent to 5.58 gpm.

### 2.4.4.3 CH-TRU Demister - Parameters

**Unique ID:** BMR-CHTRU_TR-8

The *CH-TRU demister* shall have the following parameters.

<table>
<thead>
<tr>
<th>Vessel #</th>
<th>Overflow Volume (gal)</th>
<th>Maximum Volume (gal)</th>
<th>Set Volume (gal)</th>
<th>Minimum Volume (gal)</th>
<th>Maximum Flow Rate (gpm)</th>
<th>Temperature (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SUP-TRU-CONDENSER</td>
<td>Not Modeled</td>
<td>7,000</td>
<td>3,000</td>
<td>50</td>
<td>100</td>
<td>48.889</td>
</tr>
</tbody>
</table>

Basis: Set volume and minimum volume were defined based on engineering decisions by an SME.

### 2.4.4.4 CH-TRU Processing - Start Date

**Unique ID:** BMR-CHTRU_TR-1

The *CH-TRU* processing system shall be available to begin receiving and treating waste on 1/1/2031.

Basis: The date is typically given by a customer for a scenario, or by ORP for the baseline.

### 2.4.4.5 CH-TRU Product - Specifications

**Unique ID:** BMR-CHTRU_TR-2

Filler shall be added to, and water removed from, the CH-TRU dryer such that the product withdrawn maintains a product with 10 wt% water (liquid phase), 10 wt% carrier (scouring
agent, solid phase), and 80 wt% waste loading (solid phase), all relative to the total of waste, water, and carrier.

**Basis:** Section 5.0 of *RPP-21970, Rev.1*, states that 10 wt% scouring agent, 10 wt% water, and 80 wt% waste solid.

### 2.4.4.6 CH-TRU Dryer - Scouring Agent Composition

**Unique ID:** BMR-CHTRU_TR-3

The scouring agent added to the *CH-TRU dryer* shall be composed of sand (SiO₂).

**Basis:** Sand is used as an additive during steady-state operation to provide a scouring action to reduce buildup on heating surfaces in the dryer.

### 2.4.4.7 CH-TRU Dryer - Split Factors

**Unique ID:** BMR-CHTRU_TR-11

The split factors from the tab "SUP-TRU-DRYER" in *SVF-1778, Rev. 8*, shall be applied to the *CH-TRU dryer*.

**Basis:** Split factors are to be taken and used from *SVF-1778, Rev. 8*.

### 2.4.4.8 CH-TRU Demister - Split Factors

**Unique ID:** BMR-CHTRU_TR-10

The split factors from the tab "SUPP-TRU-DRYER-CONDENSER" in *SVF-1778, Rev. 8*, shall be applied to the *CH-TRU demister*.

**Basis:** Split factors are to be taken and used from *SVF-1778, Rev. 8*.

### 2.4.4.9 CH-TRU Demister - Air Addition Rate

**Unique ID:** BMR-CHTRU_TR-4

Air, at 77°F and 14.7 psi, shall be added to the *CH-TRU demister* at a constant rate of 1,300 ft³/min when the evaporator is operating.

**Basis:** Table 9-3 from *RPP-21970, Rev.1*, states the volumetric flow rate to be 1,300 ft³/min.

### 2.4.4.10 CH-TRU Demister - Outlet Conditions

**Unique ID:** BMR-CHTRU_TR-5

The outlet conditions for the gaseous stream leaving the *CH-TRU demister* shall be at 120°F and 0.987 atm.

**Basis:** Stream 17 from *RPP-21970, Rev.1*, states a flow of 300 cfm, a pressure of 9, and a temperature less than 100°F.

### 2.4.4.11 Relocation of CH-TRU System Equipment

**Unique ID:** BMR-CHTRU_TR-12

The delay to relocate equipment from *B Complex* to *T Complex* shall be 180 days.

**Basis:** The 180-day delay was communicated as a planning assumption.
2.4.4.12 CH-TRU Product - Containers
Unique ID: BMR-CHTRU_TR-13
The WIPP-approved containers shall be 55-gal drums, capable of being filled to 85% of the maximum capacity (i.e., 46.75-gal fill volume).
Basis: Section 5.0 of RPP-21970, Rev.1, states the maximum fill volume of 55-gal drums to be 85%.

2.4.4.13 CH-TRU Product - Solids Density
Unique ID: BMR-CHTRU_TR-14
The product density of the potential CH-TRU shall be 1.48 kg/L.
Basis: Using densities of the dry solids in the waste (3.0 kg/L), scouring agent (2.65 kg/L), and water (1 kg/L), density of the dry solids waste is calculated to be 1.48 kg/L (1/density = sum of wt% / density for all components).

2.4.4.14 CH-TRU - Time Between Retrievals
Unique ID: BMR-CHTRU_TR-15
The time between the completion of one SST retrieval to the start of the next SST retrieval for potential CH-TRU processing shall be 10 days.
Basis: The 10-day delay between tanks within a complex was communicated as a planning assumption.

2.4.4.15 CH-TRU Retrieval - Order
Unique ID: BMR-CHTRU_TR-16
The SSTs containing potential CH-TRU are identified as, and shall be retrieved in the following order: B-201, B-202, B-203, B-204, T-201, T-202, T-203, T-204, T-110, T-111, T-104.
Basis: Section 5.0 of RPP-21970, Rev.1, states the SST retrieval order of B-201, B-202, B-203, B-204, T-201, T-202, T-203, T-204, T-110, T-111, T-104.
2.4.5 Figures and Diagrams

2.4.5.1 CH-TRU Functional Requirements Diagram

Unique ID: BMR-CHTRU_FIG-1
2.4.5.2 CH-TRU Model Requirements Diagram

Unique ID: BMR-CHTRU_FIG-2

2.5 DOUBLE-SHELL TANKS

The DST system sends, receives, stores, and manages the Hanford tank waste. DSTs differ from SSTs primarily by the secondary containment liner. There are 28 DSTs (27 currently in service) on the Hanford Site—three in the 200 West Area and 25 in the 200 East Area. All were constructed between 1968 and 1986. The DSTs contain nearly all of the supernatant (liquid waste) and significant amounts of waste salts and sludges. The DSTs currently play an integral role in completing the RPP mission, including:

- Storing tank waste in accordance with RCRA,
- Supporting SST retrievals by receiving the retrieved SST waste,
• Supporting 242-A Evaporator operation,
• Staging waste for DFLAW and receiving DFLAW secondary waste,
• Staging feed for delivery to the WTP and receiving secondary waste from the WTP.

Effective and efficient management of the storage space available in the remaining 27 DSTs is essential to the success of the RPP mission. The total operating capacity of the 27 in-service DSTs is 31,176,500 gal. Not all of the DST space is available for waste storage. Some headspace (i.e., the space above the waste surface in the tank) must be set aside to accommodate certain operating constraints such as maintaining emergency space, staging feed to the WTP, and flammable gas hazard mitigation.

Most DSTs are currently equipped with transfer pumps. Transfer pumps are used to pump waste from DSTs to other DSTs, the 242-A Evaporator, the WTP, and elsewhere. Variable inlet height transfer pumps provide the capability to decant supernatant from above a layer of settled solids. In the future, Mixer pumps will be installed provide motive force to mobilize DST solids. Mixer pumps are used to mobilize sludge for transfer, improve solids blending, enhance dissolution of settled salts, and homogenize staged feed before sampling and delivery.

Once all SSTs have been retrieved and all retrievable waste from the DSTs delivered for treatment, the DSTs will be closed. Under current TPA Milestone M-045-00A, DOE is to complete the closure of all DST tank farms on a “to be determined” basis established as 5 years after retrieval under M-062-45 but no later than 9/30/2052. Closure will be conducted in accordance with applicable regulatory requirements.

The model includes all 28 DSTs and their transfer equipment (transfer pumps and mixer pumps). Each DST is equipped with the transfer equipment it is planned to eventually have installed at model initialization, and the first time each piece of equipment is used in the model is the projected need date.

In the model, the DST system uses logic-driven transfers to perform the functions of receiving SST waste, feed and receiving bottoms from the 242-A Evaporator, feeding the WTP (as well as TSCR and LAWPS), and mitigating certain wastes including: dissolving saltcake (Group A and others), precipitating strontium and TRU elements from complexed concentrate, and blending high fissile uranium and high zirconium sludges. The first several years of DST operation are aligned with current Multi-Year Operation Plan (MYOP) in lieu of logic-driven transfers.

### 2.5.1 System Requirements

**2.5.1.1 Store Waste**

**Unique ID:** BMR-DST_SR-4

The DST system shall store waste.

**Basis:** N/A

**2.5.1.2 Receive Waste**

**Unique ID:** BMR-DST_SR-1

The DST system shall receive waste from other systems in the RPP Mission Flowsheet.

**Basis:** N/A
2.5.1.3 Send Waste
Unique ID: BMR-DST_SR-2
The DST system shall transfer waste to other systems in the RPP Mission Flowsheet.
Basis: N/A

2.5.1.4 Manage Waste
Unique ID: BMR-DST_SR-3
The DST system shall internally transfer, mix, and adjust the chemistry of waste as needed to meet the goals of the RPP Mission.
Basis: N/A

2.5.2 Functional Requirements

2.5.2.1 Integrate Field Operations
Unique ID: BMR-DST_FR-15
The DST system shall have the capability to reflect historical and planned near-term operations.
Basis: N/A

2.5.2.2 Store Waste - East Area
Unique ID: BMR-DST_FR-6
The DST system shall have the capability to store and manage waste within the East Area DSTs.
Basis: N/A

2.5.2.3 Store Waste - West Area
Unique ID: BMR-DST_FR-20
The DST system shall have the capability to store and manage waste within the West Area DSTs.
Basis: N/A

2.5.2.4 Feed 242-A Evaporator
Unique ID: BMR-DST_FR-9
The DST system shall have the capability to transfer dilute waste to and otherwise support the 242-A Evaporator system.
Basis: N/A

2.5.2.5 Receive Other Waste Sources Waste
Unique ID: BMR-DST_FR-18
The DST system shall have the capability to receive waste from the Other Waste Sources system.
Basis: N/A
2.5.2.6 Receive SST/WRF Waste - 200-East Area

Unique ID: BMR-DST_FR-1

The _DST system_ shall have the capability to receive waste from the _SST system_ and _WRF system_ into _200-East Area DSTs_.

Basis: N/A

2.5.2.7 Receive Cross-Site Waste Slurry

Unique ID: BMR-DST_FR-26

The _DST system_ shall have the capability to receive waste slurry from _West Area DSTs_ into _East Area DSTs_.

Basis: N/A

2.5.2.8 Receive SST/WRF Waste - West Area

Unique ID: BMR-DST_FR-5

The _DST system_ shall have the capability to receive waste from the _SST system_ and _WRF system_ into _West Area DSTs_.

Basis: N/A

2.5.2.9 Prepare TSCR/LAWPS Feed

Unique ID: BMR-DST_FR-19

The _DST system_ shall have the capability to prepare feed for the _TSCR_ and _LAWPS_ systems.

Basis: N/A

2.5.2.10 Feed TSCR/LAWPS

Unique ID: BMR-DST_FR-3

The _DST system_ shall have the capability to prepare feed for the _TSCR_ and _LAWPS_ systems.

Basis: N/A

2.5.2.11 Store TSCR/LAWPS Pretreated LAW Feed

Unique ID: BMR-DST_FR-30

The _DST system_ shall have the capability to store pretreated _LAW_ feed (_LAW_) from the _TSCR_ and _LAWPS_ systems on an interim basis and transfer that feed to the _LAW Vitrification_ system.

Basis: N/A

2.5.2.12 Receive TSCR/LAWPS Returns

Unique ID: BMR-DST_FR-4

The _DST system_ shall have the capability to receive plant wash returns from the _TSCR_ and _LAWPS_ systems.

Basis: N/A
2.5.2.13 Receive WTP Returns
Unique ID: BMR-DST_FR-10
The DST system shall have the capability to receive waste returns from the WTP facilities.
Basis: N/A

2.5.2.14 Prepare LAW Feed
Unique ID: BMR-DST_FR-7
The DST system shall have the capability to prepare and transfer LAW feed to the FRP system.
Basis: N/A

2.5.2.15 Dissolve Saltcake
Unique ID: BMR-DST_FR-16
The DST system shall have the capability to manage saltcake levels in accordance with existing and proposed future operational controls.
Basis: N/A

2.5.2.16 Store Group A Waste
Unique ID: BMR-DST_FR-23
The DST system shall have the capability to store and manage Group A waste separate from other wastes.
Basis: N/A

2.5.2.17 Mitigate Group A Waste
Unique ID: BMR-DST_FR-27
The DST system shall have the capability to mitigate DSTs containing Group A waste, removing the hazard posed by BDGReS.
Basis: N/A

2.5.2.18 Store Complexed Concentrate Waste
Unique ID: BMR-DST_FR-25
The DST system shall have the capability to store and manage complexed concentrate separate from other wastes.
Basis: N/A

2.5.2.19 Precipitate Complexed Strontium and TRU Elements
Unique ID: BMR-DST_FR-11
The DST system shall have the capability to precipitate strontium and transuranic isotopes from complexed concentrate in order to meet WTP WAC.
Basis: N/A
2.5.2.20 Prepare HLW Feed  
**Unique ID:** BMR-DST_FR-8  
The *DST system* shall have the capability to prepare and transfer *HLW* feed to the *TWCS system.*  
**Basis:** N/A

2.5.2.21 Store High Cesium Waste  
**Unique ID:** BMR-DST_FR-22  
The *DST system* shall have the capability to store and manage high cesium waste separate from other wastes.  
**Basis:** N/A

2.5.2.22 Blend High Fissile Uranium Sludge  
**Unique ID:** BMR-DST_FR-17  
The *DST system* shall have the capability to blend high fissile uranium sludge in order to meet *WTP WAC.*  
**Basis:** N/A

2.5.2.23 Blend High Zirconium Sludge  
**Unique ID:** BMR-DST_FR-21  
The *DST system* shall have the capability to blend high zirconium sludge in order to optimize waste feed delivery.  
**Basis:** N/A

2.5.2.24 Clean Out DSTs  
**Unique ID:** BMR-DST_FR-24  
The *DST system* shall have the capability to clean out *DSTs* once they are no longer operationally necessary.  
**Basis:** N/A

2.5.2.25 Close DSTs  
**Unique ID:** BMR-DST_FR-13  
The *DST system* shall have the capability to close *DSTs* once they are cleaned out to the limits of technology.  
**Basis:** N/A

2.5.2.26 DST Transfers  
**Unique ID:** BMR-DST_FR-2  
The *DST system* shall have the capability of transferring waste to and from *DSTs.*  
**Basis:** N/A
2.5.2.27 DST Physical Configuration
Unique ID: BMR-DST_FR-12
The DST system shall have the capability to have a physical configuration which constrains its operation.
Basis: N/A

2.5.2.28 DST Solids Settling
Unique ID: BMR-DST_FR-28
The DST system shall have the capability to settle waste solids into distinct layers within the DSTs.
Basis: N/A

2.5.2.29 DST Evaporation
Unique ID: BMR-DST_FR-31
The DST system shall have the capability to evaporate water from the waste in the DSTs.
Basis: N/A

2.5.2.30 DST Emergency Space
Unique ID: BMR-DST_FR-14
The DST system shall have the capability to be constrained to maintain a fixed amount of available space for emergency use.
Basis: N/A

2.6 242-A EVAPORATOR

The primary mission of the 242-A Evaporator is to support DST system waste storage by reducing dilute waste volume. The 242-A Evaporator operates on a campaign basis, using the time between campaigns to perform maintenance and implement facility upgrades as necessary. The 242-A Evaporator resumed operations in September 2014 after facility upgrades and preventative maintenance and has been operating as-needed since.

The 242-A Evaporator began operating in 1977, and since then, the evaporator has removed more than 80 Mgal of water from Hanford waste—maximizing DST space availability. Space within the existing DSTs is limited; therefore, the 242-A Evaporator is critical to meeting TPA milestones and continuing the cleanup mission. By boiling off liquids in the waste feed sent to the evaporator, space is created in the DST system. This additional space enables SST waste retrievals to continue in the near-term and waste treatment returns from initial plant operations in the future, including direct-feed operations to the WTP vitrification facilities. The 242-A
Evaporator is also used to concentrate the waste to meet interface control document (ICD) feed requirements.

The 242-A Evaporator is located in the 200 East Area, south of A-Farm and north of the AW-Farm. The 242-A Evaporator employs a conventional forced circulation, vacuum evaporation system. Components of the evaporator system include the reboiler, vapor-liquid separator, recirculation pump and pipe loop, bottoms product pump, condensers, condensate collection vessel, and vessel ventilation system. A forced circulation pump recirculates the evaporator contents and discharges to the evaporator reboiler, which raises the temperature of the liquid. The waste feed enters the recirculation line and is pumped to the reboiler where the waste is heated. Steam condensate from the reboiler and cooling water from the condensers are continually monitored for radiation, pH, and conductivity, and then discharged from the building to the 200 Area Treated Effluent Disposal Facility (TEDF).

The vapor-liquid separator is maintained at a negative gauge pressure by a two-stage steam eductor system and by controlling the in-bleed of air to the suction side of the vacuum eductor. Under this vacuum pressure, a fraction of the water in the heated feed flashes to steam in the separator vessel and is drawn through two wire mesh deentrainer pads into the primary condenser.

As evaporation takes place in the separator vessel, the feed becomes concentrated. When the process solution is concentrated to the specific gravity specified for the campaign, a fraction is withdrawn from the recirculation line, upstream of the feed addition point, and is either gravity drained or pumped by the bottoms pump to DSTs in either the AP or AW Tank Farms. The offgas leaving the evaporator separator vessel passes through three condensers. The condensate from all three condensers is collected in the condensate collection tank. The process condensate from the collection tank is discharged to the Liquid Effluent Retention Facility (LERF).

Non-condensable vapors from the evaporator are filtered and discharged to the atmosphere via the vessel vent system. This system consists of a de-entrainment pad, prefilter, heater, high-efficiency filter assembly, and vessel vent exhauster. The 242-A Evaporator stack is equipped with sampling, monitoring, and alarms to ensure that the offgas meets environmental and safety requirements.

Each campaign requires staging and sampling of the candidate feed waste to ensure that the material can be processed within the operating limits of the evaporator and transfer system per HNF-SD-WM-OCD-015. The 242-A Evaporator has a final status RCRA Part B permit.

In the model, a 242-A Evaporator campaign is performed whenever there is a sufficient volume of dilute waste in the 242-Evaporator feed tank, DST AW-102, and there is a available DST to receive the bottoms. Dilute waste is staged in the DSTs and transferred to AW-102 once sufficient time has passed to allow for sampling and sample analysis.

The 242-A Evaporator is modeled as the 242-A separator vessel, 242-A condenser, and 242-A stack. The 242-A separator vessel is modeled as a splitter (volume-less) which receives waste feed from AW-102 and sends streams of vapor to the 242-A condenser and bottoms to a DST in AP-Farm or AW-Farm the rate of feed transfer from AW-102 is based on the capabilities of the reboiler (i.e., the maximum boiloff rate) and the bottoms product pump. The 242-A condenser receives the vapors from the 242-A separator (including water vapor representing the steam eductors) and sends streams of condensate to LERF and non-condensable vapor to the 242-A
Streams of steam and cooling water to the 242-A Evaporator and discharge to TEDF are not modeled. Post-campaign flushing of the 242-A Evaporator is accounted for in AW-102.

2.6.1 System Requirements

2.6.1.1 System Requirements

Unique ID: BMR-242A_SR-1

The 242-A Evaporator system shall concentrate dilute waste through evaporation.

Basis: N/A

2.6.2 Functional Requirements

2.6.2.1 Functional Requirements

Unique ID: BMR-242A_FR-1

The 242-A Evaporator system shall have the capability to receive dilute waste from the DST system.

Basis: N/A

2.6.2.2 Functional Requirements

Unique ID: BMR-242A_FR-2

The 242-A Evaporator system shall have the capability to concentrate the dilute waste.

Basis: N/A

2.6.2.3 Functional Requirements

Unique ID: BMR-242A_FR-3

The 242-A Evaporator system shall have the capability to return concentrated waste to the DST system.

Basis: N/A

2.6.2.4 Functional Requirements

Unique ID: BMR-242A_FR-5

The 242-A Evaporator system shall have the capability of condensing vapors contained in the evaporator offgas into liquid effluent.

Basis: N/A

2.6.2.5 Functional Requirements

Unique ID: BMR-242A_FR-4

The 242-A Evaporator system shall have the capability to send liquid effluent to the LERF system.

Basis: N/A
2.6.2.6 Functional Requirements
Unique ID: BMR-242A_FR-6
The 242-A Evaporator system shall have the capability to filter and discharge gaseous effluent to the facility stack.
Basis: N/A

2.6.2.7 Functional Requirements
Unique ID: BMR-242A_FR-9
The 242-A Evaporator system shall have the capability to drain residual slurry to the DST system following evaporator campaigns.
Basis: N/A

2.6.2.8 Functional Requirements
Unique ID: BMR-242A_FR-8
The 242-A Evaporator system and associated slurry lines shall have the capability to be flushed to the DST system following evaporator campaigns.
Basis: N/A

2.6.2.9 Functional Requirements
Unique ID: BMR-242A_FR-7
The 242-A Evaporator system shall have the capability to send steam condensate and cooling water to TEDF.
Basis: N/A

2.6.2.10 Functional Requirements
Unique ID: BMR-242A_FR-10
The 242-A Evaporator system shall have the capability of performing a cold run.
Basis: N/A

2.6.3 Model Requirements

2.6.3.1 Model Requirements
Unique ID: BMR-242A_MR-3
The 242-A Evaporator shall include a separator unit identified as 242-A, which represents the vessel C-A-1.
Basis: N/A; this is a model object name only (immaterial to results).
2.6.3.2  Model Requirements

Unique ID: BMR-242A_MR-1

The 242-A Evaporator shall include a condenser unit identified as 242-A-CONDENSER and represents the three condenser units E-C-1, E-C-2, and E-C-3.

Basis: N/A; this is a model object name only (immaterial to results).

2.6.3.3  Model Requirements

Unique ID: BMR-242A_MR-2

The 242-A Evaporator shall include a stack unit identified as 242-A-STACK.

Basis: N/A; this is a model object name only (immaterial to results).

2.6.3.4  Model Requirements

Unique ID: BMR-242A_MR-4

The feed to the 242-A Evaporator shall be greater than or equal to the 242-A Minimum Nitrate to Chloride Mole Ratio and less than or equal to the 242-A Maximum Bottoms Cs-137 Concentration.

Basis: An 0.8 Ci/L limit on Cs-137 is documented in the 242-A Evaporator Operating Specifications (OSD-T-151-00012, Rev. 6, Operating Specifications for the 242-A Evaporator, which itself cites the 242-A Evaporator documented safety analysis [DSA; HNF-14755, 242-A Evaporator Documented Safety Analysis] for the limit). A maximum 80% approach is a safety margin currently used in operations planning to mitigate risk from sample uncertainty and feed and process variability. Minimum nitrate to chloride ratio is based on 242-A Evaporator Operating Specification per OSD-T-151-00012, Rev. 6.

2.6.3.5  Model Requirements

Unique ID: BMR-242A_MR-15

The 242-A bottoms discharge rate shall be the 242-A Maximum Bottoms Discharge Rate at fractional WVRs less than the quotient of the 242-A Maximum Boil-Off Rate and the 242-A Maximum Feed Rate. At greater fractional WVRs, the 242-A bottoms discharge rate shall be reduced, down to the 242-A Minimum Bottoms Discharge Rate at the 242-A Maximum Waste Volume Reduction.

Basis: This requirement maximizes the bottoms discharge rate within the given constraints for the boil-off rate and te bottoms discharge rate; maximizing the bottoms discharge rate helps maximize the rate the campaign is processed.

2.6.3.6  Model Requirements

Unique ID: BMR-242A_MR-16

The 242-A boil-off rate shall be the 242-A Maximum Boil-Off Rate at fractional WVRs greater than the quotient of the 242-A Maximum Boil-Off Rate and the 242-A Maximum Feed Rate. At lesser fractional WVRs, the 242-A boil-off rate shall be reduced (to as low as zero).
Basis: This requirement maximizes the boil-off rate within the given constraints for the boil-off rate and the bottoms discharge rate; maximizing the boil-off rate helps maximize the rate the campaign is processed.

2.6.3.7 Model Requirements

Unique ID: BMR-242A_MR-13

The 242-A feed rate shall be the sum of the 242-A Bottoms Discharge Rate and the 242-A Boil-Off Rate and shall not exceed the 242-A Maximum Feed Rate.

Basis: The following is from an assumption that waste volume is approximately conserved within the 242-A Evaporator.

2.6.3.8 Model Requirements

Unique ID: BMR-242A_MR-14

A 242-A Evaporator campaign shall be triggered when the DST system sends feed to the 242-A Evaporator system that meets the 242-A Feed Composition Requirement.

Basis: N/A; this is a DST system interface requirement. The requirements that determine the need for evaporator campaigns are owned by the DST System.

2.6.3.9 Model Requirements

Unique ID: BMR-242A_MR-5

The 242-A Evaporator shall concentrate the feed based on the fractional WVR determined from the minimum of the following (but must be greater than or equal to zero):

1. The 242-A Maximum Waste Volume Reduction
2. The WVR which would result in the bottoms reaching the 242-A Maximum Bottoms Specific Gravity
3. The WVR which would result in the bottoms reaching the 242-A Maximum Bottoms Cs-137 Concentration.

Basis: The maximum WVR is based on the assumption that waste volume is conserved within the 242-A Evaporator. The maximum WVR must be equal to the maximum boil-off rate divided by the minimum feed rate at that boil-off rate (the sum of the minimum bottoms discharge rate and the maximum boil-off rate).

The maximum bottoms SpG is determined in reality for each 242-A Evaporator campaign on balancing minimizing the likelihood of solids precipitation (estimated using boil-down studies) with maximizing available space in the DST system. The historic average bottoms SpG where the optimum balance has occurred is 1.43. This value is used for all modeled 242-A Evaporator campaigns as a simplifying assumption. The conversion to WVR is based on assumptions of conservation of dry mass in the primary waste process stream and linear SpG.

An 0.8 Ci/L limit on Cs-137 is documented in the 242-A Evaporator Operating Specifications (OSD-T-151-00012, Rev. 6, which itself cites the 242-A Evaporator DSA [HNF-14755] for the limit). A maximum 80% approach is a safety margin currently used in operations planning to
mitigate risk from sample uncertainty and feed and process variability. Conversion to WVR assumes conservation of Cs-137 in the primary waste stream.

2.6.3.10 Model Requirements

Unique ID: BMR-242A_MR-6

The amount of contaminants carried into the vapor stream from the 242-A separator shall be calculated based on the 242-A Separator Vessel Partition Factors and equation 6 in RPP-RPT-52097, Evaporator Partition Coefficients.

Basis: The partition factors and split factors from the "EVAP-SEP" and "RPP-17152_AppA" worksheets in the workbook released under SVF-1778, Rev. 8, are applied to the 242-A Evaporator separator. RPP-RPT-17152, Rev. 12, Table A-1 provides the reference for each partition factor or split in the EVAP-SEP worksheet of SVF-1778. References include HNF-14755, RPP-17239, and RPP-RPT-52097 for partition coefficients, and additionally, 24590-PTF-MEC-FEP-00004, Waste Feed and Treated LAW Evaporator System DF Estimates, for split factors.

2.6.3.11 Model Requirements

Unique ID: BMR-242A_MR-7

The 242-A separator vessel shall send vapors to the 242-A-CONDENSER.

Basis: This requirement is based on simplified flowsheet components and HNF-14755, Rev. 6D, Figure 2-6 (242-A Evaporator Process Flow Diagram).

2.6.3.12 Model Requirements

Unique ID: BMR-242A_MR-19

The 242-A separator vessel shall send liquids to the DST System.

Basis: This requirement is based on simplified flowsheet components and HNF-14755, Rev. 6D, Figure 2-6 (242-A Evaporator Process Flow Diagram).

2.6.3.13 Model Requirements

Unique ID: BMR-242A_MR-8

The 242-A-CONDENSER vapor shall be routed to the 242-A-STACK.

Basis: This requirement is based on simplified flowsheet components and HNF-14755, Rev. 6D, Figure 2-6 (242-A Evaporator Process Flow Diagram).

2.6.3.14 Model Requirements

Unique ID: BMR-242A_MR-12

The 242-A-CONDENSER shall transfer process condensate to one of the LERF systems.

Basis: This requirement is based on simplified flowsheet components and HNF-14755, Rev. 6D, Figure 2-6 (242-A Evaporator Process Flow Diagram).
2.6.3.15 Model Requirements

**Unique ID:** BMR-242A_MR-9

The predicted component splits in the 242-A-CONDENSER offgas and condensate shall be based on the 242-A-CONDENSER Split Factors.

**Basis:** The split factors from the "EVAP-DMST" worksheet in the workbook released under SVF-1778, Rev. 8, are applied to the 242-A condenser. The 242-A condenser splits are based on 24590-PTF-MEC-FEP-00004, which were derived from flowsheet data in the 242-A Evaporator safety analysis report (HNF-14755).

2.6.3.16 Model Requirements

**Unique ID:** BMR-242A_MR-11

Offgas from the 242-A-CONDENSER shall be discharged at saturation conditions of the condenser outlet which is calculated using the Mole Fraction of Water at Saturation calculation at the 242-A CONDENSER Outlet Conditions.

**Basis:** The saturation condition is based on 24590-HLW-M4C-HOP-00011, Rev. 1, HLW Melter Offgas System Design Basis Flowsheet.

2.6.3.17 Model Requirements

**Unique ID:** BMR-242A_MR-10

The 242-A-CONDENSER shall include the 242-A-CONDENSER Water Addition when operating, which represents the amount of steam condensate added while using the vacuum eductor system to maintain a vacuum between the evaporator and condensers.

**Basis:** Water is added to the evaporator due to process upsets, startup, and the steam jets. An addition is modeled based on a historical average ratio of process condensate produced per WVR per RPP-RPT-52097, Rev. 0, Recommendation for Updating Evaporator Partition Coefficients, Appendix A.

2.6.3.18 Model Requirements

**Unique ID:** BMR-242A_MR-17

The 242-A post campaign drain-back shall be accounted for in the DST system based on the 242-A Drain-Back Equivalent Feed Volume. (This is a placeholder until we have time to implement an explicit modeling of the drain-back.)

**Basis:** The basis for the drain-back is WRPS-1705902, email from John Conner. Due to current limitations of the model, the drain-back is modeled as leaving an additional amount of feed that would equate to the drain-back volume for a given campaign fractional WVR in the 242-A Evaporator feed tank.

2.6.3.19 Model Requirements

**Unique ID:** BMR-242A_MR-18

The 242-A post campaign deep flush shall be a transfer of 242-A Deep Flush Equivalent Volume of water to the DST system.
Basis: The basis for the deep flush is WRPS-1705902, email from John Conner. Due to current limitations of the model, the drain-back is modeled as leaving an additional amount of feed that would equate to the drain-back volume for a given campaign fractional WVR in the 242-A Evaporator feed tank. The deep flush is modeled as volume of water that, combined with this amount of feed, would equate to the combined deep flush and drain-back volumes (assuming additive volumes).

2.6.4 Technical Requirements

2.6.4.1 Technical Requirements

Unique ID: BMR-242A_TR-2

For simplification, the 242-A separator unit shall be modeled as a volumeless splitter which does not have the actual physical attributes of the vessel associated with it.

Basis: This has provided the desired level of results in past modeling. Because the 242-A Evaporator is flushed after each campaign, there is no mixing of different feeds within the 242-A Evaporator, which alleviates the need for modeling hold-up.

2.6.4.2 Technical Requirements

Unique ID: BMR-242A_TR-5

The 242-A-STACK shall operate at 21.1°C (70°F) and 1 atm.

Basis: N/A; this is the standard condition for temperature and pressure.

2.6.4.3 Technical Requirements

Unique ID: BMR-242A_TR-4

For simplification, the 242-A-CONDENSER separator unit shall be modeled as a volumeless splitter which does not have the actual physical attributes of the vessel associated with it. However, the 242-A-CONDENSER shall have the following parametric values:

<table>
<thead>
<tr>
<th>Maximum Volume (gal)</th>
<th>Upper Set Volume (gal)</th>
<th>Set Volume (gal)</th>
<th>Minimum Volume (gal)</th>
<th>Maximum Pump Rate (gpm)</th>
<th>Outlet Pressure (atm)</th>
<th>Outlet Temperature (°F)</th>
</tr>
</thead>
<tbody>
<tr>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>60</td>
<td>1</td>
<td>110</td>
</tr>
</tbody>
</table>

Basis: This has provided the desired level of results in past modeling. Because the 242-A Evaporator is flushed after each campaign, there is no mixing of different feeds within the 242-A Evaporator, which alleviates the need for modeling hold-up.

The maximum flow rate and outlet temperature are specified in Table 2-1 of HNF-14755, Rev.6. The outlet pressure is the standard condition for pressure.
2.6.4.4 Technical Requirements

Unique ID: BMR-242A_TR-3

The maximum bottoms SpG that the 242-A Evaporator concentrated feed to shall be 1.43. This limit may be converted to a maximum fractional WVR limit for the campaign by the following formula:

$$\text{Maximum Fractional WVR} = \frac{\text{Maximum Bottoms Specific Gravity} - \text{Feed Specific Gravity}}{\text{Maximum Bottoms Specific Gravity} - 1}$$

**Basis:** In reality, the bottoms SpG is determined for each 242-A Evaporator campaign on balancing minimizing the likelihood of solids precipitation (estimated using boil-down studies) with maximizing available space in the DST system. The historic average bottoms SpG where the optimum balance has occurred is 1.43. This value is used for all modeled 242-A Evaporator campaigns as a simplifying assumption.

The conversion to WVR is based on assumptions of conservation of dry mass in the primary waste process stream and linear SpG.

2.6.4.5 Technical Requirements

Unique ID: BMR-242A_TR-14

The maximum fractional WVR of the 242-A Evaporator shall be the quotient of the 242-A Maximum Boil-Off Rate and the sum of the 242-A Minimum Bottoms Discharge Rate and the 242-A Maximum Boil-Off Rate.

**Basis:** This is based on the assumption that waste volume is conserved within the 242-A Evaporator, the maximum WVR must be equal to the maximum boil-off rate divided by the minimum feed rate at that boil-off rate (the sum of the minimum bottoms discharge rate and the maximum boil-off rate).

2.6.4.6 Technical Requirements

Unique ID: BMR-242A_TR-1

The 242-A Evaporator maximum bottoms Cs-137 concentration shall be 80% of the 242-A Evaporator ALARA limit of 0.8 Ci/L. This limit may be converted to a maximum fractional WVR limit for the campaign by the following formula:

$$\text{Maximum Fractional WVR} = \left(1 - \frac{\text{Feed } ^{137}\text{Cs Concentration}}{\text{Maximum Bottoms } ^{137}\text{Cs Concentration}}\right)$$

**Basis:** This 0.8 Ci/L limit on Cs-137 is documented in the 242-A Evaporator Operating Specifications (OSD-T-151-00012, Rev. 6, which itself cites the 242-A Evaporator DSA [HNF-14755] for the limit). The maximum 80% approach is a safety margin currently used in operations planning to mitigate risk from sample uncertainty and feed and process variability.

Conversion to the WVR assumes conservation of Cs-137 in the primary waste stream.

2.6.4.7 Technical Requirements

Unique ID: BMR-242A_TR-12

The minimum nitrate to chloride mole ratio for feed to the 242-A Evaporator is 2.

2.6.4.8 Technical Requirements

Unique ID: BMR-242A_TR-7

The partition factors and split factors from the "EVAP-SEP" and RPP-17152_AppA worksheets in the workbook released under SVF-1778, Rev. 8, shall be the 242-A separator partition factors.

Basis: RPP-RPT-17152, Rev. 12, Table A-1, provides the reference for each partition factor or split in the EVAP-SEP worksheet of SVF-1778, Rev. 8. References include HNF-14755, RPP-17239, and RPP-RPT-52097 for partition coefficients, and additionally, 24590-PTF-MEC-FEP-00004 for split factors.

2.6.4.9 Technical Requirements

Unique ID: BMR-242A_TR-10

The 242-A separator's minimum bottoms discharge rate shall be 30 gpm.

Basis: This requirement is per HNF-14775, Rev. 6-D, Section 2.5.3.

2.6.4.10 Technical Requirements

Unique ID: BMR-242A_TR-11

The 242-A separator vessel's maximum bottoms discharge rate shall be 70 gpm.

Basis: This requirement is per HNF-14775, Rev. 6-D, Section 2.5.3.

2.6.4.11 Technical Requirements

Unique ID: BMR-242A_TR-6

The 242-A maximum boil-off rate shall be 40 gpm.

Basis: This is an approximate upper bound based on the heat transfer capability of the 242-A Evaporator reboiler. Considering the maximum condensate rate of 60 gpm from 242-A DSA (HNF-14755) and 1.27 gal of process condensate produced per gallon of boil-off, a maximum rate of ∼47 gpm might be expected. However, heat transfer to the feed is more limiting: RPP-RPT-59355, Rev. 1, 242-A Evaporator Campaign EC-03 Post-Run Report, Table D-2 provides historical boil-off rate values for past campaigns, none of which exceed 41 gpm.

2.6.4.12 Technical Requirements

Unique ID: BMR-242A_TR-13

The 242-A separator vessel's maximum feed rate shall be the sum of the 242-A Maximum Bottoms Discharge Rate and 242-A Maximum Boil-Off Rate.

Basis: This is a derivative of a volume balance and the requirements for the maximum bottoms discharge and maximum boil-off rates.
2.6.4.13 Technical Requirements

Unique ID: BMR-242A_TR-9

The split factors from the "EVAP-DMST" worksheet in the workbook released under SVF-1778, Rev. 8, shall be applied to the 242-A-CONDENSER.

Basis: The 242-A condenser splits are based on 24590-PTF-MEC-FEP-00004, which were derived from flowsheet data in HNF-14755.

2.6.4.14 Technical Requirements

Unique ID: BMR-242A_TR-8

The 242-A-CONDENSER water addition shall be 0.27 gal of water per gal of boil-off in the 242-A Evaporator.

Basis: This requirement is based on a historical average ratio of process condensate produced per WVR per RPP-RPT-52097, Rev. 0, Appendix A. This includes water added to the evaporator due to process upsets, startup, and the steam jets.

2.6.4.15 Technical Requirements

Unique ID: BMR-242A_TR-15

The volume of the 242-A drain-back shall be 5,000 gal.

Basis: This requirement is per WRPS-1705902.

2.6.4.16 Technical Requirements

Unique ID: BMR-242A_TR-16

The volume of the 242-A deep flush shall be 35,000 gal.

Basis: This requirement is per WRPS-1705902.

2.6.4.17 Technical Requirements

Unique ID: BMR-242A_TR-17

The 242-A Separator Vessel drain-back equivalent feed volume shall be calculated from the 242-A Drain-Back Volume and the 242-A Campaign Waste Volume Reduction according to the following formula:

\[
\text{Drain Back Equivalent Volume} = \frac{\text{Drain Back Volume}}{1 - \text{Fractional WVR}}
\]

Basis: This is the amount of feed that would equate to the drain-back volume for a given campaign fractional WVR.

2.6.4.18 Technical Requirements

Unique ID: BMR-242A_TR-18

The 242-A deep flush equivalent volume shall be calculated from the 242-A Deep Flush Volume, 242-A Drain-Back Volume, and 242-A Drain-Back Equivalent Feed Volume according to the following formula:
Basis: This is the volume of water that combined with the drain-back equivalent volume would equate to the combined deep flush and drain-back volumes (assuming additive volumes).

2.6.5 242-A Evaporator Figures

2.6.5.1 242-A Evaporator Flow Diagram

Unique ID: BMR-242A_FIG-1
2.7 TANK-SIDE CESIUM REMOVAL

The purpose of the Tank-Side Cesium Removal (TSCR) system is to pretreat LAW waste by removing radioactive cesium prior to feeding to the Waste Treatment Plant (WTP) Low Activity Waste (LAW) Vitrification system. The TSCR system is planned to be operational prior to the higher capacity LAWPS system. The LAWPS system replaces the TSCR system when it becomes operational.

The TSCR system is comprised of two pre-filters and four ion exchange columns. The feed, storage, and returns tanks are existing Double Shell Tanks (DSTs).

The TSCR pre-filters operate in an alternating fashion, such that one pre-filter is online, while the other is back-flushed with filtered feed from the online pre-filter and put in standby mode. The filtered solids are routed to the TSCR/LAWPS Returns Receipt Tank. The filtered feed is then routed to TSCR cesium ion exchange, which consists of four column in series (modeled as a single column in TOPSim with four times the cesium capacity), which are loaded sequentially. The columns use a non-elutable ion-exchange media, which remains in the columns after they are spent. When the columns are fully loaded with cesium, the feed is stopped, and the loaded columns are displaced with dilute caustic solution followed by an inhibited water rinse, air-dried, removed, and routed to interim storage. Air-drying and storage of the columns are not modeled.
in TOPSim; however, the time it takes to displace, rinse, air-dry, remove, replace, and condition the fresh ion exchange columns is modeled as a pause in TSCR operations. The displacement caustic, water rinse, and conditioning caustic are routed to the TSCR/LAWPS Returns Receipt Tank, and the pretreated LAW Feed is routed to the Interim LAW Storage Tank.

### 2.7.1 System Requirements

#### 2.7.1.1 TSCR Solids Removal

**Unique ID:** BMR-TSCR_SR-1

The TSCR System shall remove solids from the TSCR waste feed.

**Basis:** N/A

#### 2.7.1.2 TSCR Radioactive Cesium (Cs) Removal

**Unique ID:** BMR-TSCR_SR-2

The TSCR System shall selectively remove radioactive Cs from filtered TSCR waste feed with non-elutable resin.

**Basis:** N/A

### 2.7.2 Functional Requirements

#### 2.7.2.1 TSCR Pre-Filtration Feed Receipt

**Unique ID:** BMR-TSCR_FR-1

The TSCR system shall have the capability to receive TSCR pre-filter feed from the DST system.

**Basis:** N/A

#### 2.7.2.2 TSCR Pre-Filtration Solids Removal

**Unique ID:** BMR-TSCR_FR-2

The TSCR system shall have the capability to remove solids from the TSCR pre-filter feed.

**Basis:** N/A

#### 2.7.2.3 TSCR Pre-Filtration Flush

**Unique ID:** BMR-TSCR_FR-3

The TSCR system shall have the capability to flush solids from the TSCR pre-filters.

**Basis:** N/A

#### 2.7.2.4 TSCR Filtrate Transfer to TSCR Cesium Ion Exchange (CsIX)

**Unique ID:** BMR-TSCR_FR-4

The TSCR system shall have the capability to transfer filtrate from the pre-filters to the TSCR CsIX columns.

**Basis:** N/A
2.7.2.5  TSCR Flushed Solids Transfer to DSTs

**Unique ID:** BMR-TSCR_FR-5

The TSCR system shall have the capability to transfer separated solids from the pre-filters to the DST system.

**Basis:** N/A

2.7.2.6  TSCR CsIX Filtered Feed Receipt

**Unique ID:** BMR-TSCR_FR-6

The TSCR system shall have the capability to transfer filtered feed from the TSCR pre-filters to the CsIX columns.

**Basis:** N/A

2.7.2.7  TSCR CsIX Radioactive Cesium Removal

**Unique ID:** BMR-TSCR_FR-7

The TSCR system shall have the capability to selectively remove radioactive cesium from the TSCR filtered feed using non-elutable ion-exchange resin.

**Basis:** N/A

2.7.2.8  TSCR Pre-Treated Feed Transfer to DSTs

**Unique ID:** BMR-TSCR_FR-8

The TSCR system shall have the capability to transfer pre-treated feed from the TSCR CsIX columns to the DSTs.

**Basis:** N/A

2.7.2.9  TSCR Spent Column Replacement

**Unique ID:** BMR-TSCR_FR-9

The TSCR system shall have the capability to remove spent CsIX columns and replace the spent columns with fresh columns.

**Basis:** N/A

2.7.3  Model Requirements

2.7.3.1  TSCR Pre-Filters (TSCR-FLTR-00001/2) Identification

**Unique ID:** BMR-TSCR_MR-1

The TSCR system shall include two TSCR Pre-filters identified as TSCR-FLTR-00001 and TSCR-FLTR-00002.

**Basis:** Per RPP-SPEC-61910, Rev. C, "The pre-filtration subsystem consists of multiple filter units, so that a clean filter is alternated on-line at all times."
2.7.3.2  TSCR Pre-Filter (TSCR-FLTR-00001/2) Waste Feed Receipt

Unique ID: BMR-TSCR_MR-6

The TSCR Pre-Filters (TSCR-FLTR-00001/2) shall receive waste feed transferred from the TSCR/LAWPS Feed Tank at the Waste Feed Rate.

Basis: N/A

2.7.3.3  TSCR Pre-Filters (TSCR-FLTR-00001/2) Start Transferring

Unique ID: BMR-TSCR_MR-7

The TSCR pre-filters shall be available to receive waste feed on the TSCR Start Date and after the cesium ion-exchange (CsIX) Column Removal and Replacement Cycle has completed.

Basis: Per RPP-SPEC-61910, Rev. C, "When all ion-exchange columns within the process enclosure are loaded, the spent ion-exchange columns will be replaced."

2.7.3.4  TSCR Pre-filter (TSCR-FLTR-00001/2) Pause Feed

Unique ID: BMR-TSCR_MR-22

After receiving the TSCR Commissioning Volume, feed to TSCR shall be paused until 5/18/2021 to allow the addition and mixing of caustic in the Interim LAW Storage Tank.

Basis: N/A

2.7.3.5  TSCR Pre-Filters (TSCR-FLTR-00001/2) Configuration

Unique ID: BMR-TSCR_MR-2

The TSCR pre-filters shall be configured with one filter online and the other in standby mode.

Basis: Per RPP-SPEC-61910, Rev. C, "The pre-filtration subsystem consists of multiple filter units, so that a clean filter is alternated on-line at all times."

2.7.3.6  TSCR Pre-Filters (TSCR-FLTR-00001/2) Solids Removal

Unique ID: BMR-TSCR_MR-5

The TSCR pre-filters shall remove the TSCR Pre-Filtration Solids Removal Fraction of solids from the waste feed. The solids shall be collected in the online pre-filter.

Basis: N/A

2.7.3.7  TSCR Pre-Filters (TSCR-FLTR-00001/2) Operations

Unique ID: BMR-TSCR_MR-3

After the TSCR Pre-Filter Flush Interval Time has elapsed, the waste feed shall be diverted from the online pre-filter to the standby pre-filter.

Basis: Email from Sean Reaksecker to Bernards, Jeanne K., et. al.; Notes from TCCR Meeting with Mark Keefer (SRR), 10/31/2017. "Every 45 minutes or when the dP reaches 3-5 psi, the filter is backflushed for 30 seconds at the max flow rate of 15-20 gpm. The IX column is isolated during this process."
2.7.3.8 TSCR Pre-Filters (TSCR-FLTR-00001/2) Flush

**Unique ID:** BMR-TSCR_MR-4

After the waste feed has been diverted to the standby pre-filter, the previously online (now standby) pre-filter shall be flushed with filtrate from the currently online (previously standby) pre-filter at the Pre-Filter Flush Rate for the Filter Flush Duration.

**Basis:** Per RPP-SPEC-61910, Rev. C, "The solids remain in the offline filter until flushed out with a side stream of filtrate from the online filter."

2.7.3.9 TSCR Pre-Filter (TSCR-FLTR-00001/2) Solids Routing

**Unique ID:** BMR-TSCR_MR-18

The solids flushed from the standby TSCR Pre-Filter shall be routed to the TSCR/LAWPS Returns Receipt Tank.

**Basis:** Per RPP-SPEC-61910, Rev. C, "The solids remain in the offline filter until flushed out with a side stream of filtrate from the online filter. Filter flush is sent back to a DST."

2.7.3.10 TSCR Pre-Filters (TSCR-FLTR-00001/2) Filtered Waste Feed Routing

**Unique ID:** BMR-TSCR_MR-9

After passing through the pre-filters, the filtered waste feed shall be routed to the TSCR CsIX column.

**Basis:** Per RPP-SPEC-61910, Rev. C, "The TSCR system will receive tank supernatant waste from the DST system, filter out undissolved solids, and treat the tank supernatant waste by removing radioactive cesium using an ion-exchange subsystem."

2.7.3.11 TSCR Pre-Filter (TSCR-FLTR-00001/2) Stop Transferring

**Unique ID:** BMR-TSCR_MR-8

Waste feed transfer to the TSCR pre-filters (TSCR-FLTR-00001/2) shall stop when the TSCR CsIX column (TSCR-CSIX-00001) is fully loaded with cesium.

**Basis:** Per RPP-SPEC-61910, Rev. C, "When all ion-exchange columns within the process enclosure are loaded, the spent ion-exchange columns will be replaced." This implies that all ion-exchange columns are off-line for replacement, so the pre-filters cannot receive waste feed.

2.7.3.12 TSCR CsIX (TSCR-CSIX-00001) Filtered Feed Receipt

**Unique ID:** BMR-TSCR_MR-10

TSCR-CSIX-00001 shall receive filtered feed from the TSCR pre-filters (TSCR-FLTR-00001/2).

**Basis:** Per RPP-SPEC-61910, Rev. C, "The TSCR system will receive tank supernatant waste from the DST system, filter out undissolved solids, and treat the tank supernatant waste by removing radioactive cesium using an ion-exchange subsystem."
2.7.3.13 TSCR CsIX (TSCR-CSIX-00001) Contaminant Adsorption

Unique ID: BMR-TSCR_MR-13

Cesium (137-Cs, 134-Cs, Cs+) shall be selectively adsorbed onto the column resin according to the TSCR CsIX Cesium Removal Fraction.

Basis: The ion exchange system is designed to remove radioactive Cs from filtered waste; however, Cs+ will also be adsorbed onto the resin, as it is selective for Cs whether or not radioactive.

2.7.3.14 TSCR CsIX (TSCR-CSIX-00001) Cs Loading

Unique ID: BMR-TSCR_MR-12

The TSCR CsIX Column (TSCR-CSIX-00001) shall be loaded with Cs until the Maximum 137-Cs Accumulation has been reached.

Basis: N/A

2.7.3.15 TSCR CsIX (TSCR-CSIX-00001) Routing

Unique ID: BMR-TSCR_MR-11

The TSCR CsIX Column (TSCR-CSIX-00001) shall route Pretreated LAW to the Interim LAW Storage Tank.

Basis: Per RPP-SPEC-61910, Rev. C, "The TSCR system will receive tank supernatant waste from the DST system, filter out undissolved solids, and treat the tank supernatant waste by removing radioactive cesium using an ion-exchange subsystem. The liquid and gaseous effluents from the TSCR system will be returned to the DST system. Treated waste will be sent to a separate DST."

2.7.3.16 TSCR CsIX (TSCR-CSIX-00001) Spent CsIX Column Removal and Replacement

Unique ID: BMR-TSCR_MR-15

When the TSCR CsIX column (TSCR-CSIX-00001) is fully loaded, feed to TSCR-FLTR-00001/2 shall stop for the TSCR CsIX Column Removal and Replacement Duration.

Basis: Per RPP-SPEC-61910, Rev. C, "When all ion-exchange columns within the process enclosure are loaded, the spent ion-exchange columns will be replaced."

2.7.3.17 TSCR CsIX (TSCR-CSIX-00001) Spent CsIX Column Displacement

Unique ID: BMR-TSCR_MR-14

After the spent TSCR CsIX column is taken off-line for removal and replacement, the column shall be displaced with caustic at the TSCR CsIX Column Displacement Concentration by transferring the TSCR CsIX Column Displacement Volume at the TSCR CsIX Column Displacement Rate through the TSCR CsIX column and then to the TSCR/LAWPS Returns Receipt Tank.

Basis: Per RPP-SPEC-61910, Rev. C, "Each spent ion-exchange column will be displaced with caustic followed by a water rinse. The caustic and water flush will be sent to a DST."
2.7.3.18 TSCR CsIX (TSCR-CSIX-00001) Spent CsIX Column Rinse

Unique ID: BMR-TSCR_MR-16

After the displacement step is complete, the spent TSCR CsIX Column (TSCR-CSIX-00001) shall be rinsed with inhibited water by transferring the TSCR CsIX Column Rinse Volume at the TSCR CsIX Column Rinse Rate through the TSCR CsIX column and then to the TSCR/LAWPS Returns Receipt Tank.

Basis: Per RPP-SPEC-61910, Rev. C, "Each spent ion-exchange column will be displaced with caustic followed by a water rinse. The caustic and water flush will be sent to a DST."

2.7.3.19 TSCR CsIX (TSCR-CSIX-00001) Replacement Column Conditioning

Unique ID: BMR-TSCR_MR-17

Just prior to the end of the TSCR CsIX Column Removal and Replacement Duration, the (new) CsIX column shall be conditioned with caustic at the TSCR CsIX Column Conditioning Caustic Concentration by transferring the TSCR CsIX Column Conditioning Volume at the TSCR CsIX Column Conditioning Rate through the TSCR CsIX column and then to the TSCR/LAWPS Returns Receipt Tank.

Basis: Per RPP-SPEC-61910, Rev. C, "The newly installed ion-exchange columns will be flushed with caustic solution and water for fines removal and pre-conditioning prior to use. The caustic pre-conditioning solution will be sent to a DST." Currently there is no volume basis for the water rinse, so it is not modeled.

2.7.3.20 TSCR CsIX (TSCR-CSIX-00001) CsIX Column Removal and Replacement Counter

Unique ID: BMR-TSCR_MR-19

The number of times that the TSCR CsIX Column (TSCR-CSIX-00001) is removed and replaced shall be counted.

Basis: N/A

2.7.3.21 TSCR Pre-Filter (TSCR-FLTR-00001/2) Stop TSCR Operations

Unique ID: BMR-TSCR_MR-21

Waste Feed to the TSCR pre-filters (TSCR-FLTR-00001) shall stop on the TSCR End Date.

Basis: N/A

2.7.3.22 TSCR CsIX (TSCR-CSIX-00001) Identification

Unique ID: BMR-TSCR_MR-20

The TSCR System shall include one cesium ion exchange column identified as TSCR-CSIX-00001, which represents four columns, each with one quarter of the ion exchange bed volume used for TSCR-CSIX-00001.

Basis: N/A
2.7.4 Technical Requirements

2.7.4.1 TSCR Pre-Filters (TSCR-FLTR-00001/2) Waste Feed Rate

Unique ID: BMR-TSCR_TR-1

The Waste Feed Rate to the Pre-Filters (TSCR-FLTR-00001/2) is 5 gpm.

Basis: Per RPP-SPEC-61910, Rev. C, "The TSCR system shall have a minimum throughput of 5 gpm."

2.7.4.2 TSCR Start Date

Unique ID: BMR-TSCR_TR-2

The TSCR Start Date is 2/20/2021.

Basis: An early TSCR start date is required to prevent the Interim LAW Storage Tank from emptying and limiting LAW Vitrification throughput before LAWPS starts up.

2.7.4.3 TSCR Pre-filters (TSCR-FLTR-00001/2) TSCR Commissioning Volume

Unique ID: BMR-TSCR_TR-13

The TSCR Commissioning Volume is 170,000 gallons.

Basis: N/A

2.7.4.4 TSCR Pre-Filters (TSCR-FLTR-00001/2) TSCR Pre-Filtration Solids Removal Fraction

Unique ID: BMR-TSCR_TR-4

The TSCR Pre-Filtration Solids Removal Fraction is 100%.

Basis: Enabling Assumption.

2.7.4.5 TSCR Pre-Filters (TSCR-FLTR-00001/2) Pre-Filter Flush Interval Time

Unique ID: BMR-TSCR_TR-3

The TSCR Pre-Filter Flush Interval Time is 45 minutes.

Basis: email from Sean Reaksecker to Bernards, Jeanne K., et. al., Notes from TCCR Meeting with Mark Keefer (SRR), 10/31/2017. "Every 45 minutes or when the dP reaches 3-5 psi, the filter is backflushed for 30 seconds at the max flow rate of 15-20 gpm. The IX column is isolated during this process."

2.7.4.6 TSCR Pre-Filters (TSCR-FLTR-00001/2) Flush Duration and Rate

Unique ID: BMR-TSCR_TR-5

The Pre-Filter Flush Rate is 15 gpm and the Filter Flush Duration is 30 seconds.

Basis: email from Sean Reaksecker to Bernards, Jeanne K., et. al., Notes from TCCR Meeting with Mark Keefer (SRR), 10/31/2017. "Every 45 minutes or when the dP reaches 3-5 psi, the filter is backflushed for 30 seconds at the max flow rate of 15-20 gpm. The IX column is isolated during this process."
2.7.4.7 TSCR CsIX (TSCR-CSIX-00001) Cesium Removal Fraction

Unique ID: BMR-TSCR_TR-6

The TSCR CsIX Cesium Removal Fraction, which applies to 137-Cs, 134-Cs, and Cs+, is 99.99%.

Basis: Per Rose Russell, 99.9% 137-Cs removal is required, however, it was suggested to use a value of 99.99%, as that was considered to be a more realistic removal fraction for CST resin.

2.7.4.8 TSCR CsIX (TSCR-CSIX-00001) Maximum 137-Cs Accumulation

Unique ID: BMR-TSCR_TR-7

The Maximum 137-Cs Accumulation on the TSCR-CSIX-00001 resin is 100,000 Ci.

Basis:

1. Per RPP-SPEC-61910, Rev. C, "The TSCR system shall treat a minimum of 170,000 gallons of waste from Tank AP-107 during the first phase of the demonstration project. This corresponds to at least 100,000 Ci of cesium."

2. Email from Sean Reaksecker to Bernards, Jeanne K., et. al., Notes from TCCR Meeting with Mark Keefer (SRR), 10/31/2017. "The goal is to predict column loading to maintain the 25,000 Ci/column limit. This is a conservative limit to prevent excessive heat; at 91,000 Ci a 3 M salt solution will boil in the columns." There are 4 ion-exchange columns in a TSCR unit. The columns are modeled as a single column with a maximum loading of 100,000 Ci of 137-Cs.

2.7.4.9 TSCR CsIX (TSCR-CSIX-00001) CsIX Column Removal and Replacement Duration

Unique ID: BMR-TSCR_TR-8

The TSCR CsIX Column Removal and Replacement Duration is 20 days.

Basis: Email from Sean Reaksecker to Bernards, Jeanne K., et. al., Notes from TCCR Meeting with Mark Keefer (SRR), 10/31/2017. "For each column, perform caustic then water rinse, drain column with forced air, then blow air up through the column for ~8 days to dry the resin. Remove columns by crane through the top of the unit (4 days for one column, or 2 weeks for 3 columns; same time applies for loading in new columns)." Based on this, the turnaround time for removing and replacing the four TSCR columns is assumed to be 20 days.

2.7.4.10 TSCR CsIX (TSCR-CSIX-00001) CsIX Displacement

Unique ID: BMR-TSCR_TR-9

The TSCR CsIX column displacement fluid concentration, volume, and rate is as follows:

| TSCR CsIX Column Displacement Concentration | 0.1M caustic |
| TSCR CsIX Column Displacement Volume       | 1,040 gal   |
| TSCR CsIX Column Displacement Rate         | 5 gpm       |

Basis: Per RPP-SPEC-61910, Rev. C, "Each spent ion-exchange column will be displaced with caustic followed by a water rinse." In our October 2017 meeting with Mark Keefer, he stated
that SRR was using 2 Bed Volumes (BV) of 0.1M caustic and that the BV of each column is 130 gallons, for a total BV of 520 gallons. The displacement rate was assumed to be the same as the feed rate.

2.7.4.11 TSCR CsIX (TSCR-CSIX-00001) Spent CsIX Column Rinse

Unique ID: BMR-TSCR_TR-10

The TSCR CsIX column rinse water volume and rate is as follows:

<table>
<thead>
<tr>
<th>TSCR CsIX Column Rinse Volume</th>
<th>1,560 gal</th>
</tr>
</thead>
<tbody>
<tr>
<td>TSCR CsIX Column Rinse Rate</td>
<td>5 gpm</td>
</tr>
</tbody>
</table>

Basis: Per RPP-SPEC-61910, Rev. C, "Each spent ion-exchange column will be displaced with caustic followed by a water rinse." In our October 2017 meeting with Mark Keefer, he stated that SRR was using 3 Bed Volumes (BV) of water and that the BV of each column is 130 gallons, for a total BV of 520 gallons. The rinse rate was assumed to be the same as the feed rate.

2.7.4.12 TSCR CsIX (TSCR-CSIX-00001) Replacement Column Conditioning

Unique ID: BMR-TSCR_TR-11

The TSCR CsIX column conditioning fluid concentration, volume, and rate is as follows:

<table>
<thead>
<tr>
<th>TSCR CsIX Column Conditioning Concentration</th>
<th>0.1M caustic</th>
</tr>
</thead>
<tbody>
<tr>
<td>TSCR CsIX Column Conditioning Volume</td>
<td>2,600 gal</td>
</tr>
<tr>
<td>TSCR CsIX Column Conditioning Rate</td>
<td>5 gpm</td>
</tr>
</tbody>
</table>

Basis: Per RPP-SPEC-61910, Rev. C, "The newly installed ion-exchange columns will be flushed with caustic solution and water for fines removal and pre-conditioning prior to use." In our October 2017 meeting with Mark Keefer, he stated that SRR was using 5 Bed Volumes (BV) of 0.1M caustic and that the BV of each column is 130 gallons, for a total BV of 520 gallons. The conditioning rate was assumed to be the same as the feed rate.

2.7.4.13 TSCR End Date

Unique ID: BMR-TSCR_TR-12

The TSCR End Date is a function of the LAWPS Start Date. On the LAWPS Start Date, pretreatment of the current DFLAW campaign in AP-107 shall be completed using the TSCR, and the next DFLAW campaign (and all future DFLAW campaigns) will be pretreated using LAWPS.

Basis: Assumed end date per Todd Wagnon.

2.8 LOW-ACTIVITY WASTE PRETREATMENT SYSTEM

The purpose of the LAWPS system is to pretreat LAW waste by removing radioactive cesium prior to feeding to the Waste Treatment Plant (WTP) Low Activity Waste (LAW) Vitrification system. LAW Waste Feed is routed from the TSCR/LAWPS Feed Tank to two pre-filters, which operate in an alternating fashion, to remove solids from the LAW Waste Feed prior to removal of radioactive cesium (predominantly 137-Cs) by ion exchange. After the radioactive cesium is
removed, the pretreated LAW Feed is routed to the Interim LAW Storage Tank, where it is staged for DFLAW operations.

The LAWPS system is comprised of two pre-filters and two ion exchange columns. The feed, storage, and returns tanks are existing Double Shell Tanks (DSTs). The pre-filters operate in alternating fashion, such that one pre-filter is online, while the other is back-flushed with filtered feed from the online pre-filter and put in standby mode. The filtered solids are routed to the TSCR/LAWPS Returns Receipt Tank. The filtered feed is then routed to LAWPS cesium ion exchange, which consists of one online column and one column in standby mode. The columns use a non-elutable ion-exchange media, which remains in the columns after they are spent. When the online column is fully loaded with cesium, the feed is routed to the standby column and the loaded column is removed from service, displaced with dilute caustic solution followed by an inhibited water rinse, air-dried, and routed to storage. Air-drying and storage of the columns are not modeled in TOPSim. The new standby column is conditioned with dilute caustic prior to being put in standby mode, where it remains until the online column is fully loaded with cesium. The displacement caustic, water rinse, and conditioning caustic are routed to the TSCR/LAWPS Returns Receipt Tank, and the pretreated LAW Feed is routed to the Interim LAW Storage Tank.

2.8.1 System Requirements

2.8.1.1 LAWPS Solids Removal

Unique ID: BMR-LAWPS_SR-6

The LAWPS system shall remove solids from the LAWPS waste feed.

Basis: N/A

2.8.1.2 LAWPS Radioactive Cesium (Cs) Removal

Unique ID: BMR-LAWPS_SR-7

The LAWPS system shall selectively remove radioactive Cs from pre-filtered LAWPS waste feed with non-elutable resin.

Basis: N/A

2.8.2 Functional Requirements

2.8.2.1 LAWPS Pre-Filter Feed Receipt

Unique ID: BMR-LAWPS_FR-31

The LAWPS system shall have the capability to receive LAWPS waste feed from the DST system.

Basis: N/A

2.8.2.2 LAWPS Pre-Filter Solids Removal

Unique ID: BMR-LAWPS_FR-32

The LAWPS system shall have the capability to remove solids from the LAWPS waste feed.

Basis: N/A
2.8.2.3 LAWPS Pre-Filter Flush

Unique ID: BMR-LAWPS_FR-33

The LAWPS system shall have the capability to flush solids from the LAWPS pre-filters.

Basis: N/A

2.8.2.4 LAWPS Filtrate Transfer to LAWPS Cesium Ion Exchange (CsIX)

Unique ID: BMR-LAWPS_FR-34

The LAWPS system shall have the capability to transfer filtrate from the pre-filters to the LAWPS CsIX columns.

Basis: N/A

2.8.2.5 LAWPS Flushed Solids Transfer to DSTs

Unique ID: BMR-LAWPS_FR-35

The LAWPS system shall have the capability to transfer separated solids from the pre-filters to the DST system.

Basis: N/A

2.8.2.6 LAWPS CsIX Filtered Feed Receipt

Unique ID: BMR-LAWPS_FR-36

The LAWPS system shall have the capability to transfer filtered feed from the LAWPS pre-filters to the CsIX columns.

Basis: N/A

2.8.2.7 LAWPS CsIX Radioactive Cesium Removal

Unique ID: BMR-LAWPS_FR-37

The LAWPS system shall have the capability to selectively remove radioactive cesium from the LAWPS filtered feed using non-elutable ion-exchange resin.

Basis: N/A

2.8.2.8 LAWPS Pre-Treated Feed Transfer to DSTs

Unique ID: BMR-LAWPS_FR-38

The LAWPS system shall have the capability to transfer pre-treated feed from the LAWPS CsIX columns to the DST System.

Basis: N/A

2.8.2.9 LAWPS Spent Column Replacement

Unique ID: BMR-LAWPS_FR-39

The LAWPS system shall have the capability to remove spent CsIX columns and replace the spent columns with fresh columns.
Basis: N/A

2.8.3 Model Requirements

2.8.3.1 LAWPS Pre-Filters (LAWPS-FLTR-00001/2) Identification

Unique ID: BMR-LAWPS_MR-52

The LAWPS system shall include two LAWPS Pre-filters identified as LAWPS-FLTR-00001 and LAWPS-FLTR-00002.

Basis: Assumed to be similar to TSCR Filtration.

2.8.3.2 LAWPS Pre-Filters (LAWPS-FLTR-00001/2) Waste Feed Receipt

Unique ID: BMR-LAWPS_MR-53

The LAWPS Pre-Filters (LAWPS-FLTR-00001/2) shall receive waste feed from the TSCR/LAWPS Feed Tank at the LAWPS Waste Feed Rate.

Basis: Assumed to operate the same as TSCR.

2.8.3.3 LAWPS Pre-Filters (LAWPS-FLTR-00001/2) Start Transferring

Unique ID: BMR-LAWPS_MR-54

The LAWPS pre-filters shall be available to receive waste feed on 2/25/2024.

Basis: Logic developed in discussion with Todd Wagnon and Alec Schubick.

2.8.3.4 LAWPS Pre-Filters (LAWPS-FLTR-00001/2) Configuration

Unique ID: BMR-LAWPS_MR-55

The LAWPS pre-filters shall be configured with one filter online and the other in standby mode.

Basis: Assumed to be similar to TSCR Filtration.

2.8.3.5 LAWPS Pre-Filters (LAWPS-FLTR-00001/2) Solids Removal

Unique ID: BMR-LAWPS_MR-56

The LAWPS pre-filters shall remove the LAWPS Pre-Filtration Solids Removal Fraction of solids from the waste feed. The solids shall be collected in the online pre-filter.

Basis: Assumed to be similar to TSCR Filtration.

2.8.3.6 LAWPS Pre-Filters (LAWPS-FLTR-00001/2) Operations

Unique ID: BMR-LAWPS_MR-57

After the LAWPS Pre-Filter Flush Interval Time has elapsed, the waste feed shall be diverted from the online pre-filter to the standby pre-filter.

Basis: Assumed to be similar to TSCR Filtration.
2.8.3.7 LAWPS Pre-Filters (LAWPS-FLTR-00001/2) Flush

**Unique ID:** BMR-LAWPS_MR-58

After the waste feed has been diverted to the standby pre-filter, the previously online (now standby) pre-filter shall be flushed with filtrate from the currently online (previously standby) pre-filter at the *LAWPS Pre-Filter Flush Rate* for the *LAWPS Filter Flush Duration*.

**Basis:** Assumed to be similar to TSCR Filtration.

2.8.3.8 LAWPS Pre-Filters (LAWPS-FLTR-00001/2) Solids Routing

**Unique ID:** BMR-LAWPS_MR-59

The solids slurry flushed from the standby LAWPS Pre-Filters shall be routed to *TSCR/LAWPS Returns Receipt Tank*.

**Basis:** Assumed to be similar to TSCR Filtration.

2.8.3.9 LAWPS Pre-Filters (LAWPS-FLTR-00001/2) Filtered Waste Feed Routing

**Unique ID:** BMR-LAWPS_MR-60

After passing through the pre-filters, the filtered waste feed shall be routed to the LAWPS CsIX columns.

**Basis:** Assumed to be similar to TSCR.

2.8.3.10 LAWPS CsIX (LAWPS-CSIX-00001/2) Identification

**Unique ID:** BMR-LAWPS_MR-70

The LAWPS System shall include two cesium ion exchange columns identified as LAWPS-CSIX-00001 and LAWPS-CSIX-00002.

**Basis:** Current conceptual design is three columns. Two of the columns are in a lead/lag configuration, with the third in standby mode. That configuration is being represented with two columns in the model since it does not affect model results. The first column represents the two columns in lead/lag configuration and the second column is on standby. Reference OUO

2.8.3.11 LAWPS CsIX (LAWPS-CSIX-00001/2) Filtered Feed Receipt

**Unique ID:** BMR-LAWPS_MR-61

LAWPS-CSIX-00001/2 shall receive filtered feed from the LAWPS pre-filters (LAWPS-FLTR-00001/2).

**Basis:** Assumed to be similar to TSCR CsIX configuration.

2.8.3.12 LAWPS CsIX (LAWPS-CSIX-00001/2) Configuration

**Unique ID:** BMR-LAWPS_MR-71

The LAWPS cesium (Cs) ion-exchange columns shall be configured with one column online and the other in standby mode.

**Basis:** Current conceptual design is three columns. Two of the columns are in a lead/lag configuration, with the third in standby mode. That configuration is being represented with two
columns in the model since it does not affect model results. The first column represents the two columns in lead/lag configuration and the second column is on standby. Reference OUO

2.8.3.13 LAWPS CsIX (LAWPS-CSIX-00001/2) Contaminant Adsorption

Unique ID: BMR-LAWPS_MR-62

Cesium (137-Cs, 134-Cs, Cs+) shall be selectively adsorbed onto the ion-exchange column resin according to the LAWPS CsIX Cesium Removal Fraction.

Basis: Assumed to be similar to TSCR CsIX.

2.8.3.14 LAWPS CsIX (LAWPS-CSIX-00001/2) Cs Loading

Unique ID: BMR-LAWPS_MR-63

The LAWPS CsIX Column (LAWPS-CSIX-00001/2) shall be loaded with Cs until the LAWPS Maximum 137-Cs Accumulation has been reached.

Basis: Assumed to be similar to TSCR CsIX.

2.8.3.15 LAWPS CsIX (LAWPS-CSIX-00001/2) Routing

Unique ID: BMR-LAWPS_MR-64

The LAWPS CsIX Column (LAWPS-CSIX-00001/2) shall route pretreated LAW to the Interim LAW Storage Tank.

Basis: TSCR and LAWPS will use the same DST for interim LAW Storage. (Reference?)

2.8.3.16 LAWPS CsIX (LAWPS-CSIX-00001/2) Operations

Unique ID: BMR-LAWPS_MR-72

After the online CsIX column loading has reached the LAWPS Maximum 137-Cs Accumulation, the filtered waste feed shall be diverted to the standby CsIX column.

Basis: Current conceptual design is 3 columns. Two of the columns are in a lead/lag configuration, with the third in standby mode. That configuration is being represented with two columns in the model since it does not affect model results. The first column represents the two columns in lead/lag configuration and the second column is on standby. This reference is OUO.

2.8.3.17 LAWPS CsIX (LAWPS-CSIX-00001/2) Spent CsIX Column Removal and Replacement

Unique ID: BMR-LAWPS_MR-65

When the online LAWPS CsIX column (LAWPS-CSIX-00001 or -00002) is fully loaded, it shall be taken offline for removal and replacement.

Basis: Preparation of the spent LAWPS CsIX columns is assumed to occur similarly to removal and replacement of the TSCR CsIX columns. In order to remove the columns, 2 BV of 0.1M caustic for displacement is required, followed by 3 BV of inhibited water rinse and an air-dry. The air-dry is not modeled in LAWPS. The new standby CsIX column is conditioned with 5 BV of 0.1M caustic before use.
2.8.3.18 LAWPS CsIX (LAWPS-CSIX-00001/2) Spent CsIX Column Displacement

Unique ID: BMR-LAWPS_MR-66

Immediately after the spent LAWPS CsIX column is taken off-line for removal and replacement, the column shall be displaced with caustic at the LAWPS CsIX Column Displacement Concentration by transferring the LAWPS CsIX Column Displacement Volume at the LAWPS CsIX Column Displacement Rate through the LAWPS CsIX column and then to the TSCR/LAWPS Returns Receipt Tank.

Basis: Assumed to be similar to TSCR.

2.8.3.19 LAWPS CsIX (LAWPS-CSIX-00001/2) Spent CsIX Column Rinse

Unique ID: BMR-LAWPS_MR-67

Immediately after the displacement step is complete, the spent LAWPS CsIX column shall be rinsed with inhibited water by transferring the LAWPS CsIX Column Rinse Volume at the LAWPS CsIX Column Rinse Rate through the LAWPS CsIX column and then to the TSCR/LAWPS Returns Receipt Tank.

Basis: Assumed to be similar to TSCR.

2.8.3.20 LAWPS CsIX (LAWPS-CSIX-00001/2) Replacement Column Conditioning

Unique ID: BMR-LAWPS_MR-68

Immediately after the spent LAWPS CsIX column is taken off-line for removal and replacement, the fresh CsIX column shall be conditioned with caustic at the LAWPS CsIX Column Conditioning Caustic Concentration by transferring the LAWPS CsIX Column Conditioning Volume at the LAWPS CsIX Column Conditioning Rate through the LAWPS CsIX column and then to TSCR/LAWPS Returns Receipt Tank.

Basis: Assumed to be similar to TSCR.

2.8.3.21 LAWPS CsIX (LAWPS-CSIX-00001/2) CsIX Column Removal and Replacement Counter

Unique ID: BMR-LAWPS_MR-69

The number of times that the LAWPS CsIX Columns (LAWPS-CSIX-00001/2) are removed and replaced shall be counted.

Basis: N/A

2.8.4 Technical Requirements

2.8.4.1 LAWPS Pre-Filters (LAWPS-FLTR-00001/2) Waste Feed Rate

Unique ID: BMR-LAWPS_TR-72

The waste feed rate to the LAWPS Pre-Filters (LAWPS-FLTR-00001/2) is 6.3 gpm.

Basis: Assumed 6.3 gpm (31269-21-CALC-0034, Rev. 1) as it is the feed rate required to meet an instantaneous rate of 185 kg Na per hour (RPP-SPEC-56967, Rev. 6)
2.8.4.2 LAWPS Pre-Filters (LAWPS-FLTR-00001/2) LAWPS Pre-Filtration Solids Removal Fraction

Unique ID: BMR-LAWPS_TR-73

The LAWPS Pre-Filtration Solids Removal Fraction is 100%.

Basis: Enabling assumption.

2.8.4.3 LAWPS Pre-Filters (LAWPS-FLTR-00001/2) LAWPS Pre-Filter Flush Interval Time

Unique ID: BMR-LAWPS_TR-74

The LAWPS Pre-Filter Flush Interval Time is 45 minutes.

Basis: Assumed to be similar to TSCR.

2.8.4.4 LAWPS Pre-Filters (LAWPS-FLTR-00001/2) Flush Duration and Rate

Unique ID: BMR-LAWPS_TR-75

The LAWPS Pre-Filter Flush Rate is 15 gpm and the Filter Flush Duration is 30 seconds.

Basis: Assumed to be similar to TSCR.

2.8.4.5 LAWPS CsIX (LAWPS-CSIX-00001/2) Cesium Removal Fraction

Unique ID: BMR-LAWPS_TR-76

The LAWPS CsIX Cesium Removal Fraction, which applies to 137-Cs, 134-Cs, and Cs+, is 99.99%.

Basis: Assumed to be similar to TSCR.

2.8.4.6 LAWPS CsIX (LAWPS-CSIX-00001/2) Maximum 137-Cs Accumulation

Unique ID: BMR-LAWPS_TR-77

The Maximum 137-Cs Accumulation on the LAWPS-CSIX-00001/2 resin is 150,000 Ci.

Basis: Preliminary verbal direction from Rose Russell. Will update when the LAWPS project makes decision.

2.8.4.7 LAWPS CsIX (LAWPS-CSIX-00001) CsIX Displacement

Unique ID: BMR-LAWPS_TR-78

The LAWPS CsIX column displacement fluid concentration, volume, and rate is as follows:

<table>
<thead>
<tr>
<th>LAWPS CsIX Column Displacement Concentration</th>
<th>0.1M caustic</th>
</tr>
</thead>
<tbody>
<tr>
<td>LAWPS CsIX Column Displacement Volume</td>
<td>750 gallons</td>
</tr>
<tr>
<td>LAWPS CsIX Column Displacement Rate</td>
<td>5 gpm</td>
</tr>
</tbody>
</table>

Basis: Assumed to be similar to TSCR.
2.8.4.8 LAWPS CsIX (LAWPS-CSIX-00001/2) Spent CsIX Column Rinse

**Unique ID:** BMR-LAWPS_TR-79

The LAWPS CsIX column rinse water volume and rate is as follows:

<table>
<thead>
<tr>
<th>LAWPS CsIX Column Rinse Volume</th>
<th>1,125 gallons</th>
</tr>
</thead>
<tbody>
<tr>
<td>LAWPS CsIX Column Rinse Rate</td>
<td>5 gpm</td>
</tr>
</tbody>
</table>

**Basis:** Assumed to be similar to TSCR.

2.8.4.9 LAWPS CsIX (LAWPS-CSIX-00001/2) Replacement Column Conditioning

**Unique ID:** BMR-LAWPS_TR-80

The LAWPS CsIX column conditioning fluid concentration, volume, and rate is as follows:

<table>
<thead>
<tr>
<th>LAWPS CsIX Column Conditioning Concentration</th>
<th>0.1M caustic</th>
</tr>
</thead>
<tbody>
<tr>
<td>LAWPS CsIX Column Conditioning Volume</td>
<td>1,875 gallons</td>
</tr>
<tr>
<td>LAWPS CsIX Column Conditioning Rate</td>
<td>5 gpm</td>
</tr>
</tbody>
</table>

**Basis:** Assumed to be similar to TSCR.

2.9 TANK WASTE CHARACTERIZATION AND STAGING

The Tank Waste Characterization and Staging (TWCS) capability is a proposed new facility in the 200-East Area envisioned to provide better slurry mixing, sampling, and feed staging than would otherwise be possible using DSTs. The TWCS tanks will have the capability to accept transfers from DSTs, keep waste slurries adequately suspended to allow representative sampling of the waste, make transfers to each other, and transfer batches of feed to the WTP HLW Vitrification Facility.

This facility has not been designed and details of the vessel sizes are not available. Based on the assumptions and sizing calculations in RPP-RPT-45955, it is assumed that the TWCS capability would include six tanks with a maximum capacity of approximately 500 kgal each. The six tanks are numbered sequentially TWCSF-1, TWCSF-2, etc. through TWCSF-6 in the model. The space provided by these tanks is counted as part of the DST emergency space requirement.

Only one transfer from a DST to a TWCS vessel is allowed at a time, and only one transfer from a TWCS vessel to the WTP is allowed at a time. The pump-out rate is 140 gpm.

Transfers to the WTP are directed to the WTP PT HLW lag storage process vessel (HLP-VSL-00022) and target less than 10 wt% solids.

All waste transfers would be followed by a flush with inhibited water. Every transfer from a DST to a TWCS tank would include a 2,100 gal flush. Each transfer from a TWCS vessel to the WTP would be followed by a 3,000 gal flush, in three parts: 1) 1,000 gal is routed to HLP-VSL-00022 as a pre-warming flush prior to the transfer and then a 2,000 gallon post transfer.
flush which is split; 2) 800 gal is routed to HLP-VSL-00022 and 3) 1,200 is routed to the WTP PT HLW Effluent Transfer Vessel (PWD-VSL-00043). Transfers to WTP are targeted at 143,200 gal, so that after the 1,800 gallon flush is added the total transfer meets the maximum HLW batch size of 145,000 identified in 24590-WTP-ICD-MG-01-019, ICD-19.

Sampling and characterization activities are simulated by a 190 day hold time (10 days for the sample and 180 days for the analysis).

2.9.1 System Requirements

2.9.1.1 TWCS Storage of Waste

Unique ID: BMR-TWCS_SR-3

The TWCS shall receive waste from the DSTs and provide lag storage prior to transfer to the WTP Facilities.

Basis: N/A

2.9.1.2 TWCS Stage Waste

Unique ID: BMR-TWCS_SR-1

The TWCS shall blend, mix, and characterize wastes in preparation for delivery to WTP Facilities.

Basis: N/A

2.9.1.3 TWCS Deliver Feed

Unique ID: BMR-TWCS_SR-2

The TWCS shall provide feed to the WTP Facilities.

Basis: N/A

2.9.1.4 TWCS End of Mission Cleanout

Unique ID: BMR-TWCS_SR-4

The TWCS shall be cleaned out to specified levels at the end of the mission.

Basis: N/A

2.9.2 Functional Requirements

2.9.2.1 TWCS Receive Waste

Unique ID: BMR-TWCS_FR-8

The TWCS shall have the capability to receive waste and flushes from the DSTs.

Basis: N/A
2.9.2.2 TWCS Storage

Unique ID: BMR-TWCS_FR-9

The TWCS shall have the capability to store wastes.

Basis: N/A

2.9.2.3 TWCS Sample

Unique ID: BMR-TWCS_FR-11

The TWCS shall have the capability to be sampled.

Basis: N/A

2.9.2.4 TWCS Transfer to WTP

Unique ID: BMR-TWCS_FR-13

The TWCS shall have the capability to transfer to the WTP facilities.

Basis: N/A

2.9.2.5 TWCS Clean Out

Unique ID: BMR-TWCS_FR-14

The TWCS shall have the capability to be cleaned out at the end of the mission.

Basis: N/A

2.9.3 Model Requirements

2.9.3.1 TWCS Vessel Identification

Unique ID: BMR-TWCS_MR-1

The TWCS shall include six tanks identified as TWCSF-1, TWCSF-2, TWCSF-3, TWCSF-4, TWCSF-5 and TWCSF-6.

Basis: The TWCSF concept places emphasis on the ability to feed WTP with a consistent and controllable waste feed. The physical configuration of the storage tanks (e.g. height to diameter ratio) is an important aspect of that control in that it is harder to mix fast-settling solids in large diameter tanks. Document RPP-RPT-44860 describes the concept for the East Area WRF. Section 4.2 of this document describes the facility as 6 x 500kgal tanks, referencing a 2009 study performed by ARES.

2.9.3.2 TWCS Facility Constraint

Unique ID: BMR-TWCS_MR-10

The TWCS facility shall only receive one transfer at a time from the 200 East DSTs.

Basis: The ability to receive multiple transfers simultaneously would add complexity to the TWCS concept. Studies such as RPP-RPT-45955, East Area Waste Retrieval Facility Location and Tank Configuration Study, have not identified this ability as important to operational flexibility.
2.9.3.3 TWCS Feed Receipt Sources
Unique ID: BMR-TWCS_MR-2

The TWCS vessels shall receive HLW from the east area DSTs first from the TF-HOT-COM-TANKS then from the TF-HLW-FEED-TANKS planning groups.

Basis: The WTP requires HLW feed for hot commissioning prior to HLW feed for the balance of the mission.

2.9.3.4 TWCS Transfer Set Up Time Application
Unique ID: BMR-TWCS_MR-11

The TWCS Transfer Set Up Time shall be applied prior to a transfer from the DSTs to a TWCS vessel.

Basis: Transfers of hazardous waste within Tank Farms require a formal protocol that takes time to execute.

2.9.3.5 TWCS Vessel Filling Sequence
Unique ID: BMR-TWCS_MR-12

The TWCS vessels shall be filled and emptied in the order they were received.

Basis: First in, first out logic is the most efficient way to utilize the group of tanks given that there is a set of activities that must occur in series after each tank is filled and before the tank contents can be sent forward to the WTP.

2.9.3.6 TWCS - Hot Commissioning Batch
Unique ID: BMR-TWCS_MR-16

The first batch into and out of the the TWCS shall be from the Hot Commissioning DST.

Basis: The WTP requires HLW feed for hot commissioning prior to HLW feed for the balance of the mission. All HLW feed to the WTP must be certified as compliant with established waste acceptance criteria.

2.9.3.7 TWCS Initiate Fill
Unique ID: BMR-TWCS_MR-3

A TWCS vessel shall be available to fill after the TWCS Start-Up date and when the volume is less than the set volume.

Basis: The TWCSF is not available until it has been commissioned and declared ready for operation. Additionally, design criteria for tanks such as WAC 173-303-640 requires the use of appropriate controls and practices to prevent spills and overflows from tank or containment systems.

2.9.3.8 TWCS Vessel Complete Filling
Unique ID: BMR-TWCS_MR-4

A TWCS vessel shall complete filling when its volume is between the upper and lower set volumes.
**Basis:** With regard to the upper set volume, WAC 173-303-640 requires the owner or operator to use appropriate controls and practices to prevent spills and overflows from tank or containment systems. The lower set volume is a typical vessel constraint that is generally based on a physical limitation and/or a safety concern.

### 2.9.3.9 TWCS Post Receipt Line Flush

**Unique ID:** BMR-TWCS_MR-6

Each transfer received from the DSTs to the TWCS vessels shall include the *TWCS Vessel Feed Receipt Flush*.

**Basis:** Section 3.4.3.2 of TFC-ENG-STD-26 states that a flush with raw or inhibited water is recommended directly following, and required within 24 hours after, a concentrated supernatant or slurry transfer.

### 2.9.3.10 TWCS Apply Solubility

**Unique ID:** BMR-TWCS_MR-5

After a *TWCS* vessel has completed filling, solubility shall be applied at the vessel temperature.

**Basis:** The waste acceptance criteria for the WTP places limitations on solids. Mixing operations at the TWCS prior to sampling will add heat to the waste which will enhance the dissolution of some solid species. Solid particles may precipitate when the vessel contents return to their original temperature. This would compromise the certification of waste acceptability.

### 2.9.3.11 TWCS Sampling and Analysis

**Unique ID:** BMR-TWCS_MR-7

After solubility has been applied in the *TWCS* vessel, the *TWCS Vessel Sample Time* shall be applied.

**Basis:** ICD-19 requires certification that the waste feed has been sampled and found to be within the limits of the established waste acceptance criteria. Work processes related to sampling, analysis, review and approval generally take several months to execute.

### 2.9.3.12 TWCS Vessel Transfer to WTP

**Unique ID:** BMR-TWCS_MR-8

After the prescribed sampling time has elapsed and after the *PT Start Date*, the *TWCS* vessel shall be available to transfer to the *HLW Feed Receipt Vessel (HLP-VSL-00022)*.

**Basis:** The WTP HLW Feed Receipt Vessel is HLP-VSL-00022

### 2.9.3.13 TWCS Complete Discharge

**Unique ID:** BMR-TWCS_MR-15

A *TWCS* vessel shall complete discharging when it reaches its minimum volume or less than the minimum HLW batch size (see *HLW Batch Size*) remains in the *TWCS* vessel.

**Basis:** Vessels such as those envisioned for TWCS generally have a limit on how low the transfer pump will operate due to physical or safety concerns. Additionally, the assumed size of each TWCS vessel is much larger than the WTP HLW Feed Receipt Vessel, HLP-VSL-00022
which makes it possible to overflow the Receipt Vessel. Design criteria such as WAC 173-303-640 requires the use of appropriate controls and practices to prevent spills and overflows from tank or containment systems.

2.9.3.14 TWCS Vessel Constraint

Unique ID: BMR-TWCS_MR-9

Each TWCS vessel shall be restricted to only one transfer in or out at a time.

Basis: The ability for each vessel to receive or make multiple transfers simultaneously would add complexity to the TWCS concept. Studies such as RPP-RPT-45955, *East Area Waste Retrieval Facility Location and Tank Configuration Study*, have not identified this ability as important to operational flexibility.

2.9.3.15 TWCS Characterized Waste Protection

Unique ID: BMR-TWCS_MR-13

After the waste has been sampled, no new waste shall be added to the TWCS vessel until the contents have been discharged. The remaining heel in the TWCS vessel can be mixed with the next batch of waste.

Basis: The feed to be transferred to the WTP must be conform to waste acceptance criteria specified in ICD-19. Samples taken from a specific vessel for analysis must be representative of the vessel contents which means that no new waste can be added to the vessel until the contents have been discharged to the WTP or returned to the DST system. It is assumed that heels are mixed in with new contents before the contents are sampled.

2.9.3.16 TWCS Cleanout

Unique ID: BMR-TWCS_MR-14

The TWCS vessels shall be cleaned out to the TWCS Vessel Cleanout Volume and the discharge volume shall be at least the TWCS Cleanout Batch Size.

Basis: The system must close and stabilize DSTs, DST farms, and ancillary facilities when they are no longer required to conduct the RPP mission in accordance with approved closure plans and the TC&WM EIS Record of Decision (DE-AC27-08RV14800, Section C.1.4).

2.9.4 Technical Requirements

2.9.4.1 TWCS Vessels Parameters

Unique ID: BMR-TWCS_TR-1

The TWCS vessels shall have the following parametric values.

<table>
<thead>
<tr>
<th>Vessel #</th>
<th>Overflow Volume (gal)</th>
<th>Maximum Volume (gal)</th>
<th>Upper Set Volume (gal)</th>
<th>Lower Set Volume (gal)</th>
<th>Minimum Volume (gal)</th>
<th>Flow rate (gpm)</th>
<th>Temperature (°C)</th>
</tr>
</thead>
</table>

2-100
| TWCSF-1 through TWCSF-6 | N/A | 500,000 | 500,000 | 464,600 | 34,100 | 140 | 25 |

**Basis:** Consistent with RPP-RPT-45955, 500 kgal is chosen as a nominal volume for each vessel in order to meet the waste throughput requirements (given waste sampling time assumptions). The six vessels is consistent with RPP-RPT-44860.

### 2.9.4.2 TWCS Start-Up date

**Unique ID:** BMR-TWCS_TR-6

The TWCS start-up date shall be 6/30/2032.

**Basis:** Section 4.1 of RPP-40149-VOL3 states that in order to meet commitments for treatment of waste identified in the Consent Decree (2016), TWCS must be available to receive HLW from Tank Farms by June 30, 2032.

### 2.9.4.3 TWCS Vessel Feed Receipt Flush

**Unique ID:** BMR-TWCS_TR-7

The TWCS vessel feed receipt flush shall be 2,100 gallons of *Inhibited Water*.

**Basis:** The volume is based on an estimated average pipe length to the TWCS based on the location selected in RPP-RPT-45955 and the flushing requirements of Section 3.4.3.2 of TFC-ENG-STD-26. Inhibited water is a conservative assumption required for corrosion control based on OSD-T-151-00007.

### 2.9.4.4 TWCS Vessel Sample Time

**Unique ID:** BMR-TWCS_TR-2

The TWCS vessel sample time shall be 190 days, which includes 10 days for sampling and 180 days for analysis.

**Basis:** 24590-WTP-ICD-MG-01-019, Rev. 7. ICD-19 requires that samples are delivered to the WTP Contractor at least 180 days prior to the feed transfer. It is assumed that each TWCSF tank full of waste requires 10 days for mixing/sampling. Per email from B. Gallaher to S. Reaksecker, DST sampling requires 1 day to complete. The remaining 9 days is allocated to mixing the tank. The reduction in mixing/sampling time from 30 days (for a DST) to 10 days for a TWCSF tank was estimated based on each TWCSF tank having a diameter of 44 ft and being designed specifically for mixing and sampling. Since no formal design has been proposed, a detailed estimate of the actual time required is not available.

### 2.9.4.5 TWCS Transfer Set Up Time

**Unique ID:** BMR-TWCS_TR-4

The set up time for a transfer from the DSTs to a TWCS vessel shall be 5 days.

**Basis:** This assumption based on operational experience within Tank Farms. Transfers of hazardous waste within Tank Farms require a formal protocol that takes time to execute.
2.9.4.6  TWCS Vessel Cleanout Volume

**Unique ID:** BMR-TWCS_TR-3

The TWCS vessel cleanout volume shall be 1,000 gallons.

**Basis:** DOE M 435.1 and other applicable design criteria require features that are designed to facilitate decontamination. Strategically-placed spray wands are a typical feature for the cleanout of a vessel. Multiple rinses are also typical to dilute collected contamination so a total volume of 1,000 gallon for a 500,000 gal vessel is reasonable.

2.9.4.7  TWCS Minimum Cleanout Batch Size

**Unique ID:** BMR-TWCS_TR-5

The TWCS vessel minimum cleanout batch size shall be 100 gallons.

**Basis:** Chapter I, 1.E(20) of DOE M 435.1 states that waste minimization and pollution prevention shall be implemented for radioactive waste management facilities, operations, and activities. It is assumed that each vessel will have spray wands that are placed strategically to minimize the volume of water required to clean them out. So 100 gallons for each rinse is reasonable.

2.10  LIQUID EFFLUENT RETENTION FACILITY

The LERF is used to store low-activity potentially hazardous aqueous waste generated on the Hanford Site from a variety of remediation and waste management activities. The LERF consists of three lined and covered surface reservoirs which store the aqueous waste and feed it to the ETF. Two of the basins are in service and are modeled in the HSM as their actual capacities.

2.10.1  System Requirements

2.10.1.1  Receive Liquid Effluent

**Unique ID:** BMR-LERF_SR-1

The LERF shall receive and store liquid effluent, and transfer contents for treatment at ETF.

**Basis:** N/A

2.10.2  Functional Requirements

2.10.2.1  LERF Waste Receipt

**Unique ID:** BMR-LERF_FR-1

The LERF shall have the capability to receive liquid effluent from 242-A, EMF, CH-TRU, RLD and STLP.

**Basis:** N/A

2.10.2.2  LERF Waste Storage

**Unique ID:** BMR-LERF_FR-2

The LERF shall have the capacity to store liquid effluent within three lined basins.
Basis: N/A

2.10.2.3  LERF Waste Routing

Unique ID: BMR-LERF_FR-3

The LERF shall have the capability to route accumulated liquid effluent to the ETF.

Basis: N/A

2.10.3  Model Requirements

2.10.3.1  LERF Basins Identification

Unique ID: BMR-LERF_MR-4

The LERF shall consist of two LERF basins identified as LERF-BASIN-1 and LERF-BASIN-2. The third LERF basin shall not be modeled at this time as it receives wastes that fall outside of the scope of the treatment mission.

Basis: There are two LERF basins

2.10.3.2  LERF Basins Alternating Filling

Unique ID: BMR-LERF_MR-1

One LERF basin shall be empty, full, sampling, or emptying when the other LERF basin is filling (i.e. alternate filling).

Basis: Two LERF basins fill alternately.

2.10.3.3  LERF Basins Full

Unique ID: BMR-LERF_MR-6

A LERF basin shall stop receiving liquid effluent when the total volume in the basin is equal to the maximum volume of the basin (i.e. basin is full).

Basis: LERF basin stops receiving when its limit is exceeded during or/and upon completion of transfer.

2.10.3.4  LERF Basins Alternating Emptying

Unique ID: BMR-LERF_MR-5

One LERF basin shall be empty, full, sampling, or filling when the other LERF basin is emptying (i.e. alternate emptying).

Basis: Two LERF basins empty alternately.

2.10.3.5  LERF Basins Empty

Unique ID: BMR-LERF_MR-7

A LERF basin shall be empty when the total volume in the basin is less than or equal to the minimum volume of the basin.

Basis: Basin is to be emptied when the total volume is minimum volume or less.
2.10.3.6 LERF Basins Receipt

Unique ID: BMR-LERF_MR-2

The *LERF* shall receive *liquid effluent* from its sources when a *LERF basin* is empty or filling.

*Basis:* LERF basin receives as long as its limit is not exceeded during or/and upon completion of transfer.

2.10.3.7 LERF Basins Simultaneous Receipt

Unique ID: BMR-LERF_MR-8

A *LERF basin* shall be capable of receiving from multiple sources simultaneously.

*Basis:* LERF basin can receive from multiple sources as long as its limit is not exceeded.

2.10.3.8 LERF 242-A Waste Source

Unique ID: BMR-LERF_MR-9

The *LERF basins* shall receive *liquid effluent* from the 242-A-CONDENSER.

*Basis:* 242-A Evaporator process condensate is to be received and treated.

2.10.3.9 LERF CH-TRU Waste Source

Unique ID: BMR-LERF_MR-10

The *LERF basins* shall receive *liquid effluent* from the supplemental CH-TRU demister.

*Basis:* Derived from the CH-TRU process description and process flow diagram, and including a simplifying assumption that the DWS Liquid Effluent Tanks and the LES Storage do not need to be modeled.

2.10.3.10 LERF EMF Waste Source

Unique ID: BMR-LERF_MR-11

The *LERF basins* shall receive *liquid effluent* from the EMF-DMST-00001 - EMF Evaporator Demister/Condenser.

*Basis:* LERF basin receives transfer from evaporator demister/condenser

2.10.3.11 LERF RLD Waste Source

Unique ID: BMR-LERF_MR-12

The *LERF basins* shall receive *liquid effluent* from the RLD-VSL-00006B - Process Condensate Vessel.

*Basis:* LERF basin receives transfers from process condensate vessel.

2.10.3.12 LERF SLVP Waste Source

Unique ID: BMR-LERF_MR-13

The *LERF basins* shall receive *liquid effluent* from the SLVP caustic scrubber (SLVP-SCB-00001).
Basis: It is initially designed by subject matter expert that basin receives from SLVP caustic scrubber.

2.10.3.13 LERF STLP Waste Source

Unique ID: BMR-LERF_MR-14

The LERF basins shall receive liquid effluent from the second LAW back-end evaporator condenser (STLP-DMST-00001).

Basis: It was designed and engineered by subject matter expert initially that the basin receives from second LAW back-end evaporator condenser.

2.10.3.14 LERF LVP Waste Source

Unique ID: BMR-LERF_MR-16

The LERF Basins shall receive liquid effluent from the Caustic Scrubber Column (LVP-SCB-00001) during DFLAW operations.

Basis: It was designed and engineered by subject matter expert initially that the basin receives from caustic scrubber column during DFLAW operation.

2.10.3.15 LERF Basins Transfer Trigger

Unique ID: BMR-LERF_MR-3

A LERF basin shall transfer its contents (down to the vessel minimum volume) to the ETF when the vessel is within 1M gallons of the set volume and the ETF is capable of receiving.

Basis: Basin can transfer to ETF as long as there is enough capacity to complete the transferred volume (1M gal or less).

2.10.3.16 LERF Basins Waste Destination

Unique ID: BMR-LERF_MR-15

The LERF basins shall transfer liquid effluent to the ETF separation vessel.

Basis: As per RPP-RPT-57991, liquid effluent from LERF will be transferred to ETF.

2.10.4 Technical Requirements

2.10.4.1 LERF Basins Parameters

Unique ID: BMR-LERF_TR-1

Each LERF basin shall have the following parameters.

<table>
<thead>
<tr>
<th>Vessel #</th>
<th>Overflow Volume (gal)</th>
<th>Maximum Volume (gal)</th>
<th>Set Volume (gal)</th>
<th>Minimum Volume (gal)</th>
<th>Maximum Flow Rate (gpm)</th>
<th>Temperature (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>LERF-BASIN-1</td>
<td>Not Modeled</td>
<td>7,800,000</td>
<td>7,800,000</td>
<td>250,000</td>
<td>100</td>
<td>N/A</td>
</tr>
</tbody>
</table>
Basis: LERF-BASIN has approximate capacity of 7.8 Mgal, and operates in the range of 70 - 110 gpm.

2.10.5 LERF Future Development

Unique ID: BMR-TXT-429

2.11 EFFLUENT TREATMENT FACILITY

The ETF consists of a series of wastewater process units that are configured to provide treatment for contaminants that might be present in aqueous waste generated on the Hanford Site. The main treatment train includes process units that remove or destroy dangerous organic and radioactive constituents from the aqueous waste. Residue from these treatment processes are concentrated and dried into a powder in a secondary treatment train. (A project upgrade to solidify residues is planned.)

The treated liquid effluent is directed to verification tanks, where it is sampled, analyzed, and verified to be below release limits. The treated effluent is discharged under a state waste discharge permit and approved delisting petition to the state approved land disposal site (SALDS) located in the 600 Area. The treated effluent is discharged as a non-dangerous, delisted waste. In the HSM, the ETF is modeled as a black-box, where the liquid contaminants are split to a solid fraction, which is then used to estimate the number of drums of powder generated, based on an estimated density.

2.11.1 System Requirements

2.11.1.1 Liquid Treatment

Unique ID: BMR-ETF_SR-1

The ETF shall remove organics, contaminants and solids from liquid effluent so that the resulting liquid stream meets applicable state and federal requirements for disposal at the SALDS.

Basis: N/A

2.11.2 Functional Requirements

2.11.2.1 ETF Waste Receipt

Unique ID: BMR-ETF_FR-1

The ETF shall have the capability of receiving liquid effluent from the LERF.

Basis: N/A
2.11.2.2 Primary Waste Treatment - Solids Removal

Unique ID: BMR-ETF_FR-7

The ETF shall have the capability of removing suspended solids generated within the treatment process.

Basis: N/A

2.11.2.3 Treated Liquid Storage

Unique ID: BMR-ETF_FR-3

The ETF shall have the capability of storing the treated liquid stream.

Basis: N/A

2.11.2.4 Treated Solids Storage

Unique ID: BMR-ETF_FR-4

The ETF shall have the capability of storing the treated solids powder in drums.

Basis: N/A

2.11.3 Model Requirements

2.11.3.1 ETF Separation Vessel Identification

Unique ID: BMR-ETF_MR-1

The ETF separation vessel shall consist of a block splitter identified as ETF-SPLITS.

Basis: Naming convention for block splitter was initially chosen and used by SME.

2.11.3.2 ETF Liquid Storage Vessel

Unique ID: BMR-ETF_MR-2

The ETF liquid storage vessel shall be identified as ETF-LIQUID-EFFLUENT.

Basis: SME originally named the vessel.

2.11.3.3 ETF Solids Storage Vessel

Unique ID: BMR-ETF_MR-3

The ETF solids storage vessel shall be identified as ETF-SOLID-EFFLUENT.

Basis: SME originally named the vessel.

2.11.3.4 ETF Separation Vessel Receipt

Unique ID: BMR-ETF_MR-4

The ETF separation vessel shall receive liquid effluent when a LERF basin is available to transfer its contents.

Basis: Since ETF separation vessel receives liquid effluent indirectly via LERF basin, available space in LERF basin must be secured for the transfer.
2.11.3.5 ETF Apply splits

Unique ID: BMR-ETF_MR-5

When a full batch of liquid effluent has been received, liquid/solids separation shall occur in the ETF separation vessel based on the ETF separation vessel splits.

Basis: Separation vessel split separates liquid/solid in separation vessel.

2.11.3.6 ETF Solids Routing

Unique ID: BMR-ETF_MR-6

After the splits have been applied, the stream shall be transferred from the ETF separation vessel to the ETF solids storage vessel. Then all components shall be converted to the solid phase.

Basis: Separated phases are segregated into their respective storage vessels upon separation in separation vessel. Solid phase is transferred to ETF solids storage vessel.

2.11.3.7 ETF Liquid Routing

Unique ID: BMR-ETF_MR-7

After the splits have been applied, the liquid stream (including accompanying un-split solids) is transferred from the ETF separation vessel to the ETF liquid storage vessel in their respective phases (liquids and solids).

Basis: Separated phases are segregated into their respective storage vessels upon separation in separation vessel. Liquid phase is transferred to ETF liquid storage vessel.

2.11.3.8 ETF Solids Packaging

Unique ID: BMR-ETF_MR-8

The number of solids packages shall be calculated and tracked based on the solids received to the ETF solids storage vessel.

Basis: Solid packages can be accounted based on the volume of solids received in solids storage vessel.

2.11.4 Technical Requirements

2.11.4.1 ETF Separation Vessel Parameters

Unique ID: BMR-ETF_TR-1

The ETF separation vessel shall act as a simple splitter to separate solids and liquids and therefore does not have vessel parameters.

Basis: Purpose of separation vessel is to segregate solid and liquid waste apart.

2.11.4.2 ETF Liquid Storage Vessel Parameters

Unique ID: BMR-ETF_TR-2

The ETF liquid storage vessel shall have the following parameters.
### 2.11.4.3 ETF Solids Storage Vessel Parameters

**Unique ID:** BMR-ETF_TR-3

The ETF solids storage vessel shall have the following parameters.

<table>
<thead>
<tr>
<th>Vessel #</th>
<th>Overflow Volume (gal)</th>
<th>Maximum Volume (gal)</th>
<th>Set Volume (gal)</th>
<th>Minimum Volume (gal)</th>
<th>Maximum Flow Rate (gpm)</th>
<th>Temperature (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ETF-SOLID-EFFLUENT</td>
<td>Not Modeled</td>
<td>10,000,000,000</td>
<td>Not Modeled</td>
<td>Not Modeled</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>

**Basis:** Engineering judgement of SME led to adequate maximum volume to accommodate the solid storage of the vessel.

### 2.11.4.4 ETF Split Factors

**Unique ID:** BMR-ETF_TR-4

The split factors from the tab "ETF-SPLITS" in SVF-1778, Rev. 8 shall be applied to the ETF separation vessel.

**Basis:** Split factors from SVF-1778 Rev.8 are to be applied.

### 2.11.4.5 ETF Solids Bulk Density

**Unique ID:** BMR-ETF_TR-5

The bulk density of the solids sent to the ETF solids storage vessel and the ETF liquid storage vessel shall be 1.18 kg/L.

**Basis:** SpG for S Complex waste is 1.18 g/mL

### 2.11.4.6 ETF Solids Containers

**Unique ID:** BMR-ETF_TR-6

55 gallon drums shall be used to calculate the number of equivalent ETF solids packages, filled to 100%.

**Basis:** 55 gallon drums are used for ETF packages.
2.12 WASTE PHYSICAL PROPERTIES

The Waste system contains the model requirements and assumptions pertaining to waste behavior and composition. This system has no physical components but contains the bases for describing waste behavior in physical systems. This system establishes the initial waste inventory (volume and composition), and contains the rules that are used for modeling phase equilibria, chemical reactions, and radioactive decay.

2.12.1 System Requirements

2.12.1.1 Waste Behavior

Unique ID: BMR-WASTE_SR-1

The waste shall behave in accordance with established physical laws.

Basis: N/A

2.12.1.2 Waste Composition

Unique ID: BMR-WASTE_SR-2

The waste shall consist of unique chemical components which account for its entire mass.

Basis: N/A

2.12.2 Functional Requirements

2.12.2.1 Waste Phase Equilibria

Unique ID: BMR-WASTE_FR-1

The waste shall have the capability to move between the solid and aqueous or aqueous and gaseous phases dependent on physical and process conditions.

Basis: Waste phases can change solid/liquid and liquid/gas based on solubility and Henry's constant of components, respectively.

2.12.2.2 Waste Chemical Reactions

Unique ID: BMR-WASTE_FR-3

Chemical components of the waste shall have the capability to react to form other chemical components dependent on physical and process conditions.

Basis: N/A

2.12.2.3 Waste Volume

Unique ID: BMR-WASTE_FR-4

The waste volume shall have the capability to change dependent on physical and process conditions.

Basis: N/A
2.12.2.4 Waste Initial Inventory

Unique ID: BMR-WASTE_FR-2

The initial composition of the waste shall have the capability to be specified.

Basis: N/A

2.12.2.5 Waste Radioactive Decay

Unique ID: BMR-WASTE_FR-5

The radioactive components of the waste shall have the capability to decay over time.

Basis: Radioactive isotopes decay over time according to their known half-life, specific activity, and parent-daughter decay relationship (decay calculation).

2.12.3 Model Requirements

2.12.3.1 Waste Splits Calculation

Unique ID: BMR-WASTE_MR-13

The waste shall have the capability to move between the aqueous and gaseous phases at specified points in the process according to split factors.

Basis: Components can move between solid/liquid phases according to their corresponding split factors based on Table D-1 from 24590-WTP-MDD-PR-01-002, Rev. 13.

2.12.3.2 Unique Component Inventories

Unique ID: BMR-WASTE_MR-6

The same inventory shall not be counted under multiple components.

Basis: Same component will not be counted under multi-species component to avoid redundant counting.

2.12.3.3 Wash and Caustic Leach Factors

Unique ID: BMR-WASTE_MR-12

Wash and caustic leach factors will be determined depending on components of the tank contents. The water wash factors are used for partitioning waste into solid and liquid phases during retrieval and staging, and caustic leach factors are used to determine the extent of solids dissolution during caustic leaching for each HLW batch delivered to the WTP.

Basis: The wash factors are applied to DST solids at the start of a model run and to SST solids when retrieval water is added. The leach factors are applied in the ultrafiltration process of the WTP. Leach factors are used for following components: Al, Bi, Ca, Cr, Fe, Na, P, Si, S, and U. The application of wash and caustic leach factors will be determined based on requirement (24590-WTP-MDD-PR-01-002, Rev. 13).

2.12.3.4 Solubility correlation

Unique ID: BMR-WASTE_MR-14

Solubility correlation shall be applied in considerations of:
1. 'G-calc' applications
2. Sr-90 solubility (2000) calculation as per requirement (BMR-WASTE_TR-349)
3. Conversion to total Sr solubility by multiplying factor (BMR-WASTE_TR-350)
4. Matching the moles of liquid Sr\textsubscript{Total} to calculated moles of liquid Sr: Equal fraction of Sr-90 and Sr\textsubscript{+2} shall precipitate to solid phase when liquid Sr exceeds calculated value, and shall dissolve when liquid Sr is less than calculated value.
5. Yr-90 decay to secular equilibrium for its decay rate will be similar to Sr-90 decay rate.
6. Wash factors and caustic leach factors (BMR-WASTE_MR-12)

**Basis:** Solubility correlation is applied for G-calc application, Sr-90 solubility, total Sr solubility conversion, moles matching and decays as per requirements.

### 2.12.3.5 Mass Balance
**Unique ID:** BMR-WASTE_MR-15
Total mass balance of all components in DST and SST shall be calculated and accounted for.

**Basis:** Ensure mass is conserved and properly accounted for throughout the flowsheet.

### 2.12.3.6 Density Correlation for Liquid
**Unique ID:** BMR-WASTE_MR-16
The liquid volume is calculated using the mass and density correlations.

**Basis:** Liquid density is found using calculation with density coefficient and molecular weights and mass of components.

\[
d_i = \frac{d_w m_T}{(m_T - d_w 1000 \sum k m_{k_i})}
\]

where:
- \(d_i\) = Density of liquid
- \(d_w\) = Reference density of water (which is assumed as 1 in TOPSim)
- \(Y_i\) = Density coefficient (L/gmol)
- \(m_T\) = Total component mass (kg)
- \(k\) = Amount of component i (kmol)

### 2.12.3.7 Decay Frequency
**Unique ID:** BMR-WASTE_MR-17
Radionuclides shall be decayed annually on January 1st. TOPSim shall take the reference decay date from most recent revision of RPP-33715.

**Basis:** Annual decay of radionuclides provides reasonable compositional accuracy of model data while balancing the computational demand of performing decay calculations.
2.12.3.8 Decay Function

Unique ID: BMR-WASTE_MR-18
Radionuclide decay shall be calculated using decay equation.

**Basis:** Radionuclide decay equations require half-lives for components of interest and their mother-daughter isotope relationships.

2.12.3.9 Reaction Process

Unique ID: BMR-WASTE_MR-19
All reaction process shall have proper reactants and products based on their stoichiometric reaction balance.

**Basis:** Reactions are necessary in order to maintain adequate accounting of chemical components and mass balances.

2.12.3.10 Density Correlation for Solids

Unique ID: BMR-WASTE_MR-20
The solid volume is calculated using the mass and density correlations.

**Basis:** Solid density is found using calculation with density coefficient and molecular weights and mass of components.

2.12.4 Technical Requirements

2.12.4.1 106-RU-OXIDE

Unique ID: BMR-WASTE_TR-1
1.0 106-Ru(l) + 1.0 O₂(g) --> 1.0 106-Ru(o) + 2.0 O(BOUND)(o)

**Basis:** This balanced equation is based on oxidation reactions table on page 93 of 24590-WTP-MDD-PR-01-002, Rev. 13.

2.12.4.2 113M-CD-OXIDE

Unique ID: BMR-WASTE_TR-2
1.0 113m-Cd(l) + 0.5 O₂(g) --> 1.0 113m-Cd(o) + 1.0 O(BOUND)(o)

**Basis:** This balanced equation is based on oxidation reactions table on page 92 of 24590-WTP-MDD-PR-01-002, Rev. 13.

2.12.4.3 125-SB-OXIDE

Unique ID: BMR-WASTE_TR-3
2.0 125-Sb(l) + 1.5 O₂(g) --> 2.0 125-Sb(o) + 3.0 O(BOUND)(o)

**Basis:** This balanced equation is based on oxidation reactions table on page 93 of 24590-WTP-MDD-PR-01-002, Rev. 13.
### 2.12.4.4 126-SN-OXIDE

**Unique ID:** BMR-WASTE_TR-4  

\[ 1.0 \text{^{126}Sn(l)} + 1.0 \text{O}_2(g) \rightarrow 1.0 \text{^{126}Sn(o)} + 2.0 \text{O(BOUND)(o)} \]

**Basis:** This balanced equation is based on oxidation reactions table on page 93 of 24590-WTP-MDD-PR-01-002, Rev. 13.

### 2.12.4.5 129-I-OXIDE

**Unique ID:** BMR-WASTE_TR-5  

\[ 1.0 \text{^{129}I(l)} \rightarrow 1.0 \text{^{129}I(o)} \]

**Basis:** This balanced equation is based on oxidation reactions table on page 91 of 24590-WTP-MDD-PR-01-002, Rev. 13.

### 2.12.4.6 134-CS-OXIDE

**Unique ID:** BMR-WASTE_TR-6  

\[ 2.0 \text{^{134}Cs(l)} + 0.5 \text{O}_2(g) \rightarrow 2.0 \text{^{134}Cs(o)} + 1.0 \text{O(BOUND)(o)} \]

**Basis:** This balanced equation is based on oxidation reactions table on page 92 of 24590-WTP-MDD-PR-01-002, Rev. 13.

### 2.12.4.7 137-CS-OXIDE

**Unique ID:** BMR-WASTE_TR-7  

\[ 2.0 \text{^{137}Cs(l)} + 0.5 \text{O}_2(g) \rightarrow 2.0 \text{^{137}Cs(o)} + 1.0 \text{O(BOUND)(o)} \]

**Basis:** This balanced equation is based on oxidation reactions table on page 92 of 24590-WTP-MDD-PR-01-002, Rev. 13.

### 2.12.4.8 137M-BA-OXIDE

**Unique ID:** BMR-WASTE_TR-8  

\[ 1.0 \text{^{137m}Ba(l)} + 0.5 \text{O}_2(g) \rightarrow 1.0 \text{^{137m}Ba(o)} + 1.0 \text{O(BOUND)(o)} \]

**Basis:** This balanced equation is based on oxidation reactions table on page 92 of 24590-WTP-MDD-PR-01-002, Rev. 13.

### 2.12.4.9 14-C-OXIDE

**Unique ID:** BMR-WASTE_TR-9  

\[ 1.0 \text{^{14}C(l)} \rightarrow 1.0 \text{^{14}C(o)} \]

**Basis:** This balanced equation is based on oxidation reactions table on page 91 of 24590-WTP-MDD-PR-01-002, Rev. 13.

### 2.12.4.10 151-SM-OXIDE

**Unique ID:** BMR-WASTE_TR-10  

\[ 2.0 \text{^{151}Sm(l)} + 1.5 \text{O}_2(g) \rightarrow 2.0 \text{^{151}Sm(o)} + 3.0 \text{O(BOUND)(o)} \]
Basis: This balanced equation is based on oxidation reactions table on page 93 of 24590-WTP-MDD-PR-01-002, Rev. 13.

2.12.4.11  152-EU-OXIDE

Unique ID: BMR-WASTE_TR-11

2.0 152-Eu(l) + 1.5 O_2(g) --> 2.0 152-Eu(o) + 3.0 O(BOUND)(o)

Basis: This balanced equation is based on oxidation reactions table on page 92 of 24590-WTP-MDD-PR-01-002, Rev. 13. The balanced equation on the table is different and needs corrected balance.

2.12.4.12  154-EU-OXIDE

Unique ID: BMR-WASTE_TR-12

2.0 154-Eu(l) + 1.5 O_2(g) --> 2.0 154-Eu(o) + 3.0 O(BOUND)(o)

Basis: This balanced equation is based on oxidation reactions table on page 92 of 24590-WTP-MDD-PR-01-002, Rev. 13. The balanced equation on the table is different and needs corrected balance.

2.12.4.13  155-EU-OXIDE

Unique ID: BMR-WASTE_TR-13

2.0 155-Eu(l) + 1.5 O_2(g) --> 2.0 155-Eu(o) + 3.0 O(BOUND)(o)

Basis: This balanced equation is based on oxidation reactions table on page 92 of 24590-WTP-MDD-PR-01-002, Rev. 13. The balanced equation on the table is different and needs corrected balance.

2.12.4.14  226-RA-OXIDE

Unique ID: BMR-WASTE_TR-14

1.0 226-Ra(l) + 0.5 O_2(g) --> 1.0 226-Ra(o) + 1.0 O(BOUND)(o)

Basis: This balanced equation is based on oxidation reactions table on page 93 of 24590-WTP-MDD-PR-01-002, Rev. 13.

2.12.4.15  227-AC-OXIDE

Unique ID: BMR-WASTE_TR-15

2.0 227-Ac(l) + 1.5 O_2(g) --> 2.0 227-Ac(o) + 3.0 O(BOUND)(o)

Basis: This balanced equation is based on oxidation reactions table on page 92 of 24590-WTP-MDD-PR-01-002, Rev. 13.

2.12.4.16  228-RA-OXIDE

Unique ID: BMR-WASTE_TR-16

1.0 228-Ra(l) + 0.5 O_2(g) --> 1.0 228-Ra(o) + 1.0 O(BOUND)(o)

Basis: This balanced equation is based on oxidation reactions table on page 93 of 24590-WTP-MDD-PR-01-002, Rev. 13.
2.12.4.17  **229-TH-OXIDE**

**Unique ID:** BMR-WASTE_TR-17

1.0 $^{229}\text{Th}(l) + 1.0\ O_2(g)$ $\rightarrow$ 1.0 $^{229}\text{Th}(o) + 2.0\ O(BOUND)(o)$

**Basis:** This balanced equation is based on oxidation reactions table on page 93 of 24590-WTP-MDD-PR-01-002, Rev. 13.

2.12.4.18  **231-PA-OXIDE**

**Unique ID:** BMR-WASTE_TR-18

2.0 $^{231}\text{Pa}(l) + 1.5\ O_2(g)$ $\rightarrow$ 2.0 $^{231}\text{Pa}(o) + 3.0\ O(BOUND)(o)$

**Basis:** This balanced equation is based on oxidation reactions table on page 93 of 24590-WTP-MDD-PR-01-002, Rev. 13.

2.12.4.19  **232-TH-OXIDE**

**Unique ID:** BMR-WASTE_TR-19

1.0 $^{232}\text{Th}(l) + 1.0\ O_2(g)$ $\rightarrow$ 1.0 $^{232}\text{Th}(o) + 2.0\ O(BOUND)(o)$

**Basis:** This balanced equation is based on oxidation reactions table on page 93 of 24590-WTP-MDD-PR-01-002, Rev. 13.

2.12.4.20  **232-U-OXIDE**

**Unique ID:** BMR-WASTE_TR-20

1.0 $^{232}\text{U}(l) + 1.5\ O_2(g)$ $\rightarrow$ 1.0 $^{232}\text{U}(o) + 3.0\ O(BOUND)(o)$

**Basis:** This balanced equation is based on oxidation reactions table on page 93 of 24590-WTP-MDD-PR-01-002, Rev. 13.

2.12.4.21  **233-U-OXIDE**

**Unique ID:** BMR-WASTE_TR-21

1.0 $^{233}\text{U}(l) + 1.5\ O_2(g)$ $\rightarrow$ 1.0 $^{233}\text{U}(o) + 3.0\ O(BOUND)(o)$

**Basis:** This balanced equation is based on oxidation reactions table on page 93 of 24590-WTP-MDD-PR-01-002, Rev. 13.

2.12.4.22  **234-U-OXIDE**

**Unique ID:** BMR-WASTE_TR-22

1.0 $^{234}\text{U}(l) + 1.5\ O_2(g)$ $\rightarrow$ 1.0 $^{234}\text{U}(o) + 3.0\ O(BOUND)(o)$

**Basis:** This balanced equation is based on oxidation reactions table on page 93 of 24590-WTP-MDD-PR-01-002, Rev. 13.

2.12.4.23  **235-U-OXIDE**

**Unique ID:** BMR-WASTE_TR-23

1.0 $^{235}\text{U}(l) + 1.5\ O_2(g)$ $\rightarrow$ 1.0 $^{235}\text{U}(o) + 3.0\ O(BOUND)(o)$
Basis: This balanced equation is based on oxidation reactions table on page 93 of 24590-WTP-MDD-PR-01-002, Rev. 13.

2.12.4.24 236-U-OXIDE
Unique ID: BMR-WASTE_TR-24
1.0 236-U(l) + 1.5 O\(_2\) (g) --> 1.0 236-U(o) + 3.0 O(BOUND)(o)
Basis: This balanced equation is based on oxidation reactions table on page 93 of 24590-WTP-MDD-PR-01-002, Rev. 13.

2.12.4.25 237-NP-OXIDE
Unique ID: BMR-WASTE_TR-25
1.0 237-Np(l) + 1.0 O\(_2\) (g) --> 1.0 237-Np(o) + 2.0 O(BOUND)(o)
Basis: This balanced equation is based on oxidation reactions table on page 93 of 24590-WTP-MDD-PR-01-002, Rev. 13.

2.12.4.26 238-PU-OXIDE
Unique ID: BMR-WASTE_TR-26
1.0 238-Pu(l) + 1.0 O\(_2\) (g) --> 1.0 238-Pu(o) + 2.0 O(BOUND)(o)
Basis: This balanced equation is based on oxidation reactions table on page 93 of 24590-WTP-MDD-PR-01-002, Rev. 13.

2.12.4.27 238-U-OXIDE
Unique ID: BMR-WASTE_TR-27
1.0 238-U(l) + 1.5 O\(_2\) (g) --> 1.0 238-U(o) + 3.0 O(BOUND)(o)
Basis: This balanced equation is based on oxidation reactions table on page 93 of 24590-WTP-MDD-PR-01-002, Rev. 13.

2.12.4.28 239-PU-OXIDE
Unique ID: BMR-WASTE_TR-28
1.0 239-Pu(l) + 1.0 O\(_2\) (g) --> 1.0 239-Pu(o) + 2.0 O(BOUND)(o)
Basis: This balanced equation is based on oxidation reactions table on page 93 of 24590-WTP-MDD-PR-01-002, Rev. 13.

2.12.4.29 240-PU-OXIDE
Unique ID: BMR-WASTE_TR-29
1.0 240-Pu(l) + 1.0 O\(_2\) (g) --> 1.0 240-Pu(o) + 2.0 O(BOUND)(o)
Basis: This balanced equation is based on oxidation reactions table on page 93 of 24590-WTP-MDD-PR-01-002, Rev. 13.
2.12.4.30  241-AM-OXIDE
Unique ID: BMR-WASTE_TR-30

2.0 241-Am(l) + 1.5 O_2(g) \rightarrow 2.0 \text{241-Am(o)} + 3.0 \text{O(BOUND)(o)}

Basis: This balanced equation is based on oxidation reactions table on page 92 of 24590-WTP-MDD-PR-01-002, Rev. 13.

2.12.4.31  241-PU-OXIDE
Unique ID: BMR-WASTE_TR-31

1.0 241-Pu(l) + 1.0 O_2(g) \rightarrow 1.0 241-Pu(o) + 2.0 \text{O(BOUND)(o)}

Basis: This balanced equation is based on oxidation reactions table on page 93 of 24590-WTP-MDD-PR-01-002, Rev. 13.

2.12.4.32  242-CM-OXIDE
Unique ID: BMR-WASTE_TR-32

2.0 242-Cm(l) + 1.5 O_2(g) \rightarrow 2.0 242-Cm(o) + 3.0 \text{O(BOUND)(o)}

Basis: This balanced equation is based on oxidation reactions table on page 92 of 24590-WTP-MDD-PR-01-002, Rev. 13.

2.12.4.33  242-PU-OXIDE
Unique ID: BMR-WASTE_TR-33

1.0 242-Pu(l) + 1.0 O_2(g) \rightarrow 1.0 242-Pu(o) + 2.0 \text{O(BOUND)(o)}

Basis: This balanced equation is based on oxidation reactions table on page 93 of 24590-WTP-MDD-PR-01-002, Rev. 13.

2.12.4.34  243-AM-OXIDE
Unique ID: BMR-WASTE_TR-34

2.0 243-Am(l) + 1.5 O_2(g) \rightarrow 2.0 243-Am(o) + 3.0 \text{O(BOUND)(o)}

Basis: This balanced equation is based on oxidation reactions table on page 92 of 24590-WTP-MDD-PR-01-002, Rev. 13.

2.12.4.35  243-CM-OXIDE
Unique ID: BMR-WASTE_TR-35

2.0 243-Cm(l) + 1.5 O_2(g) \rightarrow 2.0 243-Cm(o) + 3.0 \text{O(BOUND)(o)}

Basis: This balanced equation is based on oxidation reactions table on page 92 of 24590-WTP-MDD-PR-01-002, Rev. 13.

2.12.4.36  244-CM-OXIDE
Unique ID: BMR-WASTE_TR-36

2.0 244-Cm(l) + 1.5 O_2(g) \rightarrow 2.0 244-Cm(o) + 3.0 \text{O(BOUND)(o)}
Basis: This balanced equation is based on oxidation reactions table on page 92 of 24590-WTP-MDD-PR-01-002, Rev. 13.

2.12.4.37  3-H-OXIDE
Unique ID: BMR-WASTE_TR-37
1.0 3-H(l) --> 1.0 3-H(o)

Basis: This balanced equation is based on oxidation reactions table on page 92 of 24590-WTP-MDD-PR-01-002, Rev. 13.

2.12.4.38  59-NI-OXIDE
Unique ID: BMR-WASTE_TR-38
1.0 59-Ni(l) + 0.5 O_2(g) --> 1.0 59-Ni(o) + 1.0 O(BOUND)(o)

Basis: This balanced equation is based on oxidation reactions table on page 93 of 24590-WTP-MDD-PR-01-002, Rev. 13.

2.12.4.39  60-CO-OXIDE
Unique ID: BMR-WASTE_TR-39
1.0 60-Co(l) + 0.5 O_2(g) --> 1.0 60-Co(o) + 1.0 O(BOUND)(o)

Basis: This balanced equation is based on oxidation reactions table on page 92 of 24590-WTP-MDD-PR-01-002, Rev. 13.

2.12.4.40  63-NI-OXIDE
Unique ID: BMR-WASTE_TR-40
1.0 63-Ni(l) + 0.5 O_2(g) --> 1.0 63-Ni(o) + 1.0 O(BOUND)(o)

Basis: This balanced equation is based on oxidation reactions table on page 93 of 24590-WTP-MDD-PR-01-002, Rev. 13.

2.12.4.41  79-SE-OXIDE
Unique ID: BMR-WASTE_TR-41
1.0 79-Se(l) + 1.0 O_2(g) --> 1.0 79-Se(o) + 2.0 O(BOUND)(o)

Basis: This balanced equation is based on oxidation reactions table on page 93 of 24590-WTP-MDD-PR-01-002, Rev. 13.

2.12.4.42  90-SR-OXIDE
Unique ID: BMR-WASTE_TR-42
1.0 90-Sr(l) + 0.5 O_2(g) --> 1.0 90-Sr(o) + 1.0 O(BOUND)(o)

Basis: This balanced equation is based on oxidation reactions table on page 93 of 24590-WTP-MDD-PR-01-002, Rev. 13.
2.12.4.43  90-Y-OXIDE
Unique ID: BMR-WASTE_TR-43
2.0 90-Y(l) + 1.5 O_{2}(g) \rightarrow 2.0 90-Y(o) + 3.0 O(BOUND)(o)
Basis: This balanced equation is based on oxidation reactions table on page 93 of 24590-WTP-MDD-PR-01-002, Rev. 13.

2.12.4.44  93-ZR-OXIDE
Unique ID: BMR-WASTE_TR-44
1.0 93-Zr(l) + 1.0 O_{2}(g) \rightarrow 1.0 93-Zr(o) + 2.0 O(BOUND)(o)
Basis: This balanced equation is based on oxidation reactions table on page 93 of 24590-WTP-MDD-PR-01-002, Rev. 13.

2.12.4.45  93M-Nb-OXIDE
Unique ID: BMR-WASTE_TR-45
2.0 93m-Nb(l) + 2.5 O_{2}(g) \rightarrow 2.0 93m-Nb(o) + 5.0 O(BOUND)(o)
Basis: This balanced equation is based on oxidation reactions table on page 93 of 24590-WTP-MDD-PR-01-002, Rev. 13.

2.12.4.46  99-TC-OXIDE
Unique ID: BMR-WASTE_TR-46
2.0 99-Tc(l) + 3.5 O_{2}(g) \rightarrow 2.0 99-Tc(o) + 7.0 O(BOUND)(o)
Basis: This balanced equation is based on oxidation reactions table on page 93 of 24590-WTP-MDD-PR-01-002, Rev. 13. The balanced equation on the table is different and needs corrected balance.

2.12.4.47  AG-OXIDE
Unique ID: BMR-WASTE_TR-47
2.0 Ag^{+}(l) + 0.5 O_{2}(g) \rightarrow 1.0 Ag_{2}O(o)
Basis: This balanced equation is based on oxidation reactions table on page 92 of 24590-WTP-MDD-PR-01-002, Rev. 13.

2.12.4.48  AL-OXIDE
Unique ID: BMR-WASTE_TR-48
2.0 Al^{3+}(l) + 1.5 O_{2}(g) \rightarrow 1.0 Al_{2}O_{3}(o)
Basis: This balanced equation is based on oxidation reactions table on page 92 of 24590-WTP-MDD-PR-01-002, Rev. 13.

2.12.4.49  AL-OXIDE2
Unique ID: BMR-WASTE_TR-49
2.0 Al(OH)^{4+}(l) \rightarrow 0.5 O_{2}(g) + 1.0 Al_{2}O_{3}(o) + 4.0 H_{2}O(g)
**Basis**: This balanced equation is based on oxidation reactions table on page 92 of 24590-WTP-MDD-PR-01-002, Rev. 13.

### 2.12.4.50 AL-OXIDE3

**Unique ID**: BMR-WASTE_TR-50

2.0 Al(OH)₃(l) --> 1.0 Al₂O₃(o) + 3.0 H₂O(g)

**Basis**: This balanced equation is based on oxidation reactions table on page 92 of 24590-WTP-MDD-PR-01-002, Rev. 13.

### 2.12.4.51 AL-OXIDE4

**Unique ID**: BMR-WASTE_TR-51

2.0 AlOOH(l) --> 1.0 Al₂O₃(o) + 1.0 H₂O(g)

**Basis**: N/A

### 2.12.4.52 AS-OXIDE

**Unique ID**: BMR-WASTE_TR-52

2.0 As⁺⁵(l) + 2.5 O₂(g) --→ 1.0 As₂O₅(o)

**Basis**: This balanced equation is based on oxidation reactions table on page 92 of 24590-WTP-MDD-PR-01-002, Rev. 13.

### 2.12.4.53 B-OXIDE

**Unique ID**: BMR-WASTE_TR-53

2.0 B⁺³(l) + 1.5 O₂(g) --→ 1.0 B₂O₃(o)

**Basis**: This balanced equation is based on oxidation reactions table on page 92 of 24590-WTP-MDD-PR-01-002, Rev. 13.

### 2.12.4.54 BA-OXIDE

**Unique ID**: BMR-WASTE_TR-54

1.0 Ba⁺²(l) + 0.5 O₂(g) --→ 1.0 BaO(o)

**Basis**: This balanced equation is based on oxidation reactions table on page 92 of 24590-WTP-MDD-PR-01-002, Rev. 13.

### 2.12.4.55 BE-OXIDE

**Unique ID**: BMR-WASTE_TR-55

1.0 Be⁺²(l) + 0.5 O₂(g) --→ 1.0 BeO(o)

**Basis**: This balanced equation is based on oxidation reactions table on page 92 of 24590-WTP-MDD-PR-01-002, Rev. 13.
2.12.4.56 BI-OXIDE

Unique ID: BMR-WASTE_TR-56

2.0 Bi^{3+}(l) + 1.5 O_2(g) --> 1.0 Bi_2O_3(o)

Basis: This balanced equation is based on oxidation reactions table on page 92 of 24590-WTP-MDD-PR-01-002, Rev. 13.

2.12.4.57 BV-CO3-DECOMPOSITION-1

Unique ID: BMR-WASTE_TR-57

1.0 CO_3^{2-}(l) --> 1.0 CO_2(g) + 0.5 O_2(g)

Basis: This balanced equation is based on oxidation reactions table on page 92 of 24590-WTP-MDD-PR-01-002, Rev. 13.

2.12.4.58 BV-CO3-DECOMPOSITION-2

Unique ID: BMR-WASTE_TR-58

1.0 CO_3^{2-}(l) --> 1.0 CO(g) + 1.0 O_2(g)

Basis: N/A

2.12.4.59 CA-OXIDE

Unique ID: BMR-WASTE_TR-59

1.0 Ca^{2+}(l) + 0.5 O_2(g) --> 1.0 CaO(o)

Basis: This balanced equation is based on oxidation reactions table on page 92 of 24590-WTP-MDD-PR-01-002, Rev. 13.

2.12.4.60 CD-OXIDE

Unique ID: BMR-WASTE_TR-60

1.0 Cd^{2+}(l) + 0.5 O_2(g) --> 1.0 CdO(o)

Basis: This balanced equation is based on oxidation reactions table on page 92 of 24590-WTP-MDD-PR-01-002, Rev. 13.

2.12.4.61 CE-OXIDE

Unique ID: BMR-WASTE_TR-61

2.0 Ce^{3+}(l) + 1.5 O_2(g) --> 1.0 Ce_2O_3(o)

Basis: This balanced equation is based on oxidation reactions table on page 92 of 24590-WTP-MDD-PR-01-002, Rev. 13.

2.12.4.62 CL-OXIDE

Unique ID: BMR-WASTE_TR-62

1.0 Cl^-(l) --> 1.0 Cl(o)
Basis: This balanced equation is based on oxidation reactions table on page 92 of 24590-WTP-MDD-PR-01-002, Rev. 13.

2.12.4.63   **CL-OXIDE2**

**Unique ID:** BMR-WASTE_TR-63

2.0 Cl-(l) + 2.0 Na+(l) + 1.0 H2O(l) --> 1.0 Na2O(o) + 2.0 HCl(g)

Basis: This balanced equation is based on oxidation reactions table on page 91 of 24590-WTP-MDD-PR-01-002, Rev. 13.

2.12.4.64   **CN-DECOMPOSITION**

**Unique ID:** BMR-WASTE_TR-64

2.0 CN-(l) + 2.0 O2(g) --> 2.0 CO2(g) + 1.0 N2(g)

Basis: This balanced equation is based on oxidation reactions table on page 92 of 24590-WTP-MDD-PR-01-002, Rev. 13.

2.12.4.65   **CO-OXIDE**

**Unique ID:** BMR-WASTE_TR-65

1.0 Co^{+3}(l) + 0.5 O2(g) --> 1.0 CoO(o)

Basis: This balanced equation is based on oxidation reactions table on page 92 of 24590-WTP-MDD-PR-01-002, Rev. 13.

2.12.4.66   **CO3-DECOMPOSITION**

**Unique ID:** BMR-WASTE_TR-66

1.0 CO_{3-2}(l) --> 1.0 CO2(g) + 0.5 O2(g)

Basis: This balanced equation is based on oxidation reactions table on page 92 of 24590-WTP-MDD-PR-01-002, Rev. 13.

2.12.4.67   **CR-OXIDE**

**Unique ID:** BMR-WASTE_TR-67

2.0 CrOOH(l) --> 1.0 Cr2O3(o) + 1.0 H2O(g)

Basis: N/A

2.12.4.68   **CR-OXIDE2**

**Unique ID:** BMR-WASTE_TR-68

2.0 CrO4-2(l) + 2.0 H2O(l) --> 1.0 Cr2O3(o) + 1.5 O2(g) + 4.0 OH-(l)

Basis: N/A

2.12.4.69   **CS-OXIDE**

**Unique ID:** BMR-WASTE_TR-69

2.0 Cs+2(l) + 0.5 O2(g) --> 1.0 Cs2O(o)
**Basis**: This balanced equation is based on oxidation reactions table on page 92 of 24590-WTP-MDD-PR-01-002, Rev. 13.

**2.12.4.70  CU-OXIDE**

**Unique ID**: BMR-WASTE_TR-70

1.0 Cu$^{+2}$ (l) + 0.5 O$_2$(g) $\rightarrow$ 1.0 CuO(o)

**Basis**: This balanced equation is based on oxidation reactions table on page 92 of 24590-WTP-MDD-PR-01-002, Rev. 13.

**2.12.4.71  F-OXIDE**

**Unique ID**: BMR-WASTE_TR-71

1.0 F-(l) $\rightarrow$ 1.0 F-(o)

**Basis**: This balanced equation is based on oxidation reactions table on page 92 of 24590-WTP-MDD-PR-01-002, Rev. 13.

**2.12.4.72  F-OXIDE2**

**Unique ID**: BMR-WASTE_TR-72

2.0 F-(l) + 2.0 Na+(l) + 1.0 H$_2$O(l) $\rightarrow$ 1.0 Na$_2$O(o) + 2.0 HF(g)

**Basis**: This balanced equation is based on oxidation reactions table on page 91 of 24590-WTP-MDD-PR-01-002, Rev. 13.

**2.12.4.73  FE-OXIDE**

**Unique ID**: BMR-WASTE_TR-73

2.0 Fe$^{+3}$(l) + 1.5 O$_2$(g) $\rightarrow$ 1.0 Fe$_2$O$_3$(o)

**Basis**: This balanced equation is based on oxidation reactions table on page 92 of 24590-WTP-MDD-PR-01-002, Rev. 13.

**2.12.4.74  H2O2-DECOMPOSITION**

**Unique ID**: BMR-WASTE_TR-74

2.0 H$_2$O$_2$(l) $\rightarrow$ 2.0 H$_2$O(g) + 1.0 O$_2$(g)

**Basis**: This balanced equation is based on oxidation reactions table on page 92 of 24590-WTP-MDD-PR-01-002, Rev. 13.

**2.12.4.75  HG-OXIDE**

**Unique ID**: BMR-WASTE_TR-75

1.0 Hg$^{+2}$(l) + 0.5 O$_2$(g) $\rightarrow$ 1.0 HgO(o)

**Basis**: This balanced equation is based on oxidation reactions table on page 92 of 24590-WTP-MDD-PR-01-002, Rev. 13.
2.12.4.76  **HLW-CL-OXIDE2**

**Unique ID:** BMR-WASTE_TR-76

2.0 Cl\(^{-}(l)\) + 2.0 Na\(^{+}(l)\) + 1.0 H\(_2\)O\(_(l)\) --> 1.0 Na\(_2\)O\(_(o)\) + 2.0 HCl\(_(g)\)

**Basis:** This balanced equation is based on oxidation reactions table on page 91 of 24590-WTP-MDD-PR-01-002, Rev. 13.

2.12.4.77  **HLW-F-OXIDE2**

**Unique ID:** BMR-WASTE_TR-77

2.0 F\(^{-}(l)\) + 2.0 Na\(^{+}(l)\) + 1.0 H\(_2\)O\(_(l)\) --> 1.0 Na\(_2\)O\(_(o)\) + 2.0 HF\(_(g)\)

**Basis:** This balanced equation is based on oxidation reactions table on page 91 of 24590-WTP-MDD-PR-01-002, Rev. 13.

2.12.4.78  **HLW-SO4-DECOMPOSITION**

**Unique ID:** BMR-WASTE_TR-78

1.0 SO\(_4\)\(_2^{-}(l)\) --> 1.0 SO\(_2(g)\) + 1.0 O\(_2(g)\)

**Basis:** This balanced equation is based on oxidation reactions table on page 91 of 24590-WTP-MDD-PR-01-002, Rev. 13.

2.12.4.79  **HLW-SUGAR-NO2-DECOMPOSITION**

**Unique ID:** BMR-WASTE_TR-79

0.06 C\(_{12}\)H\(_{22}\)O\(_{11}(gf)\) + 1.0 Na\(^{+}(l)\) + 1.0 NO\(_2^{-}(l)\) --> 0.5 Na\(_2\)O\(_(o)\) + 0.5 N\(_2(g)\) + 0.72 CO\(_2(g)\) + 0.66 H\(_2\)O\(_(g)\) + 0.03 O\(_2(g)\)

**Basis:** N/A

2.12.4.80  **HLW-SUGAR-NO3-DECOMPOSITION**

**Unique ID:** BMR-WASTE_TR-80

0.1 C\(_{12}\)H\(_{22}\)O\(_{11}(gf)\) + 1.0 Na\(^{+}(l)\) + 1.0 NO\(_3^{-}(l)\) --> 0.5 Na\(_2\)O\(_(o)\) + 0.5 N\(_2(g)\) + 1.2 CO\(_2(g)\) + 1.1 H\(_2\)O\(_(g)\) + 0.05 O\(_2(g)\)

**Basis:** N/A

2.12.4.81  **K-OXIDE**

**Unique ID:** BMR-WASTE_TR-81

2.0 K\(^{+}(l)\) + 0.5 O\(_2(g)\) --> 1.0 K\(_2\)O\(_(o)\)

**Basis:** This balanced equation is based on oxidation reactions table on page 92 of 24590-WTP-MDD-PR-01-002, Rev. 13.

2.12.4.82  **LA-OXIDE**

**Unique ID:** BMR-WASTE_TR-82

2.0 La\(^{3+}(l)\) + 1.5 O\(_2(g)\) --> 1.0 La\(_2\)O\(_3(o)\)
**Basis:** This balanced equation is based on oxidation reactions table on page 92 of 24590-WTP-MDD-PR-01-002, Rev. 13.

### 2.12.4.83  **LI-OXIDE**

**Unique ID:** BMR-WASTE_TR-83

2.0 Li\(^+\)(l) + 0.5 O\(_2\)(g) --> 1.0 Li\(_2\)O(o)

**Basis:** This balanced equation is based on oxidation reactions table on page 92 of 24590-WTP-MDD-PR-01-002, Rev. 13.

### 2.12.4.84  **MG-OXIDE**

**Unique ID:** BMR-WASTE_TR-84

1.0 Mg\(^{2+}\)(l) + 0.5 O\(_2\)(g) --> 1.0 MgO(o)

**Basis:** This balanced equation is based on oxidation reactions table on page 92 of 24590-WTP-MDD-PR-01-002, Rev. 13.

### 2.12.4.85  **MN-OXIDE**

**Unique ID:** BMR-WASTE_TR-85

1.0 MnO\(_4\)(l) --> 1.0 MnO(o) + 1.5 O\(_2\)(g)

**Basis:** This balanced equation is based on oxidation reactions table on page 93 of 24590-WTP-MDD-PR-01-002, Rev. 13.

### 2.12.4.86  **MN-OXIDE2**

**Unique ID:** BMR-WASTE_TR-86

1.0 Mn\(^{4+}\)(l) + 0.5 O\(_2\)(g) --> 1.0 MnO(o)

**Basis:** This balanced equation is based on oxidation reactions table on page 93 of 24590-WTP-MDD-PR-01-002, Rev. 13.

### 2.12.4.87  **MN-OXIDE3**

**Unique ID:** BMR-WASTE_TR-87

1.0 MnO\(_2\)(l) --> 1.0 MnO(o) + 0.5 O\(_2\)(g)

**Basis:** This balanced equation is based on oxidation reactions table on page 93 of 24590-WTP-MDD-PR-01-002, Rev. 13.

### 2.12.4.88  **MO-OXIDE**

**Unique ID:** BMR-WASTE_TR-88

1.0 Mo\(^{6+}\)(l) + 1.5 O\(_2\)(g) --> 1.0 MoO\(_3\)(o)

**Basis:** This balanced equation is based on oxidation reactions table on page 93 of 24590-WTP-MDD-PR-01-002, Rev. 13.
2.12.4.89  NA-OXIDE
Unique ID: BMR-WASTE_TR-89
2.0 Na⁺(l) + 0.5 O₂(g) --> 1.0 Na₂O(o)
Basis: This balanced equation is based on oxidation reactions table on page 93 of 24590-WTP-MDD-PR-01-002, Rev. 13.

2.12.4.90  ND-OXIDE
Unique ID: BMR-WASTE_TR-90
2.0 Nd³⁺(l) + 1.5 O₂(g) --> 1.0 Nd₂O₃(o)
Basis: This balanced equation is based on oxidation reactions table on page 93 of 24590-WTP-MDD-PR-01-002, Rev. 13.

2.12.4.91  NH₃-DECOMPOSITION
Unique ID: BMR-WASTE_TR-91
2.0 NH₃(l) + 3.0 O₂(g) --> 1.0 NO(g) + 1.0 NO₂(g) + 3.0 H₂O(g)
Basis: This balanced equation is based on oxidation reactions table on page 92 of 24590-WTP-MDD-PR-01-002, Rev. 13.

2.12.4.92  NH₄-DECOMPOSITION
Unique ID: BMR-WASTE_TR-92
2.0 NH₄⁺(l) + 3.5 O₂(g) --> 1.0 NO(g) + 1.0 NO₂(g) + 4.0 H₂O(g)
Basis: This balanced equation is based on oxidation reactions table on page 92 of 24590-WTP-MDD-PR-01-002, Rev. 13.

2.12.4.93  NI-OXIDE
Unique ID: BMR-WASTE_TR-93
1.0 Ni²⁺(l) + 0.5 O₂(g) --> 1.0 NiO(o)
Basis: This balanced equation is based on oxidation reactions table on page 93 of 24590-WTP-MDD-PR-01-002, Rev. 13.

2.12.4.94  NO₂-DECOMPOSITION
Unique ID: BMR-WASTE_TR-94
2.0 NO₂-(l) --> 1.0 NO(g) + 1.0 NO₂(g) + 0.5 O₂(g)
Basis: N/A

2.12.4.95  NO₂-DECOMPOSITION-VARIABLE
Unique ID: BMR-WASTE_TR-95
r₂₁ NO₂-(l) + r₂₂ H₂O(l) --> p₂₁ N₂(g) + p₂₂ NO(g) + p₂₃ NO₂(g) + p₂₄ NH₃(g) + (0.25 + p₂₅) O₂(g)
Where \( r21, r22, p21, p22, p23, p24 \) and \( p25 \) are provided in LAW Glass Melt NOx Stoichiometry Data.

**Basis:** This balanced equation is based on oxidation reactions table on page 91 of 24590-WTP-MDD-PR-01-002, Rev. 13.

### 2.12.4.96 NO\(_3\)-DECOMPOSITION

**Unique ID:** BMR-WASTE_TR-96

\[
2.0 \text{ NO}_3^-(l) \rightarrow 1.0 \text{ NO}(g) + 1.0 \text{ NO}_2(g) + 1.5 \text{ O}_2(g)
\]

**Basis:** N/A

### 2.12.4.97 NO\(_3\)-DECOMPOSITION-VARIABLE

**Unique ID:** BMR-WASTE_TR-97

\[
r11 \text{ NO}_3^-(l) + r12 \text{ H}_2\text{O}(l) \rightarrow p11 \text{ N}_2(g) + p12 \text{ NO}(g) + p13 \text{ NO}_2(g) + p14 \text{ NH}_3(g) + (0.25 + p15) \text{ O}_2(g)
\]

Where variables \( r11, r12, p11, p12, p13, p14, \) and \( p15 \) are provided in LAW Glass Melt NOx Stoichiometry Data.

**Basis:** This balanced equation is based on oxidation reactions table on page 91 of 24590-WTP-MDD-PR-01-002, Rev. 13.

### 2.12.4.98 OH-DECOMPOSITION

**Unique ID:** BMR-WASTE_TR-98

\[
2.0 \text{ OH}^-(l) \rightarrow 1.0 \text{ H}_2\text{O}(g) + 0.5 \text{ O}_2(g)
\]

**Basis:** This balanced equation is based on oxidation reactions table on page 92 of 24590-WTP-MDD-PR-01-002, Rev. 13.

### 2.12.4.99 OH-DECOMPOSITION2

**Unique ID:** BMR-WASTE_TR-99

\[
2.0 \text{ OH(BOUND)}(l) \rightarrow 1.0 \text{ H}_2\text{O}(g) + 0.5 \text{ O}_2(g)
\]

**Basis:** This balanced equation is based on oxidation reactions table on page 92 of 24590-WTP-MDD-PR-01-002, Rev. 13.

### 2.12.4.100 P-OXIDE

**Unique ID:** BMR-WASTE_TR-100

\[
2.0 \text{ PO}_4^{3-}(l) \rightarrow 1.0 \text{ P}_2\text{O}_5(o) + 1.5 \text{ O}_2(g)
\]

**Basis:** This balanced equation is based on oxidation reactions table on page 93 of 24590-WTP-MDD-PR-01-002, Rev. 13.
2.12.4.101 PB-OXIDE
Unique ID: BMR-WASTE_TR-101
1.0 Pb\(^{2+}\)(l) + 0.5 O\(_2\)(g) \rightarrow 1.0 PbO(o)
Basis: This balanced equation is based on oxidation reactions table on page 93 of 24590-WTP-MDD-PR-01-002, Rev. 13.

2.12.4.102 PD-OXIDE
Unique ID: BMR-WASTE_TR-102
1.0 Pd\(^{2+}\)(l) + 0.5 O\(_2\)(g) \rightarrow 1.0 PdO(o)
Basis: This balanced equation is based on oxidation reactions table on page 93 of 24590-WTP-MDD-PR-01-002, Rev. 13.

2.12.4.103 PEROXIDE-DECOMPOSE-REACTION
Unique ID: BMR-WASTE_TR-103
1.0 H\(_2\)O\(_2\)(l) \rightarrow 1.0 H\(_2\)O(l) + 0.5 O\(_2\)(g)
Basis: This balanced equation is based on oxidation reactions table on page 92 of 24590-WTP-MDD-PR-01-002, Rev. 13.

2.12.4.104 PR-OXIDE
Unique ID: BMR-WASTE_TR-104
2.0 Pr\(^{3+}\)(l) + 1.5 O\(_2\)(g) \rightarrow 1.0 Pr\(_2\)O\(_3\)(o)
Basis: This balanced equation is based on oxidation reactions table on page 93 of 24590-WTP-MDD-PR-01-002, Rev. 13.

2.12.4.105 PU-OXIDE
Unique ID: BMR-WASTE_TR-105
1.0 Pu^{+4}(l) + 1.0 O\(_2\)(g) \rightarrow 1.0 PuO\(_2\)(o)
Basis: This balanced equation is based on oxidation reactions table on page 93 of 24590-WTP-MDD-PR-01-002, Rev. 13.

2.12.4.106 RB-OXIDE
Unique ID: BMR-WASTE_TR-106
2.0 Rb\(^{+}\)(l) + 0.5 O\(_2\)(g) \rightarrow 1.0 RbO(o)
Basis: This balanced equation is based on oxidation reactions table on page 93 of 24590-WTP-MDD-PR-01-002, Rev. 13.

2.12.4.107 RH-OXIDE
Unique ID: BMR-WASTE_TR-107
2.0 Rh\(^{3+}\)(l) + 1.5 O\(_2\)(g) \rightarrow 1.0 Rh\(_2\)O\(_3\)(o)
2.12.4.108 RU-OXIDE

Unique ID: BMR-WASTE_TR-108

1.0 Ru$^{3+}$(l) + 1.0 O$_2$(g) --> 1.0 RuO$_2$(o)

Basis: This balanced equation is based on oxidation reactions table on page 93 of 24590-WTP-MDD-PR-01-002, Rev. 13.

2.12.4.109 S-OXIDE

Unique ID: BMR-WASTE_TR-109

1.0 SO$_4^{2-}$(l) --> 1.0 SO$_3$(o) + 0.5 O$_2$(g)

Basis: This balanced equation is based on oxidation reactions table on page 93 of 24590-WTP-MDD-PR-01-002, Rev. 13.

2.12.4.110 SB-OXIDE

Unique ID: BMR-WASTE_TR-110

2.0 Sb$^{5+}$(l) + 1.5 O$_2$(g) --> 1.0 Sb$_2$O$_3$(o)

Basis: This balanced equation is based on oxidation reactions table on page 93 of 24590-WTP-MDD-PR-01-002, Rev. 13.

2.12.4.111 SE-OXIDE

Unique ID: BMR-WASTE_TR-111

1.0 Se$^{6+}$(l) + 1.0 O$_2$(g) --> 1.0 SeO$_2$(o)

Basis: This balanced equation is based on oxidation reactions table on page 93 of 24590-WTP-MDD-PR-01-002, Rev. 13.

2.12.4.112 SI-OXIDE

Unique ID: BMR-WASTE_TR-112

1.0 Si$^{4+}$(l) + 1.0 O$_2$(g) --> 1.0 SiO$_2$(o)

Basis: This balanced equation is based on oxidation reactions table on page 93 of 24590-WTP-MDD-PR-01-002, Rev. 13.

2.12.4.113 SO$_4$-DECOMPOSITION

Unique ID: BMR-WASTE_TR-113

1.0 SO$_4^{2-}$(l) --> 1.0 SO$_2$(g) + 1.0 O$_2$(g)

Basis: This balanced equation is based on oxidation reactions table on page 91 of 24590-WTP-MDD-PR-01-002, Rev. 13.
2.12.4.114 SR-OXIDE

Unique ID: BMR-WASTE_TR-114

1.0 Sr$^{+2}$(l) + 0.5 O$_2$(g) --> 1.0 SrO(o)

Basis: This balanced equation is based on oxidation reactions table on page 93 of 24590-WTP-MDD-PR-01-002, Rev. 13.

2.12.4.115 SUGAR-DECOMPOSITION

Unique ID: BMR-WASTE_TR-115

1.0 C$_{12}$H$_{22}$O$_{11}$(gf) + 12.0 O$_2$(g) --> 12.0 CO$_2$(g) + 11.0 H$_2$O(g)

Basis: This balanced equation is based on oxidation reactions table on page 92 of 24590-WTP-MDD-PR-01-002, Rev. 13.

2.12.4.116 SUGAR-NO2-DECOMPOSITION

Unique ID: BMR-WASTE_TR-116

1.0 C$_{12}$H$_{22}$O$_{11}$(gf) + 8.0 NO$_2$-(l) + 4.0 O$_2$(g) --> 4.0 N$_2$(g) + 12.0 CO$_2$(g) + 11.0 H$_2$O(g)

Basis: This balanced equation is based on oxidation reactions table on page 92 of 24590-WTP-MDD-PR-01-002, Rev. 13.

2.12.4.117 SUGAR-NO3-DECOMPOSITION

Unique ID: BMR-WASTE_TR-117

1.0 C$_{12}$H$_{22}$O$_{11}$(gf) + 8.0 NO$_3$-(l) --> 12.0 CO$_2$(g) + 11.0 H$_2$O(g) + 4.0 N$_2$(g)

Basis: This balanced equation is based on oxidation reactions table on page 92 of 24590-WTP-MDD-PR-01-002, Rev. 13.

2.12.4.118 TA-OXIDE

Unique ID: BMR-WASTE_TR-118

2.0 Ta$^{+5}$(l) + 2.5 O$_2$(g) --> 1.0 Ta$_2$O$_5$(o)

Basis: This balanced equation is based on oxidation reactions table on page 93 of 24590-WTP-MDD-PR-01-002, Rev. 13.

2.12.4.119 TC-OXIDE

Unique ID: BMR-WASTE_TR-119

2.0 Tc$^{+7}$(l) + 3.5 O$_2$(g) --> 1.0 Tc$_2$O$_7$(o)

Basis: This balanced equation is based on oxidation reactions table on page 92 of 24590-WTP-MDD-PR-01-002, Rev. 13. Although balanced equation on table says 1.0 Tc$^{+7}$, correct number of Tc$^{+7}$ should be 2.0.

2.12.4.120 TE-OXIDE

Unique ID: BMR-WASTE_TR-120

1.0 Te$^{+6}$(l) + 1.0 O$_2$(g) --> 1.0 TeO$_2$(o)
**Basis:** This balanced equation is based on oxidation reactions table on page 93 of 24590-WTP-MDD-PR-01-002, Rev. 13.

### 2.12.4.121 TH-OXIDE
**Unique ID:** BMR-WASTE_TR-121

\[
1.0 \text{Th}^{+4}(l) + 1.0 \text{O}_2(g) \rightarrow 1.0 \text{ThO}_2(o)
\]

**Basis:** This balanced equation is based on oxidation reactions table on page 93 of 24590-WTP-MDD-PR-01-002, Rev. 13.

### 2.12.4.122 TI-OXIDE
**Unique ID:** BMR-WASTE_TR-122

\[
1.0 \text{Ti}^{+4}(l) + 1.0 \text{O}_2(g) \rightarrow 1.0 \text{TiO}_2(o)
\]

**Basis:** This balanced equation is based on oxidation reactions table on page 93 of 24590-WTP-MDD-PR-01-002, Rev. 13.

### 2.12.4.123 TL-OXIDE
**Unique ID:** BMR-WASTE_TR-123

\[
2.0 \text{Tl}^{+3}(l) + 0.5 \text{O}_2(g) \rightarrow 1.0 \text{Tl}_2\text{O}(o)
\]

**Basis:** This balanced equation is based on oxidation reactions table on page 93 of 24590-WTP-MDD-PR-01-002, Rev. 13.

### 2.12.4.124 U-OXIDE
**Unique ID:** BMR-WASTE_TR-344

\[
1.0 \text{U(TOTAL)}(l) + 1.5 \text{O}_2(g) \rightarrow 1.0 \text{UO}_3(o)
\]

**Basis:** This balanced equation is based on oxidation reactions table on page 93 of 24590-WTP-MDD-PR-01-002, Rev. 13.

### 2.12.4.125 V-OXIDE
**Unique ID:** BMR-WASTE_TR-124

\[
2.0 \text{V}^{+5}(l) + 2.5 \text{O}_2(g) \rightarrow 1.0 \text{V}_2\text{O}_5(o)
\]

**Basis:** This balanced equation is based on oxidation reactions table on page 93 of 24590-WTP-MDD-PR-01-002, Rev. 13.

### 2.12.4.126 W-OXIDE
**Unique ID:** BMR-WASTE_TR-125

\[
1.0 \text{W}^{+6}(l) + 1.5 \text{O}_2(g) \rightarrow 1.0 \text{WO}_3(o)
\]

**Basis:** This balanced equation is based on oxidation reactions table on page 93 of 24590-WTP-MDD-PR-01-002, Rev. 13.
2.12.4.127  **Y-OXIDE**  
Unique ID: BMR-WASTE_TR-126  
2.0 $\text{Y}^{3+}(l) + 1.5 \text{O}_2(g) \rightarrow 1.0 \text{Y}_2\text{O}_3(o)$  
**Basis:** This balanced equation is based on oxidation reactions table on page 93 of 24590-WTP-MDD-PR-01-002, Rev. 13.

2.12.4.128  **ZN-OXIDE**  
Unique ID: BMR-WASTE_TR-127  
1.0 $\text{Zn}^{2+}(l) + 0.5 \text{O}_2(g) \rightarrow 1.0 \text{ZnO}(o)$  
**Basis:** This balanced equation is based on oxidation reactions table on page 93 of 24590-WTP-MDD-PR-01-002, Rev. 13.

2.12.4.129  **ZR-OXIDE**  
Unique ID: BMR-WASTE_TR-128  
1.0 $\text{Zr}^{4+}(l) + 1.0 \text{O}_2(g) \rightarrow 1.0 \text{ZrO}_2(o)$  
**Basis:** This balanced equation is based on oxidation reactions table on page 93 of 24590-WTP-MDD-PR-01-002, Rev. 13. Although the balanced equation from said reference shows ZnO2 as final product, it is a typo and should read ZrO2.

2.12.4.130  **101B-R1**  
Unique ID: BMR-WASTE_TR-129  
1.0 $\text{Al(OH)}_3(s) + 1.0 \text{OH}^{-}(l) \rightarrow 1.0 \text{Al(OH)}_4^{-}(l)$  
**Basis:** N/A

2.12.4.131  **101B-R11**  
Unique ID: BMR-WASTE_TR-130  
1.0 $\text{Fe}^{3+}(s) + 3.0 \text{OH}^{-}(l) \rightarrow 1.0 \text{Fe}^{3+}(l) + 3.0 \text{OH}^{-}(l)$  
**Basis:** N/A

2.12.4.132  **101B-R12**  
Unique ID: BMR-WASTE_TR-131  
1.0 $\text{Si}^{4+}(s) + 4.0 \text{OH}^{-}(l) \rightarrow 1.0 \text{Si}^{4+}(l) + 4.0 \text{OH}^{-}(l)$  
**Basis:** N/A

2.12.4.133  **101B-R13-232**  
Unique ID: BMR-WASTE_TR-132  
1.0 $232-\text{U}(s) + 2.0 \text{OH}^{-}(l) \rightarrow 1.0 232-\text{U}(l) + 2.0 \text{OH}^{-}(l)$  
**Basis:** N/A
2.12.4.134  101B-R13-233
Unique ID: BMR-WASTE_TR-133
1.0 233-U(s) + 2.0 OH-(l) --> 1.0 233-U(l) + 2.0 OH-(l)
Basis: N/A

2.12.4.135  101B-R13-234
Unique ID: BMR-WASTE_TR-134
1.0 234-U(s) + 2.0 OH-(l) --> 1.0 234-U(l) + 2.0 OH-(l)
Basis: N/A

2.12.4.136  101B-R13-235
Unique ID: BMR-WASTE_TR-135
1.0 235-U(s) + 2.0 OH-(l) --> 1.0 235-U(l) + 2.0 OH-(l)
Basis: N/A

2.12.4.137  101B-R13-236
Unique ID: BMR-WASTE_TR-136
1.0 236-U(s) + 2.0 OH-(l) --> 1.0 236-U(l) + 2.0 OH-(l)
Basis: N/A

2.12.4.138  101B-R13-238
Unique ID: BMR-WASTE_TR-137
1.0 238-U(s) + 2.0 OH-(l) --> 1.0 238-U(l) + 2.0 OH-(l)
Basis: N/A

2.12.4.139  101B-R14
Unique ID: BMR-WASTE_TR-138
1.0 SO4-2(s) + 2.0 Na+(s) --> 1.0 SO4-2(l) + 2.0 Na+(l)
Basis: N/A

2.12.4.140  101B-R8
Unique ID: BMR-WASTE_TR-139
1.0 Bi+3(s) + 3.0 OH-(l) --> 1.0 Bi+3(l) + 3.0 OH-(l)
Basis: N/A

2.12.4.141  101B-R9
Unique ID: BMR-WASTE_TR-140
1.0 Ca+2(s) + 2.0 OH-(l) --> 1.0 Ca+2(l) + 2.0 OH-(l)
Basis: N/A

2.12.4.142 101C-R1
Unique ID: BMR-WASTE_TR-141
2.0 CrOOH(s) + 3.0 NO3-(l) + 4.0 OH-(l) --> 2.0 CrO4-2(l) + 3.0 NO2-(l) + 3.0 H2O(l)
Basis: N/A

2.12.4.143 101C-R10
Unique ID: BMR-WASTE_TR-142
1.0 PO4-3(s) + 3.0 OH-(l) --> 1.0 PO4-3(l) + 3.0 OH-(l)
Basis: N/A

2.12.4.144 101C-R11
Unique ID: BMR-WASTE_TR-143
1.0 Na+(s) + 1.0 OH-(l) --> 1.0 Na+(l) + 1.0 OH-(l)
Basis: N/A

2.12.4.145 129-I-TO-GAS
Unique ID: BMR-WASTE_TR-144
1.0 $^{129}$I(l) --> 1.0 $^{129}$I(g)
Basis: N/A

2.12.4.146 232-U-REACTION
Unique ID: BMR-WASTE_TR-145
1.0 232-U(s) + 2.0 OH-(l) --> 1.0 232-U(l) + 2.0 OH-(l)
Basis: N/A

2.12.4.147 233-U-REACTION
Unique ID: BMR-WASTE_TR-146
1.0 233-U(s) + 2.0 OH-(l) --> 1.0 233-U(l) + 2.0 OH-(l)
Basis: N/A

2.12.4.148 234-U-REACTION
Unique ID: BMR-WASTE_TR-147
1.0 234-U(s) + 2.0 OH-(l) --> 1.0 234-U(l) + 2.0 OH-(l)
Basis: N/A
2.12.4.149  235-U-REACTION  
Unique ID: BMR-WASTE_TR-148  
1.0 235-U(s) + 2.0 OH-(l) --> 1.0 235-U(l) + 2.0 OH-(l)  
Basis: N/A  

2.12.4.150  236-U-REACTION  
Unique ID: BMR-WASTE_TR-149  
1.0 236-U(s) + 2.0 OH-(l) --> 1.0 236-U(l) + 2.0 OH-(l)  
Basis: N/A  

2.12.4.151  238-U-REACTION  
Unique ID: BMR-WASTE_TR-150  
1.0 238-U(s) + 2.0 OH-(l) --> 1.0 238-U(l) + 2.0 OH-(l)  
Basis: N/A  

2.12.4.152  BI-REACTION  
Unique ID: BMR-WASTE_TR-151  
1.0 Bi+3(s) + 3.0 OH-(l) --> 1.0 Bi+3(l) + 3.0 OH-(l)  
Basis: N/A  

2.12.4.153  BOEHMITE-DISSOLUTION  
Unique ID: BMR-WASTE_TR-152  
1.0 AlOOH(s) + 1.0 OH-(l) + 1.0 H2O(l) --> 1.0 Al(OH)4-(l)  
Basis: N/A  

2.12.4.154  BOIL-3-H-REACTION  
Unique ID: BMR-WASTE_TR-153  
1.0 3-H(l) --> 1.0 3-H(g)  
Basis: N/A  

2.12.4.155  BOIL-WATER-REACTION  
Unique ID: BMR-WASTE_TR-154  
1.0 H2O(l) --> 1.0 H2O(g)  
Basis: N/A  

2.12.4.156  BV-CO-SCR-REACTION  
Unique ID: BMR-WASTE_TR-155  
1.0 CO(g) + 0.5 O2(g) --> 1.0 CO2(g)
Basis: N/A

2.12.4.157  BV-HYDROSONIC-CO2-REACTION
Unique ID: BMR-WASTE_TR-156
1.0 CO2(g) + 2.0 OH-(l) --> 1.0 CO3-2(l) + 1.0 H2O(l)
Basis: N/A

2.12.4.158  BV-HYDROSONIC-HCL-REACTION
Unique ID: BMR-WASTE_TR-157
1.0 HCl(g) + 1.0 OH-(l) --> 1.0 Cl-(l) + 1.0 H2O(l)
Basis: N/A

2.12.4.159  BV-HYDROSONIC-HF-REACTION
Unique ID: BMR-WASTE_TR-158
1.0 HF(g) + 1.0 OH-(l) --> 1.0 F-(l) + 1.0 H2O(l)
Basis: N/A

2.12.4.160  BV-HYDROSONIC-NO-REACTION
Unique ID: BMR-WASTE_TR-159
1.0 NO(g) + 0.5 O2(g) + 1.0 OH-(l) --> 0.5 NO3-(l) + 0.5 NO2-(l) + 0.5 H2O(l)
Basis: N/A

2.12.4.161  BV-HYDROSONIC-NO2-REACTION
Unique ID: BMR-WASTE_TR-160
1.0 NO2(g) + 1.0 OH-(l) --> 0.5 NO3-(l) + 0.5 NO2-(l) + 0.5 H2O(l)
Basis: N/A

2.12.4.162  BV-HYDROSONIC-P2O5-REACTION
Unique ID: BMR-WASTE_TR-161
1.0 P2O5(o) + 6.0 OH-(l) --> 2.0 PO4-3(l) + 3.0 H2O(l)
Basis: N/A

2.12.4.163  BV-HYDROSONIC-PO4-G-REACTION
Unique ID: BMR-WASTE_TR-162
1.0 PO4-3(g) + 3.0 OH-(l) --> 1.0 PO4-3(l) + 1.5 H2O(l) + 0.75 O2(g)
Basis: N/A
2.12.4.164  BV-HYDROSONIC-PO4-REACTION
Unique ID: BMR-WASTE_TR-163
1.0 PO4-3(g) --> 1.0 PO4-3(l)
Basis: N/A

2.12.4.165  BV-HYDROSONIC-SO2-REACTION
Unique ID: BMR-WASTE_TR-164
1.0 SO2(g) + 0.5 O2(g) + 2.0 OH-(l) --> 1.0 SO4-2(l) + 1.0 H2O(l)
Basis: N/A

2.12.4.166  BV-NO-SCR-REACTION
Unique ID: BMR-WASTE_TR-165
24.0 NO(g) + 16.0 NH3(g) --> 24.0 H2O(g) + 20.0 N2(g)
Basis: N/A

2.12.4.167  BV-NO2-DECOMP1
Unique ID: BMR-WASTE_TR-166
2.0 NO2-(l) --> 1.0 N2(g) + 2.0 O2(g)
Basis: N/A

2.12.4.168  BV-NO2-DECOMP2
Unique ID: BMR-WASTE_TR-167
2.0 NO2-(l) --> 2.0 NO(g) + 1.0 O2(g)
Basis: N/A

2.12.4.169  BV-NO2-DECOMP3
Unique ID: BMR-WASTE_TR-168
2.0 NO2-(l) --> 2.0 NO2(g)
Basis: N/A

2.12.4.170  BV-NO2-SCR-REACTION
Unique ID: BMR-WASTE_TR-169
24.0 NO2(g) + 32.0 NH3(g) --> 48.0 H2O(g) + 28.0 N2(g)
Basis: N/A

2.12.4.171  BV-NO3-DECOMP1
Unique ID: BMR-WASTE_TR-170
2.0 NO3-(l) --> 1.0 N2(g) + 3.0 O2(g)
Basis: N/A

2.12.4.172  BV-NO3-DECOMP2
Unique ID: BMR-WASTE_TR-171
2.0 NO3-(l) --> 2.0 NO(g) + 2.0 O2(g)
Basis: N/A

2.12.4.173  BV-NO3-DECOMP3
Unique ID: BMR-WASTE_TR-172
2.0 NO3-(l) --> 2.0 NO2(g) + 1.0 O2(g)
Basis: N/A

2.12.4.174  BV-OD1
Unique ID: BMR-WASTE_TR-173
1.0 TOC(l) + 1.0 O2(g) --> 1.0 CO2(g)
Basis: N/A

2.12.4.175  BV-OD2
Unique ID: BMR-WASTE_TR-174
1.0 TOC(l) + 0.5 O2(g) --> 1.0 CO(g)
Basis: N/A

2.12.4.176  CA-REACTION
Unique ID: BMR-WASTE_TR-175
1.0 Ca+2(s) + 2.0 OH-(l) --> 1.0 Ca+2(l) + 2.0 OH-(l)
Basis: N/A

2.12.4.177  CL-NA-REACTION
Unique ID: BMR-WASTE_TR-176
2.0 Cl-(l) + 2.0 Na+(l) + 1.0 H2O(l) --> 1.0 Na2O(o) + 2.0 HCl(g)
Basis: N/A

2.12.4.178  CO2-SCRUBBER-REACTION
Unique ID: BMR-WASTE_TR-177
1.0 CO2(g) + 1.0 H2O(l) --> 2.0 H+(l) + 1.0 CO3-2(l)
Basis: N/A
2.12.4.179 CONDENSE-WATER-REACTION
Unique ID: BMR-WASTE_TR-178
1.0 H2O(g) --> 1.0 H2O(l)
Basis: N/A

2.12.4.180 CROOH-LIQUID
Unique ID: BMR-WASTE_TR-179
2.0 CrOOH(l) + 3.0 NO3-(l) + 4.0 OH-(l) --> 2.0 CrO4-2(l) + 3.0 NO2-(l) + 3.0 H2O(l)
Basis: N/A

2.12.4.181 CRP-RXN-1
Unique ID: BMR-WASTE_TR-180
1.0 H+(s) + 1.0 OH-(l) --> 1.0 H2O(l)
Basis: N/A

2.12.4.182 CRP-RXN-2
Unique ID: BMR-WASTE_TR-181
1.0 Na+(l) --> 1.0 Na+(s)
Basis: N/A

2.12.4.183 DISSOLVE-CO2-REACTION
Unique ID: BMR-WASTE_TR-182
1.0 CO3-2(l) --> 1.0 CO2(g) + 0.5 O2(g)
Basis: N/A

2.12.4.184 EVAP-CS-REACTION
Unique ID: BMR-WASTE_TR-183
1.0 Cs+(l) + 1.0 134-Cs(l) + 1.0 137-Cs(l) --> 1.0 Cs+(g) + 1.0 134-Cs(g) + 1.0 137-Cs(g)
Basis: N/A

2.12.4.185 EVAP-IODINE-REACTION
Unique ID: BMR-WASTE_TR-184
1.0 129-I(l) --> 1.0 129-I(g)
Basis: N/A

2.12.4.186 EVAP-K-REACTION
Unique ID: BMR-WASTE_TR-185
1.0 K+(s) --> 1.0 K+(g)
2.12.4.187 EVAP-NA-REACTION
Unique ID: BMR-WASTE_TR-186
1.0 Na+(l) --> 1.0 Na+(g)
Basis: N/A

2.12.4.188 EVAP-TC-REACTION
Unique ID: BMR-WASTE_TR-187
1.0 99-Tc(s) --> 1.0 99-Tc(g)
Basis: N/A

2.12.4.189 EXTRACT-NH3-REACTION
Unique ID: BMR-WASTE_TR-188
1.0 NH3(l) --> 1.0 NH3(g)
Basis: N/A

2.12.4.190 F-NA-REACTION
Unique ID: BMR-WASTE_TR-189
2.0 F-(l) + 2.0 Na+(l) + 1.0 H2O(l) --> 1.0 Na2O(o) + 2.0 HF(g)
Basis: N/A

2.12.4.191 FC-1
Unique ID: BMR-WASTE_TR-190
1.0 NO2-(l) + 1.0 Na+(l) --> 1.0 Na+(s) + 1.0 NO2-(s)
Basis: N/A

2.12.4.192 FC-2
Unique ID: BMR-WASTE_TR-191
1.0 NO3-(l) + 1.0 Na+(l) --> 1.0 Na+(s) + 1.0 NO3-(s)
Basis: N/A

2.12.4.193 FC-3
Unique ID: BMR-WASTE_TR-192
1.0 SO4-2(l) + 2.0 Na+(l) --> 2.0 Na+(s) + 1.0 SO4-2(s)
Basis: N/A
2.12.4.194  FC-4
Unique ID: BMR-WASTE_TR-193
1.0 F-(l) + 1.0 Na+(l) --> 1.0 Na+(s) + 1.0 F-(s)
Basis: N/A

2.12.4.195  FE-REACTION
Unique ID: BMR-WASTE_TR-194
1.0 Fe+3(s) + 3.0 OH-(l) --> 1.0 Fe+3(l) + 3.0 OH-(l)
Basis: N/A

2.12.4.196  GIBBSITE-LIQUID
Unique ID: BMR-WASTE_TR-195
1.0 Al(OH)3(l) + 1.0 OH-(l) --> 1.0 Al(OH)4-(l)
Basis: N/A

2.12.4.197  H-OH-NEUT-REACTION
Unique ID: BMR-WASTE_TR-196
1.0 H+(l) + 1.0 OH-(l) --> 1.0 H2O(l)
Basis: N/A

2.12.4.198  H-OH-NEUTRALIZATION-WITH-CATION-REACTION
Unique ID: BMR-WASTE_TR-197
1.0 OH-(l) + 1.0 Na+(l) + 1.0 H+(l) + 1.0 NO3-(l) --> 1.0 Na+(l) + 1.0 NO3-(l) + 1.0 H2O(l)
Basis: N/A

2.12.4.199  HCL-SCRUBBER-REACTION
Unique ID: BMR-WASTE_TR-198
1.0 HCl(g) --> 1.0 H+(l) + 1.0 Cl-(l)
Basis: N/A

2.12.4.200  HF-SCRUBBER-REACTION
Unique ID: BMR-WASTE_TR-199
1.0 HF(g) --> 1.0 H+(l) + 1.0 F-(l)
Basis: N/A

2.12.4.201  HG-LIQUID-to-SOLID
Unique ID: BMR-WASTE_TR-342
Hg+2 (l) + 2OH- (l) → Hg+2 (s) + O-2 (s) + H2O(Bound) (s)
Basis: N/A

2.12.4.202  HG-TO-GAS-REACTION
Unique ID: BMR-WASTE_TR-341
1.0 Hg$^{+2}$(l) $\rightarrow$ 1.0 Hg$^{+2}$(g)
Basis: N/A

2.12.4.203  HLW-129-I
Unique ID: BMR-WASTE_TR-200
1.0 129-I(l) $\rightarrow$ 1.0 129-I(g)
Basis: N/A

2.12.4.204  HLW-CA-SCRUBBER-RXN
Unique ID: BMR-WASTE_TR-201
2.0 Ca$^{+2}$(s) + 1.0 O$_2$(g) + 2.0 H$_2$O(l) $\rightarrow$ 2.0 Ca$^{+2}$(l) + 4.0 OH-(l)
Basis: N/A

2.12.4.205  HLW-CL-SCRUBBER-REACTION
Unique ID: BMR-WASTE_TR-202
1.0 Na$^+(s)$ + 1.0 Cl-(s) $\rightarrow$ 1.0 Na$^+(l)$ + 1.0 Cl-(l)
Basis: N/A

2.12.4.206  HLW-F-SCRUBBER-REACTION
Unique ID: BMR-WASTE_TR-203
1.0 Na$^+(s)$ + 1.0 F-(s) $\rightarrow$ 1.0 Na$^+(l)$ + 1.0 F-(l)
Basis: N/A

2.12.4.207  HLW-H-OH-NEUT-REACTION
Unique ID: BMR-WASTE_TR-204
1.0 H+(l) + 1.0 OH-(l) $\rightarrow$ 1.0 H$_2$O(l)
Basis: N/A

2.12.4.208  HLW-HCL-SCRUBBER-REACTION
Unique ID: BMR-WASTE_TR-205
1.0 HCl(g) $\rightarrow$ 1.0 H+(l) + 1.0 Cl-(l)
Basis: N/A
2.12.4.209  HLW-HEME-CONDENSE-WATER-REACTION  
Unique ID: BMR-WASTE_TR-206  
1.0 H2O(g) --> 1.0 H2O(l)  
Basis: N/A  

2.12.4.210  HLW-HEME-P2O5-REACTION  
Unique ID: BMR-WASTE_TR-207  
1.0 P2O5(g) + 3.0 H2O(l) --> 6.0 H+(l) + 0.5 PO4-3(l) + 1.5 PO4-3(s)  
Basis: N/A  

2.12.4.211  HLW-HF-SCRUBBER-REACTION  
Unique ID: BMR-WASTE_TR-208  
1.0 HF(g) --> 1.0 H+(l) + 1.0 F-(l)  
Basis: N/A  

2.12.4.212  HLW-I-SCRUBBER-RXN  
Unique ID: BMR-WASTE_TR-209  
1.0 129-I(g) --> 1.0 129-I(l)  
Basis: N/A  

2.12.4.213  HLW-K-SCRUBBER-RXN  
Unique ID: BMR-WASTE_TR-210  
4.0 K+(s) + 1.0 O2(g) + 2.0 H2O(l) --> 4.0 K+(l) + 4.0 OH-(l)  
Basis: N/A  

2.12.4.214  HLW-LI-SCRUBBER-RXN  
Unique ID: BMR-WASTE_TR-211  
4.0 Li+(s) + 1.0 O2(g) + 2.0 H2O(l) --> 4.0 Li+(l) + 4.0 OH-(l)  
Basis: N/A  

2.12.4.215  HLW-MAKE-OH-SCRUBBER-REACTION  
Unique ID: BMR-WASTE_TR-212  
4.0 Na+(l) + 1.0 O2(g) + 2.0 H2O(l) --> 4.0 Na+(l) + 4.0 OH-(l)  
Basis: N/A  

2.12.4.216  HLW-NA-SCRUBBER-RXN  
Unique ID: BMR-WASTE_TR-213  
4.0 Na+(s) + 1.0 O2(g) + 2.0 H2O(l) --> 4.0 Na+(l) + 4.0 OH-(l)
Basis: N/A

2.12.4.217  HLW-NH3-REACTION
Unique ID: BMR-WASTE_TR-214
1.0 NH3(l) + 1.0 H2O(l) --> 1.0 NH4+(l) + 1.0 OH-(l)
Basis: N/A

2.12.4.218  HLW-NH3-SCRUBBER-RXN
Unique ID: BMR-WASTE_TR-215
1.0 NH3(g) --> 1.0 NH3(l)
Basis: N/A

2.12.4.219  HLW-NO-SCRUBBER-REACTION
Unique ID: BMR-WASTE_TR-216
4.0 NO(g) + 2.0 H2O(l) + 3.0 O2(g) --> 4.0 H+(l) + 4.0 NO3-(l)
Basis: N/A

2.12.4.220  HLW-NO2-SCRUBBER-REACTION
Unique ID: BMR-WASTE_TR-217
3.0 NO2(g) + 1.0 H2O(l) --> 2.0 H+(l) + 2.0 NO3-(l) + 1.0 NO(g)
Basis: N/A

2.12.4.221  HLW-NOX-NH3-REACTION
Unique ID: BMR-WASTE_TR-218
4.0 NO(g) + 4.0 NH3(g) + 1.0 O2(g) --> 4.0 N2(g) + 6.0 H2O(g)
Basis: N/A

2.12.4.222  HLW-NOX-NO-NH3-REACTION
Unique ID: BMR-WASTE_TR-219
6.0 NO(g) + 4.0 NH3(g) --> 5.0 N2(g) + 6.0 H2O(g)
Basis: N/A

2.12.4.223  HLW-NOX-NO2-NH3-REACTION
Unique ID: BMR-WASTE_TR-220
6.0 NO2(g) + 8.0 NH3(g) --> 7.0 N2(g) + 12.0 H2O(g)
Basis: N/A
2.12.4.224  HLW-NOX-NO2-NH3-REACTION2  
Unique ID: BMR-WASTE_TR-221  
2.0 NO2(g) + 4.0 NH3(g) + 1.0 O2(g) --> 3.0 N2(g) + 6.0 H2O(g)  
Basis: N/A  

2.12.4.225  HLW-NOX-SO2-REACTION  
Unique ID: BMR-WASTE_TR-222  
1.0 SO2(g) + 0.5 O2(g) --> 1.0 SO3(g)  
Basis: N/A  

2.12.4.226  HLW-P2O5-SCRUBBER-REACTION  
Unique ID: BMR-WASTE_TR-223  
1.0 P2O5(g) + 3.0 H2O(l) --> 6.0 H+(l) + 0.5 PO4-3(l) + 1.5 PO4-3(s)  
Basis: N/A  

2.12.4.227  HLW-SO2-SCRUBBER-REACTION  
Unique ID: BMR-WASTE_TR-224  
2.0 SO2(g) + 2.0 H2O(l) + 1.0 O2(g) --> 4.0 H+(l) + 2.0 SO4-2(l)  
Basis: N/A  

2.12.4.228  HLW-SR-SCRUBBER-RXN  
Unique ID: BMR-WASTE_TR-225  
2.0 Sr2+(s) + 1.0 O2(g) + 2.0 H2O(l) --> 2.0 Sr2+(l) + 4.0 OH-(l)  
Basis: N/A  

2.12.4.229  HLW-SR90-SCRUBBER-RXN  
Unique ID: BMR-WASTE_TR-226  
2.0 90-Sr(s) + 1.0 O2(g) + 2.0 H2O(l) --> 2.0 90-Sr(l) + 4.0 OH-(l)  
Basis: N/A  

2.12.4.230  IODINE-SUBLIME-REACTION  
Unique ID: BMR-WASTE_TR-227  
1.0 129-I(s) --> 1.0 129-I(g)  
Basis: N/A  

2.12.4.231  LAW-NO-WESP-REACTION  
Unique ID: BMR-WASTE_TR-228  
2.0 NO(g) + 1.0 O2(g) + 2.0 H2O(l) --> 4.0 H+(l) + 2.0 NO3-(l)
Basis: N/A

2.12.4.232  LAW-WESP-129-I-RXN
Unique ID: BMR-WASTE_TR-229
1.0 129-I(g) --> 1.0 129-I(l)
Basis: N/A

2.12.4.233  LAW-WESP-NO-WESP-REACTION
Unique ID: BMR-WASTE_TR-230
2.0 NO(g) + 1.0 O2(g) + 2.0 H2O(l) --> 4.0 H+(l) + 2.0 NO3-(l)
Basis: N/A

2.12.4.234  LAW-WESP-P2O5-SCRUBBER-REACTION
Unique ID: BMR-WASTE_TR-231
1.0 P2O5(g) + 3.0 H2O(l) --> 6.0 H+(l) + 0.5 PO4-3(l) + 1.5 PO4-3(s)
Basis: N/A

2.12.4.235  MAKE-OH-SCRUBBER-REACTION
Unique ID: BMR-WASTE_TR-232
1.0 O2(g) + 4.0 Na+(l) + 2.0 H2O(l) --> 4.0 Na+(l) + 4.0 OH-(l)
Basis: N/A

2.12.4.236  NA-REACTION
Unique ID: BMR-WASTE_TR-233
1.0 Na+(s) --> 1.0 Na+(l)
Basis: N/A

2.12.4.237  NEUT-REACTION
Unique ID: BMR-WASTE_TR-234
1.0 H+(l) + 1.0 OH-(l) --> 1.0 H2O(l)
Basis: N/A

2.12.4.238  NEUT-REACTION2
Unique ID: BMR-WASTE_TR-235
1.0 H+(l) + 1.0 OH(BOUND)(l) --> 1.0 H2O(g)
Basis: N/A
2.12.4.239 NH3-GENERATION
Unique ID: BMR-WASTE_TR-236
1.0 NO2-(l) + 1.0 NO3-(l) + 3.0 H2O(l) --> 2.0 NH3(g) + 4.0 O2(g)
Basis: N/A

2.12.4.240 NH3-REACTION
Unique ID: BMR-WASTE_TR-237
1.0 NH3(g) + 1.0 H2O(l) --> 1.0 NH4+(l) + 1.0 OH-(l)
Basis: N/A

2.12.4.241 NO-NH3-REACTION
Unique ID: BMR-WASTE_TR-238
6.0 NO(g) + 4.0 NH3(g) --> 5.0 N2(g) + 6.0 H2O(g)
Basis: N/A

2.12.4.242 NO-NH3-REACTION2
Unique ID: BMR-WASTE_TR-239
6.0 NO(g) + 4.0 NH3(g) --> 5.0 N2(g) + 6.0 H2O(g)
Basis: N/A

2.12.4.243 NO-SCR-REACTION
Unique ID: BMR-WASTE_TR-240
6.0 NO(g) + 4.0 NH3(l) --> 5.0 N2(g) + 6.0 H2O(g)
Basis: N/A

2.12.4.244 NO-SCRUBBER-REACTION
Unique ID: BMR-WASTE_TR-241
4.0 NO(g) + 2.0 H2O(l) + 3.0 O2(g) --> 4.0 H+(l) + 4.0 NO3-(l)
Basis: N/A

2.12.4.245 NO2-NH3-REACTION
Unique ID: BMR-WASTE_TR-242
6.0 NO2(g) + 8.0 NH3(g) --> 7.0 N2(g) + 12.0 H2O(g)
Basis: N/A

2.12.4.246 NO2-SCR-REACTION
Unique ID: BMR-WASTE_TR-243
6.0 NO2(g) + 8.0 NH3(l) --> 7.0 N2(g) + 12.0 H2O(g)
Basis: N/A

2.12.4.247 NO2-SCRUBBER-REACTION
Unique ID: BMR-WASTE_TR-244
3.0 NO2(g) + 1.0 H2O(l) --> 2.0 H+(l) + 2.0 NO3-(l) + 1.0 NO(g)
Basis: N/A

2.12.4.248 O-BOUND-TO-GAS
Unique ID: BMR-WASTE_TR-245
1.0 O(BOUND)(l) --> 0.5 O2(g)
Basis: N/A

2.12.4.249 OD-1
Unique ID: BMR-WASTE_TR-246
1.0 C2O4-2(l) --> 2.0 CO2(g)
Basis: N/A

2.12.4.250 OD-18
Unique ID: BMR-WASTE_TR-247
1.0 CHCl3(l) + 0.5 O2(g) + 1.0 H2O(l) --> 1.0 CO2(g) + 3.0 HCl(g)
Basis: N/A

2.12.4.251 OD-19
Unique ID: BMR-WASTE_TR-248
1.0 CH2Cl2(l) + 1.0 O2(g) --> 1.0 CO2(g) + 2.0 HCl(g)
Basis: N/A

2.12.4.252 OD-22
Unique ID: BMR-WASTE_TR-249
1.0 TOC(l) + 1.0 O2(g) --> 1.0 CO2(g)
Basis: N/A

2.12.4.253 OD-3
Unique ID: BMR-WASTE_TR-250
4.0 CHO2-(l) + 1.0 O2(g) --> 4.0 CO2(g) + 2.0 H2O(g)
Basis: N/A
2.12.4.254  OHBOUND-REACTION
Unique ID: BMR-WASTE_TR-251
1.0 OH(BOUND)(l) --> 1.0 OH-(l)
Basis: N/A

2.12.4.255  OX-238-PU
Unique ID: BMR-WASTE_TR-252
1.0 238-Pu(s) + 3.0 OH(BOUND)(s) + 1.0 OH-(l) --> 1.0 238-Pu(l) + 4.0 OH-(l)
Basis: N/A

2.12.4.256  OX-239-PU
Unique ID: BMR-WASTE_TR-253
1.0 239-Pu(s) + 3.0 OH(BOUND)(s) + 1.0 OH-(l) --> 1.0 239-Pu(l) + 4.0 OH-(l)
Basis: N/A

2.12.4.257  OX-240-PU
Unique ID: BMR-WASTE_TR-254
1.0 240-Pu(s) + 3.0 OH(BOUND)(s) + 1.0 OH-(l) --> 1.0 240-Pu(l) + 4.0 OH-(l)
Basis: N/A

2.12.4.258  OX-241-PU
Unique ID: BMR-WASTE_TR-255
1.0 241-Pu(s) + 3.0 OH(BOUND)(s) + 1.0 OH-(l) --> 1.0 241-Pu(l) + 4.0 OH-(l)
Basis: N/A

2.12.4.259  OX-242-PU
Unique ID: BMR-WASTE_TR-256
1.0 242-Pu(s) + 3.0 OH(BOUND)(s) + 1.0 OH-(l) --> 1.0 242-Pu(l) + 4.0 OH-(l)
Basis: N/A

2.12.4.260  OX-CR
Unique ID: BMR-WASTE_TR-257
1.0 CrOOH (s) + 1.0 MnO4- (l) + 1.0 OH- (l) \overset{?}{\rightarrow} 1.0 CrO4-2 (l) + 1.0 MnO2 (s) + 1.0 H2O (l)
Basis: N/A

2.12.4.261  OX-CR-2
Unique ID: BMR-WASTE_TR-258
1.0 MnO4-(l) --> 1.0 Mn+4(s) + 2.0 O(BOUND)(s) + 2.0 O(BOUND)(l)
Basis: N/A

2.12.4.262  OX-PUPLUS4
Unique ID: BMR-WASTE_TR-259
1.0 Pu+4(s) + 3.0 OH(BOUND)(s) + 1.0 OH-(l) --> 1.0 Pu+4(l) + 4.0 OH-(l)
Basis: N/A

2.12.4.263  OXALIC-ACID-DISSOLUTION
Unique ID: BMR-WASTE_TR-260
2.0 H+(l) + 1.0 C2O4-2(l) + 2.0 Na+(l) + 2.0 OH-(l) --> 2.0 Na+(s) + 1.0 C2O4-2(s) + 2.0 H2O(l)
Basis: N/A

2.12.4.264  P2O5-SCRUBBER-REACTION
Unique ID: BMR-WASTE_TR-261
1.0 P2O5(g) + 3.0 H2O(l) --> 6.0 H+(l) + 0.5 PO4-3(l) + 1.5 PO4-3(s)
Basis: N/A

2.12.4.265  PO4-REACTION
Unique ID: BMR-WASTE_TR-262
1.0 PO4-3(s) --> 1.0 PO4-3(l)
Basis: N/A

2.12.4.266  RXN-CR-AL-PRECIP
Unique ID: BMR-WASTE_TR-263
1.0 Al(OH)4-(l) --> 1.0 Al(OH)3(s) + 1.0 OH-(l)
Basis: N/A

2.12.4.267  RXN-CR-CATHODE
Unique ID: BMR-WASTE_TR-264
2.0 H2O(l) + 2.0 Na+(l) --> 2.0 Na+(l) + 2.0 OH-(l) + 2.0 H+(g)
Basis: N/A

2.12.4.268  RXN-CR-CATHODE-2
Unique ID: BMR-WASTE_TR-265
2.0 Na+(g) + 2.0 H2O(l) --> 2.0 Na+(l) + 2.0 OH-(l) + 2.0 H+(g)
Basis: N/A
<table>
<thead>
<tr>
<th>Reaction ID</th>
<th>Reaction Details</th>
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<tbody>
<tr>
<td>RXN-CR-NAOH</td>
<td>2.0 OH-(l) + 2.0 Na+(l) --&gt; 1.0 H2O(l) + 0.5 O2(g) + 2.0 Na+(l)</td>
</tr>
<tr>
<td>RXN-CR-NAOH2</td>
<td>2.0 Na+(l) --&gt; 2.0 Na+(g)</td>
</tr>
<tr>
<td>RXN-LAW-CAUSCRUB-CO2</td>
<td>1.0 CO2(g) + 1.0 H2O(l) --&gt; 2.0 H+(l) + 1.0 CO3-2(l)</td>
</tr>
<tr>
<td>RXN-LAW-CAUSCRUB-HCL</td>
<td>1.0 HCl(g) --&gt; 1.0 H+(l) + 1.0 Cl-(l)</td>
</tr>
<tr>
<td>RXN-LAW-CAUSCRUB-HF</td>
<td>1.0 HF(g) --&gt; 1.0 H+(l) + 1.0 F-(l)</td>
</tr>
<tr>
<td>RXN-LAW-CAUSCRUB-NH3-CONDENSE</td>
<td>1.0 NH3(g) --&gt; 1.0 NH3(l)</td>
</tr>
<tr>
<td>RXN-LAW-CAUSCRUB-NH3-REACTION</td>
<td>1.0 NH3(l) + 1.0 H2O(l) --&gt; 1.0 NH4+(l) + 1.0 OH-(l)</td>
</tr>
<tr>
<td>RXN-LAW-CAUSCRUB-NO</td>
<td>4.0 NO(g) + 2.0 H2O(l) + 3.0 O2(g) --&gt; 4.0 H+(l) + 4.0 NO3-(l)</td>
</tr>
</tbody>
</table>
Basis: N/A

2.12.4.277 RXN-LAW-CAUSCRUB-NO2
Unique ID: BMR-WASTE_TR-274
3.0 NO2(g) + 1.0 H2O(l) --> 2.0 H+(l) + 2.0 NO3-(l) + 1.0 NO(g)
Basis: N/A

2.12.4.278 RXN-LAW-CAUSCRUB-P2O5
Unique ID: BMR-WASTE_TR-275
1.0 P2O5(g) + 3.0 H2O(l) --> 6.0 H+(l) + 0.5 PO4-3(l) + 1.5 PO4-3(s)
Basis: N/A

2.12.4.279 RXN-LAW-CAUSCRUB-SO2
Unique ID: BMR-WASTE_TR-276
2.0 SO2(g) + 2.0 H2O(l) + 1.0 O2(g) --> 4.0 H+(l) + 2.0 SO4-2(l)
Basis: N/A

2.12.4.280 RXN-LAW-CAUSCRUB-SO3
Unique ID: BMR-WASTE_TR-277
1.0 SO3(g) + 1.0 H2O(l) --> 2.0 H+(l) + 1.0 SO4-2(l)
Basis: N/A

2.12.4.281 RXN-LAW-CO-EXTRACT-NH3
Unique ID: BMR-WASTE_TR-278
1.0 NH3(l) --> 1.0 NH3(g)
Basis: N/A

2.12.4.282 RXN-LAW-CO-NO-NH3
Unique ID: BMR-WASTE_TR-279
4.0 NO(g) + 4.0 NH3(g) + 1.0 O2(g) --> 4.0 N2(g) + 6.0 H2O(g)
Basis: N/A

2.12.4.283 RXN-LAW-CO-NO2-NH3
Unique ID: BMR-WASTE_TR-280
2.0 NO2(g) + 4.0 NH3(g) + 1.0 O2(g) --> 3.0 N2(g) + 6.0 H2O(g)
Basis: N/A
2.12.4.284  RXN-LAW-CO-SO2-SO3
Unique ID: BMR-WASTE_TR-281
1.0 SO2(g) + 0.5 O2(g) --> 1.0 SO3(g)
Basis: N/A

2.12.4.285  RXN-LAW-SBS-129-I
Unique ID: BMR-WASTE_TR-282
1.0 129-I(g) --> 1.0 129-I(l)
Basis: N/A

2.12.4.286  RXN-LAW-SBS-BO4
Unique ID: BMR-WASTE_TR-283
2.0 B+3(s) + 1.5 O2(g) + 3.0 H2O(l) --> 2.0 H+(l) + 2.0 B+3(l) + 4.0 O(BOUND)(l) + 2.0 H2O(l)
Basis: N/A

2.12.4.287  RXN-LAW-SBS-HCL
Unique ID: BMR-WASTE_TR-284
1.0 HCl(g) --> 1.0 H+(l) + 1.0 Cl-(l)
Basis: N/A

2.12.4.288  RXN-LAW-SBS-HF
Unique ID: BMR-WASTE_TR-285
1.0 HF(g) --> 1.0 H+(l) + 1.0 F-(l)
Basis: N/A

2.12.4.289  RXN-LAW-SBS-MAKE-OH-90-SR
Unique ID: BMR-WASTE_TR-286
2.0 90-Sr(l) + 1.0 O2(g) + 2.0 H2O(l) --> 2.0 90-Sr(l) + 4.0 OH-(l)
Basis: N/A

2.12.4.290  RXN-LAW-SBS-MAKE-OH-CA
Unique ID: BMR-WASTE_TR-287
2.0 Ca+2(l) + 1.0 O2(g) + 2.0 H2O(l) --> 2.0 Ca+2(l) + 4.0 OH-(l)
Basis: N/A

2.12.4.291  RXN-LAW-SBS-MAKE-OH-K
Unique ID: BMR-WASTE_TR-288
4.0 K+(l) + 1.0 O2(g) + 2.0 H2O(l) --> 4.0 K+(l) + 4.0 OH-(l)
Basis: N/A

2.12.4.292 RXN-LAW-SBS-MAKE-OH-LI
Unique ID: BMR-WASTE_TR-289
4.0 Li+(l) + 1.0 O2(g) + 2.0 H2O(l) --> 4.0 Li+(l) + 4.0 OH-(l)
Basis: N/A

2.12.4.293 RXN-LAW-SBS-MAKE-OH-NA
Unique ID: BMR-WASTE_TR-290
4.0 Na+(l) + 1.0 O2(g) + 2.0 H2O(l) --> 4.0 Na+(l) + 4.0 OH-(l)
Basis: N/A

2.12.4.294 RXN-LAW-SBS-MAKE-OH-SR
Unique ID: BMR-WASTE_TR-291
2.0 Sr+2(l) + 1.0 O2(g) + 2.0 H2O(l) --> 2.0 Sr+2(l) + 4.0 OH-(l)
Basis: N/A

2.12.4.295 RXN-LAW-SBS-NH3
Unique ID: BMR-WASTE_TR-292
1.0 NH3(l) + 1.0 H2O(l) --> 1.0 NH4+(l) + 1.0 OH-(l)
Basis: N/A

2.12.4.296 RXN-LAW-SBS-NH3-CONDENSE
Unique ID: BMR-WASTE_TR-293
1.0 NH3(g) --> 1.0 NH3(l)
Basis: N/A

2.12.4.297 RXN-LAW-SBS-NO
Unique ID: BMR-WASTE_TR-294
4.0 NO(g) + 2.0 H2O(l) + 3.0 O2(g) --> 4.0 H+(l) + 4.0 NO3-(l)
Basis: N/A

2.12.4.298 RXN-LAW-SBS-NO2
Unique ID: BMR-WASTE_TR-295
3.0 NO2(g) + 1.0 H2O(l) --> 2.0 H+(l) + 2.0 NO3-(l) + 1.0 NO(g)
Basis: N/A
2.12.4.299 RXN-LAW-SBS-P2O5
Unique ID: BMR-WASTE_TR-296
1.0 P2O5(g) + 3.0 H2O(l) --> 6.0 H+(l) + 0.5 PO4-3(l) + 1.5 PO4-3(s)
Basis: N/A

2.12.4.300 RXN-LAW-SBS-SO2
Unique ID: BMR-WASTE_TR-297
2.0 SO2(g) + 2.0 H2O(l) + 1.0 O2(g) --> 4.0 H+(l) + 2.0 SO4-2(l)
Basis: N/A

2.12.4.301 RXN-LAW-WESP-129-I
Unique ID: BMR-WASTE_TR-298
1.0 129-I(g) --> 1.0 129-I(l)
Basis: N/A

2.12.4.302 RXN-LAW-WESP-NO
Unique ID: BMR-WASTE_TR-299
4.0 NO(g) + 3.0 O2(g) + 2.0 H2O(l) --> 4.0 H+(l) + 4.0 NO3-(l)
Basis: N/A

2.12.4.303 RXN-LAW-WESP-P2O5
Unique ID: BMR-WASTE_TR-300
1.0 P2O5(g) + 3.0 H2O(l) --> 6.0 H+(l) + 0.5 PO4-3(l) + 1.5 PO4-3(s)
Basis: N/A

2.12.4.304 RXN-NH4-NEUTRALIZATION
Unique ID: BMR-WASTE_TR-301
1.0 NH4+(l) --> 1.0 NH3(l) + 1.0 H+(l)
Basis: N/A

2.12.4.305 RXN-WTP-H-OH-NEUT
Unique ID: BMR-WASTE_TR-302
1.0 H+(l) + 1.0 OH-(l) --> 1.0 H2O(l)
Basis: N/A

2.12.4.306 RXN-WTP-NH4
Unique ID: BMR-WASTE_TR-303
1.0 NH4+(l) + 2.0 H2O(l) --> 8.0 H+(l) + 1.0 NO2-(l)
Basis: N/A

2.12.4.307 RXN-WTP-NO2-NEUT
Unique ID: BMR-WASTE_TR-304
1.0 NO2-(l) + 8.0 H+(l) --> 1.0 NH4+(l) + 2.0 H2O(l)
Basis: N/A

2.12.4.308 RXN-WTP-NO3-NEUT
Unique ID: BMR-WASTE_TR-305
1.0 NO3-(l) + 10.0 H+(l) --> 1.0 NH4+(l) + 3.0 H2O(l)
Basis: N/A

2.12.4.309 SI-REACTION
Unique ID: BMR-WASTE_TR-306
1.0 Si+4(s) + 4.0 OH-(l) --> 1.0 Si+4(l) + 4.0 OH-(l)
Basis: N/A

2.12.4.310 SO2-SCRUBBER-REACTION
Unique ID: BMR-WASTE_TR-307
2.0 SO2(g) + 2.0 H2O(l) + 1.0 O2(g) --> 4.0 H+(l) + 2.0 SO4-2(l)
Basis: N/A

2.12.4.311 SO4-REACTION
Unique ID: BMR-WASTE_TR-308
1.0 SO4-2(s) + 2.0 Na+(s) --> 1.0 SO4-2(l) + 2.0 Na+(l)
Basis: N/A

2.12.4.312 SUBLIME-CS-REACTION
Unique ID: BMR-WASTE_TR-309
1.0 Cs+(s) + 1.0 134-Cs(s) + 1.0 137-Cs(s) --> 1.0 Cs+(g) + 1.0 134-Cs(g) + 1.0 137-Cs(g)
Basis: N/A

2.12.4.313 SUBLIME-K-REACTION
Unique ID: BMR-WASTE_TR-310
1.0 K+(s) --> 1.0 K+(g)
Basis: N/A
2.12.4.314  SUBLIME-NA-REACTION  
Unique ID: BMR-WASTE_TR-311  
1.0 Na+(s) \rightarrow 1.0 Na+(g)  
Basis: N/A  

2.12.4.315  SUBLIME-TC-REACTION  
Unique ID: BMR-WASTE_TR-312  
1.0 99-Tc(s) \rightarrow 1.0 99-Tc(g)  
Basis: N/A  

2.12.4.316  UV-ORGANIC-1  
Unique ID: BMR-WASTE_TR-313  
1.0 C2O4-2(l) \rightarrow 2.0 CO2(g)  
Basis: N/A  

2.12.4.317  UV-ORGANIC-18  
Unique ID: BMR-WASTE_TR-314  
1.0 CHCl3(l) + 1.0 H2O2(l) \rightarrow 1.0 CO2(g) + 3.0 HCl(g)  
Basis: N/A  

2.12.4.318  UV-ORGANIC-19  
Unique ID: BMR-WASTE_TR-315  
1.0 CH2Cl2(l) + 2.0 H2O2(l) \rightarrow 1.0 CO2(g) + 2.0 HCl(g) + 2.0 H2O(l)  
Basis: N/A  

2.12.4.319  UV-ORGANIC-3  
Unique ID: BMR-WASTE_TR-316  
2.0 CHO2-(l) + 1.0 H2O2(l) \rightarrow 2.0 CO2(g) + 2.0 H2O(l)  
Basis: N/A  

2.12.4.320  V12011-MN-1  
Unique ID: BMR-WASTE_TR-317  
1.0 C2O4-2(l) + 1.0 MnO4-(l) \rightarrow 1.0 MnO2(s) + 2.0 CO3-2(l)  
Basis: N/A  

2.12.4.321  V12011-MN-3  
Unique ID: BMR-WASTE_TR-318  
1.0 CHO2-(l) + 1.0 MnO4-(l) \rightarrow 1.0 MnO2(s) + 1.0 CO3-2(l) + 0.5 H2O(l) + 0.25 O2(g)
Basis: N/A

2.12.4.322  V12011-MN-9
Unique ID: BMR-WASTE_TR-319
1.0 TOC(l) + 1.0 MnO4-(l) + 2.0 OH-(l) --> 1.0 MnO2(s) + 1.0 CO3-2(l) + 1.0 H2O(l)
Basis: N/A

2.12.4.323  V12011-OH1-REACTION
Unique ID: BMR-WASTE_TR-320
1.0 241-Am(l) + 3.0 OH-(l) --> 1.0 241-Am(s) + 3.0 OH-(s)
Basis: N/A

2.12.4.324  V12011-OH10-REACTION
Unique ID: BMR-WASTE_TR-321
1.0 244-Cm(l) + 3.0 OH-(l) --> 1.0 244-Cm(s) + 3.0 OH-(s)
Basis: N/A

2.12.4.325  V12011-OH2-REACTION
Unique ID: BMR-WASTE_TR-322
1.0 243-Am(l) + 3.0 OH-(l) --> 1.0 243-Am(s) + 3.0 OH-(s)
Basis: N/A

2.12.4.326  V12011-OH3-REACTION
Unique ID: BMR-WASTE_TR-323
1.0 Pu+4(l) + 4.0 OH-(l) --> 1.0 Pu+4(s) + 4.0 OH-(s)
Basis: N/A

2.12.4.327  V12011-OH4-REACTION
Unique ID: BMR-WASTE_TR-324
1.0 239-Pu(l) + 4.0 OH-(l) --> 1.0 239-Pu(s) + 4.0 OH-(s)
Basis: N/A

2.12.4.328  V12011-OH5-REACTION
Unique ID: BMR-WASTE_TR-325
1.0 240-Pu(l) + 4.0 OH-(l) --> 1.0 240-Pu(s) + 4.0 OH-(s)
Basis: N/A
2.12.4.329 V12011-OH6-REACTION
Unique ID: BMR-WASTE_TR-326
1.0 241-Pu(l) + 4.0 OH-(l) --> 1.0 241-Pu(s) + 4.0 OH-(s)
Basis: N/A

2.12.4.330 V12011-OH7-REACTION
Unique ID: BMR-WASTE_TR-327
1.0 242-Pu(l) + 4.0 OH-(l) --> 1.0 242-Pu(s) + 4.0 OH-(s)
Basis: N/A

2.12.4.331 V12011-OH8-REACTION
Unique ID: BMR-WASTE_TR-328
1.0 242-Cm(l) + 3.0 OH-(l) --> 1.0 242-Cm(s) + 3.0 OH-(s)
Basis: N/A

2.12.4.332 V12011-OH9-REACTION
Unique ID: BMR-WASTE_TR-329
1.0 243-Cm(l) + 3.0 OH-(l) --> 1.0 243-Cm(s) + 3.0 OH-(s)
Basis: N/A

2.12.4.333 V12011-SR1-REACTION
Unique ID: BMR-WASTE_TR-330
1.0 Sr+2(l) + 1.0 CO3-2(l) --> 1.0 Sr+2(s) + 1.0 CO3-2(s)
Basis: N/A

2.12.4.334 V12011-SR2-REACTION
Unique ID: BMR-WASTE_TR-331
1.0 90-Sr(l) + 1.0 CO3-2(l) --> 1.0 90-Sr(s) + 1.0 CO3-2(s)
Basis: N/A

2.12.4.335 V15013-NEUT-REACTION
Unique ID: BMR-WASTE_TR-332
1.0 H+(l) + 1.0 OH-(l) --> 1.0 H2O(l)
Basis: N/A

2.12.4.336 PO4-SOLUBILITY
Unique ID: BMR-WASTE_TR-333
1.0 PO4-3(s) + 3.00 Na+(s) --> 1.0 PO4-3(l) + 3.0 Na+(l)
Basis: N/A

2.12.4.337  EVAPORATE-H2O
Unique ID: BMR-WASTE_TR-334
1.0 H2O(l) --> 1.0 H2O(g)
Basis: N/A

2.12.4.338  EVAPORATE-3-H
Unique ID: BMR-WASTE_TR-335
1.0 3-H(l) --> 1.0 3-H(g)
Basis: N/A

2.12.4.339  EVAPORATE-H2O2
Unique ID: BMR-WASTE_TR-336
1.0 H2O2(l) --> 1.0 H2O2(g)
Basis: N/A

2.12.4.340  CONDENSE-H2O
Unique ID: BMR-WASTE_TR-337
1.0 H2O(g) --> 1.0 H2O(l)
Basis: N/A

2.12.4.341  CONDENSE-3-H
Unique ID: BMR-WASTE_TR-338
1.0 3-H(g) --> 1.0 3-H(l)
Basis: N/A

2.12.4.342  CONDENSE-H2O2
Unique ID: BMR-WASTE_TR-339
1.0 H2O2(g) --> 1.0 H2O2(l)
Basis: N/A

2.12.4.343  CRO4-SR-TRU-REACTION
Unique ID: BMR-WASTE_TR-340
1.0 CrO4-2(l) + 1.5 NO2-(l) + 1.5 H2O(l) --> 1.0 CrOOH(s) + 1.5 NO3-(l) + 2.0 OH-(l)
Basis: N/A
2.12.4.344  LAW-CL-SCRUBBER-REACTION
Unique ID: BMR-WASTE_TR-347
1.0 Na+(s) + 1.0 Cl-(s) --> 1.0 Na+(l) + 1.0 Cl-(l)
Basis: N/A

2.12.4.345  LAW-F-SCRUBBER-REACTION
Unique ID: BMR-WASTE_TR-348
1.0 Na+(s) + 1.0 F-(s) --> 1.0 Na+(l) + 1.0 F-(l)
Basis: N/A

2.12.4.346  Mole Fraction of Water at Saturation
Unique ID: BMR-WASTE_TR-343
The following empirical correlation for the vapor pressure of water at saturation shall be utilized:

\[ P_{\text{H}_2\text{O, Sat}} = A \times T^4 + B \times T^3 + C \times T^2 + D \times T + E \]

\[ A = 9.666\times10^{-6} \]
\[ B = -3.360\times10^{-4} \]
\[ C = 3.575\times10^{-2} \]
\[ D = 1.842\times10^{-1} \]
\[ E = 6.442\times10^{0} \]

\( P_{\text{H}_2\text{O, Sat}} \) = the equilibrium saturation pressure of water in mbar

T = temperature in degrees Celsius

Assuming an ideal gas, \( x_{\text{H}_2\text{O}} = \frac{P_{\text{H}_2\text{O, Sat}}}{P} \) where \( x_{\text{H}_2\text{O}} \) is the mole fraction of water in the gaseous phase and P is the pressure of the gaseous phase.
Basis: N/A

2.12.4.347  Sr+2 Reaction
Unique ID: BMR-WASTE_TR-345
1.0 Sr+2(l) + 1.0 CO\textsubscript{3}^{-2}(l) → 1.0 Sr+2(s) + 1.0 CO\textsubscript{3}^{-2}(s)
Basis: N/A

2.12.4.348  90-Sr Reaction
Unique ID: BMR-WASTE_TR-346
1.0 90-Sr(l) + 1.0 CO\textsubscript{3}^{-2}(l) → 1.0 90-Sr(s) + 1.0 CO\textsubscript{3}^{-2}(s)
Basis: N/A
2.12.4.349 Sr Solubility

**Unique ID:** BMR-WASTE_TR-349

The strontium solubility correlation equation shall be used to calculate Sr solubility.

\[ C_{\text{Sr-90}} = A C_{\text{TOC}}^2 + B \]

where \( A = 8.5897 \times 10^{-8} \) (\( \mu \text{Ci/mL})/(\mu \text{g/mL})^2 \), \( B = 0.5628 \) \( \mu \text{Ci/mL} \), and \( C_{\text{TOC}} \) is TOC concentration excluding oxalates.

**Basis:** The strontium solubility correlation equation is from RPP-21807.

2.12.4.350 Total Sr to Sr-90 ratio

**Unique ID:** BMR-WASTE_TR-350

The ratio of 102 for total Sr to Sr-90 shall be used.

**Basis:** The ratio of 102 for total Sr to Sr-90 is calculated based on inventory (RPP-33715, Rev.12) and the decay date for the data (RPP-21807) for the year, 2000.

2.12.4.351 Density Coefficients for Liquid Waste

**Unique ID:** BMR-WASTE_TR-351

Density coefficients used for calculation of liquid density are from TOPSim MDD, RPP-55485, Rev.1 (Table “Coefficients of Density at 30°C”). Density coefficients for H⁺ and Fe⁺3 are used for partial stream densities associated with HNO₃ and Fe(NO₃)₃, respectively. NO₃⁻ density coefficient is used for NaNO₃ since there is none for Na⁺.

**Basis:**

**Coefficients of Density at 30°C**

<table>
<thead>
<tr>
<th>Component</th>
<th>Density coefficient (L/gmol)*</th>
<th>Component</th>
<th>Density coefficient (L/gmol)*</th>
</tr>
</thead>
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<tr>
<td>$^{235}$U</td>
<td>0.318</td>
<td>$^{233}$U</td>
<td>0.318</td>
</tr>
<tr>
<td>$^{235}$U</td>
<td>0.318</td>
<td>$^{234}$U</td>
<td>0.318</td>
</tr>
<tr>
<td>$^{233}$U</td>
<td>0.318</td>
<td>$^{235}$U</td>
<td>0.318</td>
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<td>$^{235}$U</td>
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<td>CrO$_4^{2-}$</td>
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* Values are calculated at 30°C (RPP-14767, 2003, Hanford Tank Waste Operations Simulator Specific Gravity Model - Derivation of Coefficients and Validation, Rev. 0, CH2M HILL Hanford Group, Inc., Richland, Washington.)
2.12.4.352 Molecular Weights

**Unique ID:** BMR-WASTE_TR-352

Molecular weights for waste components are taken from TOPSim MDD, RPP-55485, Rev.1 (Table B-1).

**Basis:**

<table>
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<th>Component</th>
<th>MW</th>
<th>Component</th>
<th>MW</th>
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</tbody>
</table>
2.12.4.353 Initial Decay Date

Unique ID: BMR-WASTE_TR-353

A date of January 1, 2008, is used in TOPSim as the reference decay date to be consistent with the reference decay date of the BBI data currently being used.

Basis: N/A

2.12.4.354 Half-Life and Specific Activity

Unique ID: BMR-WASTE_TR-354

Each component and isotope decays differently according to their half-life and specific activity.

Basis:
2.12.4.355 Mother-Daughter Isotopes

Unique ID: BMR-WASTE_TR-355

Radioactive decay products are handled consistently as a second order decay of the parent nuclides. Although TOPSim does not track every case of the said relationship, it tracks the buildup of daughter isotopes in four second-order decay chains: $^{93}$Zr, $^{232}$Th, $^{231}$Pa, and $^{241}$Pu.

Basis:

$$
\begin{align*}
^{93}\text{Zr} & \rightarrow ^{93}\text{Nb} \\
^{232}\text{Th} & \rightarrow ^{232}\text{Pa} \\
^{231}\text{Pa} & \rightarrow ^{227}\text{Ac} \\
^{241}\text{Pu} & \rightarrow ^{241}\text{Am}
\end{align*}
$$

2.12.4.356 Radionuclide Decay Equation

Unique ID: BMR-WASTE_TR-356

The decay equation with half-life constant for the isotopes shall be used to calculate radionuclide decay.
Basis:

\[ N = N_0 e^{-\lambda t} \]
\[ \lambda = \frac{\ln 2}{t_{1/2}} \]
\[ \lambda t = \left( \frac{\ln 2}{t_{1/2}} \right) t \]
\[ e^{-\lambda t} = e^{-\left( \frac{\ln 2}{t_{1/2}} \right) t} \]

Where:

- \( N \) = Mass (g)
- \( N_0 \) = Initial mass (g)
- \( t \) = The time elapsed since the initial mass was measured (years)
- \( \lambda \) = Half-life constant of the isotope (years).

**2.12.4.357 Component Waste Phases**

**Unique ID:** BMR-WASTE_TR-357

Components in the tanks can be involved in reactions involving phase changes. Reactants and products are moved to the corresponding liquid, solid, gas, or oxide positions.

**Basis:** N/A

**2.12.4.358 Solid Density**

**Unique ID:** BMR-WASTE_TR-358

Fixed particulate density of 3 g/mL is used with exception for solids in mixing tank glass former, canister, and chem add tank.

**Basis:** Solid volume is calculated with fixed densities for the corresponding solids based on TOPSim MDD.

### Solid Density Parameter Data

<table>
<thead>
<tr>
<th>Vessel Name</th>
<th>Class Name</th>
<th>Solids-Density (g/cc)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CONTACT-SUPP-TRU-PACKAGES</td>
<td>MIXING-TANK-GLASS-FORMER</td>
<td>2.58</td>
</tr>
<tr>
<td>SUP-TRU-ADDITIVE</td>
<td>CHEM-ADD-TANK</td>
<td>2.65</td>
</tr>
<tr>
<td>SLFP.VSL-00001_3 or 2_4</td>
<td>MIXING-TANK-GLASS-FORMER</td>
<td>2.6</td>
</tr>
<tr>
<td>HFP.VSL-00001_5 or 2_6</td>
<td>MIXING-TANK-GLASS-FORMER</td>
<td>2.7</td>
</tr>
<tr>
<td>GFR-TK-00022-23</td>
<td>FEED-HOPPER</td>
<td>2.937</td>
</tr>
<tr>
<td>GFR-TK-00025-29</td>
<td>FEED-HOPPER</td>
<td>2.497</td>
</tr>
<tr>
<td>SLAW-CANISTERS</td>
<td>CANISTER</td>
<td>2.58</td>
</tr>
<tr>
<td>IHLW-CANISTERS</td>
<td>CANISTER</td>
<td>2.66</td>
</tr>
<tr>
<td>ILAW-CANISTERS</td>
<td>CANISTER</td>
<td>2.58</td>
</tr>
</tbody>
</table>
2.13 CHEMICAL ADDITIONS

The Chemical Additions system tracks chemicals that are added to the waste in other systems for processing and treatment. All the chemicals modeled in the RPP flowsheet are described within this system. Specific additions of chemicals are tracked in the systems within which they are added.

2.13.1 System Requirements

2.13.1.1 Chemical Additions

Unique ID: BMR-CHEMADD_SR-1

The model shall add and track chemicals and water as required by the modeled systems.

Basis: N/A

2.13.2 Functional Requirements

2.13.2.1 Chemical Additions

Unique ID: BMR-CHEMADD_FR-1

The model shall provide chemical additions, which include air, water, glass formers, and reagents as needed and defined for the RPP storage and treatment mission.

Basis: N/A

2.13.3 Model Requirements

2.13.3.1 Inhibited Water Addition

Unique ID: BMR-CHEMADD_MR-1

The inhibited water addition shall consist of liquid water with a small amount of sodium hydroxide (NaOH) and sodium nitrite (NaNO₃).

Basis: N/A

2.13.3.2 Sodium Hydroxide Chemical Addition

Unique ID: BMR-CHEMADD_MR-3

The sodium hydroxide (NaOH) chemical addition shall consist of liquid water (H₂O), sodium (Na⁺), and hydroxide (OH⁻) in varying concentration identified in the technical requirements.

Basis: N/A

2.13.3.3 Nitric Acid Chemical Addition

Unique ID: BMR-CHEMADD_MR-4

The nitric acid (HNO₃) chemical addition shall consist of liquid water (H₂O), nitrate (NO₃⁻), and hydrogen (H⁺) in varying concentration identified in the technical requirements.

Basis: N/A
2.13.3.4 Sodium Nitrite Chemical Addition

**Unique ID:** BMR-CHEMADD_MR-5

The sodium nitrite (NaNO₂) chemical addition shall consist of liquid water (H₂O), sodium (Na⁺), and nitrite (NO₂⁻) in varying concentration identified in the technical requirements.

**Basis:** Sodium nitrite to be added will be diluted in water at concentration of 7.54 M (this is at 40 wt% NaNO₂).

2.13.3.5 Cerium Nitrate Chemical Addition

**Unique ID:** BMR-CHEMADD_MR-6

The cerium nitrate (Ce(NO₃)₃) chemical addition shall consist of liquid water (H₂O), cerium (Ce³⁺), and nitrate (NO₃⁻) in the concentration identified in the associated technical requirement.

**Basis:** N/A

2.13.3.6 Strontium Nitrate Chemical Addition

**Unique ID:** BMR-CHEMADD_MR-7

The strontium nitrate chemical addition shall consist of liquid water (H₂O), strontium (Sr²⁺), and nitrate (NO₃⁻) in the concentration identified in the associated technical requirement.

**Basis:** N/A

2.13.3.7 Water Additions

**Unique ID:** BMR-CHEMADD_MR-8

The water addition shall consist of pure water.

**Basis:** N/A

2.13.3.8 Oxalic Acid Chemical Addition

**Unique ID:** BMR-CHEMADD_MR-9

The oxalic acid chemical addition shall consist of liquid water (H₂O), oxalate (C₂O₄⁻), and hydrogen (H⁺) in the concentration identified in the associated technical requirements.

**Basis:** N/A

2.13.3.9 Sodium Permanganate Chemical Addition

**Unique ID:** BMR-CHEMADD_MR-10

The sodium permanganate chemical addition shall consist of liquid water (H₂O), sodium (Na), and manganate (MnO₄⁻) in the concentration identified in the associated technical requirement.

**Basis:** N/A

2.13.3.10 Hydrogen Peroxide Chemical Addition

**Unique ID:** BMR-CHEMADD_MR-11

The hydrogen peroxide chemical addition shall consist of pure liquid hydrogen peroxide (H₂O₂).
Basis: N/A

2.13.3.11 Ammonia Chemical Addition

Unique ID: BMR-CHEMADD_MR-12

The ammonia chemical addition shall consist of pure ammonia (NH$_3$) in the gaseous phase.

Basis: N/A

2.13.3.12 Air Addition

Unique ID: BMR-CHEMADD_MR-13

The air addition shall consist of gaseous water (H$_2$O), nitrogen (N$_2$), oxygen (O$_2$), Argon (Ar), and carbon dioxide (CO$_2$) in the concentration identified in BMR-TR-88, Air.

Basis: N/A

2.13.3.13 Glass Former Mineral Addition

Unique ID: BMR-CHEMADD_MR-14

The glass formers addition shall consist of the following minerals which composition is identified in the associated technical requirement.

- Lithium Carbonate (Li$_2$CO$_3$)
- Silica (SiO$_2$)
- Zinc Oxide (ZnO)
- Boric Acid (H$_3$BO$_3$)
- Kyanite (Al$_2$SiO$_5$)
- Wollastonite (CaSiO$_3$)
- Sodium Carbonate (Na$_2$CO$_3$)
- Forsterite olivine (MgSiO$_4$-Fe$_2$SiO$_4$)
- Hematite (Fe$_2$O$_3$)
- Rutile (TiO$_2$)
- Zircon (ZrSiO$_4$)
- Sugar (C$_{12}$H$_{22}$O$_{11}$)

Note - Glass former impurities and moisture content are not modeled at this time and may be added at a later date.

Basis: N/A

2.13.3.14 Chemical Addition Tracking

Unique ID: BMR-CHEMADD_MR-2

The model shall track the volume and component mass of all chemical additions used by the model.

Basis: N/A
2.13.3.15 TRU addition

**Unique ID:** BMR-CHEMADD_MR-15  
TRU additive will be sand (SiO2).  
**Basis:** N/A

2.13.4 Technical Requirements

2.13.4.1 Water

**Unique ID:** BMR-CHEMADD_TR-32  
The water addition shall consist of 100% H\(_2\)O.  
**Basis:** N/A

2.13.4.2 Inhibited Water

**Unique ID:** BMR-CHEMADD_TR-1  
The inhibited water addition make-up shall consist of the following liquid components and concentration.

<table>
<thead>
<tr>
<th>Component</th>
<th>Concentration (molarity)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Na(^+)</td>
<td>0.021</td>
</tr>
<tr>
<td>OH(^-)</td>
<td>0.01</td>
</tr>
<tr>
<td>NO(_2)</td>
<td>0.011</td>
</tr>
</tbody>
</table>

**Basis:** N/A

2.13.4.3 19M NaOH

**Unique ID:** BMR-CHEMADD_TR-2  
The 19M sodium hydroxide (NaOH) chemical addition make-up shall consist of the following liquid components and concentration.

<table>
<thead>
<tr>
<th>Component</th>
<th>Concentration (molarity)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Na(^+)</td>
<td>19.014</td>
</tr>
<tr>
<td>OH(^-)</td>
<td>19.000</td>
</tr>
<tr>
<td>Cl(^-)</td>
<td>1.18E-03</td>
</tr>
<tr>
<td>Carbonate, CO(_3)^-(^-)</td>
<td>6.52E-03</td>
</tr>
<tr>
<td>Sulfate, SO(_4)^-(^-)</td>
<td>1.33E-04</td>
</tr>
</tbody>
</table>

**Basis:** N/A
2.13.4.4 0.1M NaOH

Unique ID: BMR-CHEMADD_TR-3

The 0.1 molar sodium hydroxide (NaOH) chemical addition make-up shall consist of the following liquid components and concentration.

<table>
<thead>
<tr>
<th>Component</th>
<th>Concentration (molarity)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Na+</td>
<td>0.100</td>
</tr>
<tr>
<td>OH-</td>
<td>0.100</td>
</tr>
<tr>
<td>Chloride, Cl^-</td>
<td>6.20E-06</td>
</tr>
<tr>
<td>Carbonate, CO_3^-</td>
<td>3.43E-05</td>
</tr>
<tr>
<td>Sulfate, SO_4^-</td>
<td>7.00E-07</td>
</tr>
</tbody>
</table>

Basis: N/A

2.13.4.5 0.25M NaOH

Unique ID: BMR-CHEMADD_TR-4

The 0.25 molar sodium hydroxide (NaOH) chemical addition make-up shall consist of the following liquid components and concentration.

<table>
<thead>
<tr>
<th>Component</th>
<th>Concentration (molarity)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Na+</td>
<td>0.250</td>
</tr>
<tr>
<td>OH-</td>
<td>0.250</td>
</tr>
<tr>
<td>Chloride, Cl^-</td>
<td>1.55E-05</td>
</tr>
<tr>
<td>Carbonate, CO_3^-</td>
<td>8.58E-05</td>
</tr>
<tr>
<td>Sulfate, SO_4^-</td>
<td>1.75E-06</td>
</tr>
</tbody>
</table>

Basis: N/A

2.13.4.6 8.0M NaOH

Unique ID: BMR-CHEMADD_TR-5

The 8.0 molar sodium hydroxide (NaOH) chemical addition make-up shall consist of the following liquid components and concentration.

<table>
<thead>
<tr>
<th>Component</th>
<th>Concentration (molarity)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Na+</td>
<td>8.007</td>
</tr>
<tr>
<td>OH-</td>
<td>8.000</td>
</tr>
<tr>
<td>Chloride, Cl^-</td>
<td>4.96E-04</td>
</tr>
<tr>
<td>Carbonate, CO_3^-</td>
<td>2.74E-03</td>
</tr>
<tr>
<td>Sulfate, SO_4^-</td>
<td>5.60E-05</td>
</tr>
</tbody>
</table>

Basis: N/A
2.13.4.7 0.5M NaOH

Unique ID: BMR-CHEMADD_TR-6

The 0.5 molar sodium hydroxide (NaOH) chemical addition make-up shall consist of the following liquid components and concentration.

<table>
<thead>
<tr>
<th>Component</th>
<th>Concentration (molarity)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Na⁺</td>
<td>0.500</td>
</tr>
<tr>
<td>OH⁻</td>
<td>0.500</td>
</tr>
<tr>
<td>Chloride, Cl⁻</td>
<td>3.10E-05</td>
</tr>
<tr>
<td>Carbonate, CO₃⁻²</td>
<td>1.72E-04</td>
</tr>
<tr>
<td>Sulfate, SO₄⁻²</td>
<td>3.50E-06</td>
</tr>
</tbody>
</table>

Basis: N/A

2.13.4.8 2.0M NaOH

Unique ID: BMR-CHEMADD_TR-7

The 2.0 molar sodium hydroxide (NaOH) chemical addition make-up shall consist of the following liquid components and concentration.

<table>
<thead>
<tr>
<th>Component</th>
<th>Concentration (molarity)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Na⁺</td>
<td>2.002</td>
</tr>
<tr>
<td>OH⁻</td>
<td>2.000</td>
</tr>
<tr>
<td>Chloride, Cl⁻</td>
<td>1.24E-04</td>
</tr>
<tr>
<td>Carbonate, CO₃⁻²</td>
<td>6.86E-04</td>
</tr>
<tr>
<td>Sulfate, SO₄⁻²</td>
<td>1.40E-05</td>
</tr>
</tbody>
</table>

Basis: N/A

2.13.4.9 5.0M NaOH

Unique ID: BMR-CHEMADD_TR-8

The 5.0 molar sodium hydroxide (NaOH) chemical addition make-up shall consist of the following liquid components and concentration.

<table>
<thead>
<tr>
<th>Component</th>
<th>Concentration (molarity)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Na⁺</td>
<td>5.004</td>
</tr>
<tr>
<td>OH⁻</td>
<td>5.000</td>
</tr>
<tr>
<td>Chloride, Cl⁻</td>
<td>3.10E-04</td>
</tr>
<tr>
<td>Carbonate, CO₃⁻²</td>
<td>1.72E-03</td>
</tr>
<tr>
<td>Sulfate, SO₄⁻²</td>
<td>3.50E-05</td>
</tr>
</tbody>
</table>

Basis: N/A
2.13.4.10  0.45M HNO₃

**Unique ID:** BMR-CHEMADD_TR-9

The 0.45 molar nitric acid (HNO₃) chemical addition make-up shall consist of the following liquid components and concentration.

<table>
<thead>
<tr>
<th>Component</th>
<th>Concentration (molarity)</th>
</tr>
</thead>
<tbody>
<tr>
<td>H⁺</td>
<td>0.450</td>
</tr>
<tr>
<td>NO₃⁻</td>
<td>0.450</td>
</tr>
<tr>
<td>Sulfate, SO₄²⁻</td>
<td>1.22E-05</td>
</tr>
<tr>
<td>Chloride, Cl⁻</td>
<td>4.50E-07</td>
</tr>
</tbody>
</table>

**Basis:** N/A

2.13.4.11  1.0M HNO₃

**Unique ID:** BMR-CHEMADD_TR-10

The 1.0 molar nitric acid (HNO₃) chemical addition make-up shall consist of the following liquid components and concentration.

<table>
<thead>
<tr>
<th>Component</th>
<th>Concentration (molarity)</th>
</tr>
</thead>
<tbody>
<tr>
<td>H⁺</td>
<td>1.000</td>
</tr>
<tr>
<td>NO₃⁻</td>
<td>1.000</td>
</tr>
<tr>
<td>Sulfate, SO₄²⁻</td>
<td>2.70E-05</td>
</tr>
<tr>
<td>Chloride, Cl⁻</td>
<td>1.00E-06</td>
</tr>
</tbody>
</table>

**Basis:** N/A

2.13.4.12  2M HNO₃

**Unique ID:** BMR-CHEMADD_TR-11

The 2.0 molar nitric acid (HNO₃) chemical addition make-up shall consist of the following liquid components and concentration.

<table>
<thead>
<tr>
<th>Component</th>
<th>Concentration (molarity)</th>
</tr>
</thead>
<tbody>
<tr>
<td>H⁺</td>
<td>2.000</td>
</tr>
<tr>
<td>NO₃⁻</td>
<td>2.000</td>
</tr>
<tr>
<td>Sulfate, SO₄²⁻</td>
<td>5.40E-05</td>
</tr>
<tr>
<td>Chloride, Cl⁻</td>
<td>2.00E-06</td>
</tr>
</tbody>
</table>

**Basis:** N/A

2.13.4.13  5.0 M HNO₃

**Unique ID:** BMR-CHEMADD_TR-12

The 5 molar nitric acid (HNO₃) chemical addition make-up shall consist of the following liquid components and concentration.
### RPP-RPT-59470 Rev. 2

### Component Concentration (molarity)

<table>
<thead>
<tr>
<th>Component</th>
<th>Concentration (molarity)</th>
</tr>
</thead>
<tbody>
<tr>
<td>H⁺</td>
<td>5.000</td>
</tr>
<tr>
<td>NO₃⁻</td>
<td>5.000</td>
</tr>
<tr>
<td>Sulfate, SO₄²⁻</td>
<td>1.35E-04</td>
</tr>
<tr>
<td>Chloride, Cl⁻</td>
<td>5.00E-06</td>
</tr>
</tbody>
</table>

**Basis:** N/A

#### 2.13.4.14 7.5M Sodium Nitrite (NaNO₂)

**Unique ID:** BMR-CHEMADD_TR-13

The 7.5 molar sodium nitrite (NaNO₂) chemical addition make-up shall consist of the following liquid components and concentration.

<table>
<thead>
<tr>
<th>Component</th>
<th>Concentration (molarity)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Na⁺</td>
<td>7.540</td>
</tr>
<tr>
<td>NO₂⁻</td>
<td>7.500</td>
</tr>
<tr>
<td>Nitrate, NO₃⁻</td>
<td>3.04E-02</td>
</tr>
<tr>
<td>Carbonate, CO₃²⁻</td>
<td>4.94E-03</td>
</tr>
</tbody>
</table>

**Basis:** N/A

#### 2.13.4.15 0.5M Cerium Nitrate (Ce(NO₃)₃)

**Unique ID:** BMR-CHEMADD_TR-14

The 0.5 cerium nitrate (Ce(NO₃)₃) chemical addition make-up shall consist of the following liquid components and concentration.

<table>
<thead>
<tr>
<th>Component</th>
<th>Concentration (molarity)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ce³⁺</td>
<td>0.5</td>
</tr>
<tr>
<td>NO₃⁻</td>
<td>1.5</td>
</tr>
</tbody>
</table>

**Basis:** N/A

#### 2.13.4.16 3M Strontium Nitrate (Sr(NO₃)₂)

**Unique ID:** BMR-CHEMADD_TR-15

The 3.0 molar strontium nitrate (Sr(NO₃)₂) chemical addition make-up shall consist of the following liquid components and concentration.

<table>
<thead>
<tr>
<th>Component</th>
<th>Concentration (molarity)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sr⁺²</td>
<td>3.0</td>
</tr>
<tr>
<td>NO₃⁻</td>
<td>6.0</td>
</tr>
</tbody>
</table>

**Basis:** N/A
2.13.4.17 1M Oxalic Acid (H2C2O4)

**Unique ID:** BMR-CHEMADD_TR-16

The 1.0 molar oxalic acid (H$_2$C$_2$O$_4$) chemical addition make-up shall consist of the following liquid components and concentration.

<table>
<thead>
<tr>
<th>Component</th>
<th>Concentration (molarity)</th>
</tr>
</thead>
<tbody>
<tr>
<td>H$^+$</td>
<td>2.0</td>
</tr>
<tr>
<td>C$_2$O$_4^{2-}$</td>
<td>1.0</td>
</tr>
</tbody>
</table>

**Basis:** N/A

2.13.4.18 3.83M Sodium Permanganate (NaMnO4)

**Unique ID:** BMR-CHEMADD_TR-17

The 3.83 molar sodium permanganate (NaMnO$_4$) chemical addition make-up shall consist of the following liquid components and concentration.

<table>
<thead>
<tr>
<th>Component</th>
<th>Concentration (molarity)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Na$^+$</td>
<td>3.83</td>
</tr>
<tr>
<td>MnO$_4^{2-}$</td>
<td>3.83</td>
</tr>
</tbody>
</table>

**Basis:** N/A

2.13.4.19 1.0M Sodium Permanganate (NaMnO4)

**Unique ID:** BMR-CHEMADD_TR-18

The 1.0 molar sodium permanganate (NaMnO$_4$) chemical addition make-up shall consist of the following liquid components and concentration.

<table>
<thead>
<tr>
<th>Component</th>
<th>Concentration (molarity)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Na$^+$</td>
<td>1.0</td>
</tr>
<tr>
<td>MnO$_4^{2-}$</td>
<td>1.0</td>
</tr>
</tbody>
</table>

**Basis:** N/A

2.13.4.20 Hydrogen Peroxide (H2O2)

**Unique ID:** BMR-CHEMADD_TR-33

The hydrogen peroxide chemical addition is modeled as pure H$_2$O$_2$.

**Basis:** N/A

2.13.4.21 Air

**Unique ID:** BMR-CHEMADD_TR-19

The air addition make-up shall consist of the following gaseous components and molar concentration @ 25 C and 1 atm.

<table>
<thead>
<tr>
<th>Component</th>
<th>Concentration (mole percentage)</th>
</tr>
</thead>
<tbody>
<tr>
<td>N$_2$</td>
<td>77.21%</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>-----</td>
<td>-----</td>
</tr>
<tr>
<td>O₂</td>
<td>20.71%</td>
</tr>
<tr>
<td>H₂O</td>
<td>1.13%</td>
</tr>
<tr>
<td>Ar</td>
<td>0.92%</td>
</tr>
<tr>
<td>CO₂</td>
<td>0.03%</td>
</tr>
</tbody>
</table>

**Basis:** N/A

### 2.13.4.22 NH₃ Gas

**Unique ID:** BMR-CHEMADD_TR-34

The NH₃ chemical addition shall consist of 100% gaseous NH₃.

**Basis:** N/A

### 2.13.4.23 Glass Former - Lithium Carbonate

**Unique ID:** BMR-CHEMADD_TR-20

The lithium carbonate glass former shall consist of pure lithium oxide (Li₂O).

**Basis:** N/A

### 2.13.4.24 Glass Former - Silica

**Unique ID:** BMR-CHEMADD_TR-21

The glass former silica shall consist of pure silica (SiO₂).

**Basis:** N/A

### 2.13.4.25 Glass Former - Zinc Oxide

**Unique ID:** BMR-CHEMADD_TR-22

The zinc oxide glass former shall consist of pure zinc oxide (ZnO).

**Basis:** N/A

### 2.13.4.26 Glass Former - Boric Acid

**Unique ID:** BMR-CHEMADD_TR-23

The boric acid glass former shall consist of pure boron oxide (B₂O₃).

**Basis:** N/A

### 2.13.4.27 Glass Former - Kyanite

**Unique ID:** BMR-CHEMADD_TR-24

The kyanite glass former shall consist of pure aluminum oxide (Al₂O₃).

**Basis:** N/A

### 2.13.4.28 Glass Former - Wollastonite

**Unique ID:** BMR-CHEMADD_TR-25

The wollastonite glass former shall consist of pure calcium oxide (CaO).
Basis: N/A

2.13.4.29 Glass Former - Sodium Carbonate
Unique ID: BMR-CHEMADD_TR-26
The sodium carbonate glass former shall consist of pure sodium oxide (Na₂O).
Basis: N/A

2.13.4.30 Glass Former - Forsterite Olivine
Unique ID: BMR-CHEMADD_TR-27
The forsterite olivine glass former shall consist of pure magnesium oxide (MgO).
Basis: N/A

2.13.4.31 Glass Former - Hermatite
Unique ID: BMR-CHEMADD_TR-28
The hermatite glass former shall consist of pure iron oxide (Fe₂O₃).
Basis: N/A

2.13.4.32 Glass Former - Rutile
Unique ID: BMR-CHEMADD_TR-29
The rutile glass former shall consist of pure titanium oxide (TiO₂).
Basis: N/A

2.13.4.33 Glass Former - Zircon
Unique ID: BMR-CHEMADD_TR-30
The zircon glass former shall consist of pure Zirconium oxide (ZrO₂).
Basis: N/A

2.13.4.34 Glass Former - Sugar
Unique ID: BMR-CHEMADD_TR-31
The sugar glass former shall consist of pure sucrose (C₁₂H₂₂O₁₁).
Basis: N/A

2.13.4.35 11.0M NaOH
Unique ID: BMR-CHEMADD_TR-35
The 11.0 molar sodium hydroxide (NaOH) chemical addition make-up shall consist of the following liquid components and concentration.

<table>
<thead>
<tr>
<th>Component</th>
<th>Concentration (molarity)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Na⁺</td>
<td>11.00838</td>
</tr>
<tr>
<td>OH⁻</td>
<td>11.00</td>
</tr>
</tbody>
</table>
### Chloride, Cl⁻
- **Value:** 6.82E-04

### Carbonate, CO₃²⁻
- **Value:** 3.78E-03

### Sulfate, SO₄²⁻
- **Value:** 7.70E-05

**Basis:** N/A

**2.13.4.36 Scouring agent additive**

**Unique ID:** BMR-CHEMADD_TR-38

Scouring agents (mostly SiO2) are added into TRU.

**Basis:** N/A
3.0 WTP (FULL DETAIL)

3.1 WASTE TREATMENT AND IMMOBILIZATION FEED EVAPORATION PROCESS

The purpose of the FEP is to reduce the volumetric throughput of the UFP and other downstream unit operations, and also separate water for reuse and disposal. The FEP system includes two evaporator feed tanks which receive recycle streams from throughout the plant and may also receive LAW or HLW feed from the feed receipt vessels. The feed tanks supply feed to two evaporators, which concentrate the recycles or waste to approximately a 5 M sodium concentration. The design of the FEP system is similar to the 242-A Evaporator; it is a continuous, forced circulation, vacuum evaporator system. The current flowsheet baseline bypasses the second front-end evaporator, FEP-SEP-00001B (and condenser) and pumps waste directly to the ultrafiltration feed preparation vessels UFP-VSL-00001A and B based. The FEP-SEP-VSL-00001A evaporator is used to concentrate plant recycles only in TOPSim. This baseline is consistent with the WTP baseline and is valid since nearly all of the incoming feed does not require evaporation.

The Waste Feed Evaporator Feed Vessels (FEP-VSL-00017A and FEP-VSL-00017B) operate in an alternating order and receive feeds from the PWD and RDP systems. The dilute feed is then fed forward to the separator vessel (FEP-SEP-00001A) where constituents are boiled off based on splits. Dynamic splits, identical to the 242-A evaporator are used for the FEP evaporator which are based on the WVR. The bottoms product (concentrated recycles) from FEP-SEP-00001A is transferred to either of the Ultrafiltration Feed Preparation Vessels (UFP-VSL-00001A or UFP-VSL-00001B). The evaporator remains idle until one of the ultrafiltration feed preparation vessels becomes available and one of the evaporator feed vessels (FEP-VSL-00017A/B) completes filling.

The offgas from evaporator is routed to FEP-DMST-00001A where split factors are applied and the condensed liquid stream is sent to the radioactive liquid disposal (RLD) system via RLD-VSL-00006A and the noncondensable stream is routed to the WTP pretreatment stack. Air and water are constantly added to the condenser. All of the added water leaves with the condensate and all of the added air is routed to the stack.
3.1.1 System Requirements

3.1.1.1 FEP System Requirement

Unique ID: BMR-FEP_SR-1

The FEP shall concentrate dilute recycles from throughout the WTP and dilute LAW and HLW feeds and transfer the concentrated product and effluents to downstream processes.

Basis: The FEP system requirement is based on the description in Section 2.2.1 of the BARD (24590-WTP-RPT-PT-02-005, BARD Rev. 8). Note concentration of dilute LAW and HLW feeds is not modeled.

3.1.2 Functional Requirements
3.1.2.1 FEP Receive Recycles from PWD

**Unique ID:** BMR-FEP_FR-1

The *FEP* shall have the capability of receiving recycle streams from the *PWD*.

**Basis:** This functional requirement is based on the functions discussed in Section 3.1 Receive Waste Feed and Dilute Recycles in the *FEP* System Description.

3.1.2.2 FEP Feed Receipt from RDP

**Unique ID:** BMR-FEP_FR-9

The *FEP* shall have the capability of receiving recycle streams from the *RDP*.

**Basis:** This functional requirement is based on the functions discussed in Section 3.1 Receive Waste Feed and Dilute Recycles in the *FEP* System Description.

3.1.2.3 FEP Concentrate Feed

**Unique ID:** BMR-FEP_FR-2

The *FEP* shall have the capability of concentrating the received plant recycles and dilute *LAW* using evaporation.

**Basis:** This functional requirement is based on the functions discussed in Section 3.4 Concentrate Process Fluids in the *FEP* System Description.

3.1.2.4 FEP Condense the Offgas

**Unique ID:** BMR-FEP_FR-6

The *FEP* shall have the capability of condensing vapor contained in the evaporator offgas.

**Basis:** This functional requirement is based on the functions discussed in Section 3.6 Transfer Overheads in the *FEP* System Description.

3.1.2.5 FEP Evaporator Concentrate Transfer to UFP

**Unique ID:** BMR-FEP_FR-5

The *FEP* shall have the capability to transfer the evaporator concentrate to *UFP*.

**Basis:** This functional requirement is based on the functions discussed in Section 3.5 Transfer Process Fluids in the *FEP* System Description.

3.1.2.6 FEP Evaporator Transfer to FRP

**Unique ID:** BMR-FEP.FR-8

The *FEP* shall have the capability to transfer evaporator concentrate and feed to the *FRP*.

**Basis:** This functional requirement is based on the statement "A piping route from FEP to FRP-VSL-00002A will be included in the design, but jumpers to enable use of the route will not be designed. In the event that use of the route is desired, the acceptability of sending FEP concentrate to FRP-VSL-00002A will require evaluation." Section 4.1 Service Provided (Production) in the *FEP* System Description. This route is necessary for modeling purposes to provide an outlet when a pretreatment water lock situation occurs during modeling.
3.1.2.7 FEP Offgas Routing

**Unique ID:** BMR-FEP_FR-3

The *FEP* shall have the capability to route the non-condensable stream from the evaporator offgas to the WTP-Stack via the pretreatment vessel vent and exhaust system (The pretreatment vessel vent and exhaust system is not modeled at this time).

**Basis:** This functional requirement is based on the discussion in Section 2.2.2.3 Evaporator Operations and Figure 2.2-2 of the BARD (24590-WTP-RPT-PT-02-005, BARD Rev. 8). The gaseous output from the FEP system is actually sent to the process ventilation system caustic scrubber (PVP-SCB-00001); however, TOPsim does not currently model the PVP system, so the offgas is routed directly to the PT stack.

3.1.2.8 FEP Process Condensate Routing

**Unique ID:** BMR-FEP_FR-4

The *FEP* shall have the capability to route the condensable stream from the evaporator offgas to the *RLD*.

**Basis:** This functional requirement is based on the functions discussed in Section 3.5 Transfer Process Fluids in the FEP System Description.

3.1.3 Model Requirements

See the FEP Model Logic diagram.

3.1.3.1 FEP Evaporator Feed Vessels (FEP-VSL-00017A and FEP-VSL-00017B)

**Unique ID:** BMR-FEP_MR-1

The *FEP* shall include of two evaporator feed vessels identified as FEP-VSL-00017A and FEP-VSL-00017B.

**Basis:** This model requirement is based on Figure 2.2-2 of the BARD (24590-WTP-RPT-PT-02-005, BARD Rev. 8) and Section 4.8.2 Waste Feed Evaporation Process (FEP) System in 24590-WTP-MDD-PR-01-002, WTP MDD.

3.1.3.2 FEP Waste Feed Evaporator (FEP-SEP-00001A)

**Unique ID:** BMR-FEP_MR-2

The *FEP* shall include a waste feed evaporator separator vessel identified as FEP-SEP-00001A.

**Basis:** This model requirement is based Figure 2.2-2 of the BARD (24590-WTP-RPT-PT-02-005, BARD Rev. 8) and Section 4.8.2 Waste Feed Evaporation Process (FEP) System in 24590-WTP-MDD-PR-01-002, WTP MDD. Note that the FEP-SEP-00001B is not modeled per Section 2.2.2.3 Evaporator Operations in the BARD (24590-WTP-RPT-PT-02-005, BARD Rev. 8) "It is estimated that during normal operation it will be necessary to operate only one evaporator at a time (CCN 021805, System PT-120: Evaporator Capacity)."
3.1.3.3 **FEP Waste Feed Evaporator Demister (FEP-DMST-00001A)**

**Unique ID:** BMR-FEP_MR-3

The *FEP* shall include a waste feed evaporator demister identified as FEP-DMST-00001A.

**Basis:** This model requirement is based on Figure 2.2-2 of the BARD (24590-WTP-RPT-PT-02-005, BARD Rev. 8) and Section 4.8.2 *Waste Feed Evaporation Process (FEP) System* in 24590-WTP-MDD-PR-01-002, WTP MDD. Note that the FEP-DMST-00001B is not modeled per Section 2.2.2.3 Evaporator Operations in the BARD (24590-WTP-RPT-PT-02-005, BARD Rev. 8) "It is estimated that during normal operation it will be necessary to operate only one evaporator at a time (CCN 021805, System PT-120: Evaporator Capacity)."

3.1.3.4 **FEP Feed Sources**

**Unique ID:** BMR-FEP_MR-4

The two *Waste Feed Evaporator Feed Vessels (FEP-VSL-00017A/B)* shall each receive feed from the following sources.

- The *Acidic/Alkaline Effluent Vessel* (PWD-VSL-00015 and PWD-VSL-00016)
- The *Plant Wash Vessel* (PWD-VSL-00044)
- The *RDP-VSL-00002A - Spent Resin Slurry Vessel*

**Basis:** This model requirement is based on Section 2.2.2.1 *Material Transfer to FEP System* in the BARD (24590-WTP-RPT-PT-02-005, BARD Rev. 8) and is also described in Section 4.8.2 *Waste Feed Evaporation Process (FEP) System* in 24590-WTP-MDD-PR-01-002, WTP MDD. Note that evaporator rework or receipts from the FRP system are not modeled.

3.1.3.5 **FEP Waste Receipt Trigger**

**Unique ID:** BMR-FEP_MR-18

Each of the *Waste Feed Evaporator Feed Vessels (FEP-VSL-00017A/B)* shall be available to receive waste when the volume is less than the set volume.

**Basis:** This model requirement is based on the description in Section 4.8.2 *Waste Feed Evaporation Process (FEP) System* in 24590-WTP-MDD-PR-01-002, WTP MDD.

3.1.3.6 **FEP Evaporator Feed Vessels (FEP-VSL-00017A/B) Alternate Filling**

**Unique ID:** BMR-FEP_MR-5

The *Waste Feed Evaporator Feed Vessels (FEP-VSL-00017A/B)* shall fill in an alternating fashion (e.g. as one is filling the other is emptying).

**Basis:** This model requirement is based on the description in Section 4.8.2 *Waste Feed Evaporation Process (FEP) System* in 24590-WTP-MDD-PR-01-002, WTP MDD.

3.1.3.7 **FEP Waste Feed Evaporator Feed Vessels (FEP-VSL-00017A/B) Complete Filling**

**Unique ID:** BMR-FEP_MR-19

Each of the *Waste Feed Evaporator Feed Vessels (FEP-VSL-00017A/B)* shall complete filling when the volume is at the set volume.
**Basis:** This model requirement is based on the description in Section 4.8.2 *Waste Feed Evaporation Process (FEP) System* in 24590-WTP-MDD-PR-01-002, WTP MDD.

### 3.1.3.8 FEP Evaporator Feed Vessel (FEP-VSL-00017A/B) Solubility Application

**Unique ID:** BMR-FEP_MR-6

After the *Waste Feed Evaporator Feed Vessels (FEP-VSL-00017A/B)* has completed filling and prior to discharge, the *Solubility Application* shall be applied at the vessel temperature.

**Basis:** This model requirement is based on the description in Section 4.8.2 *Waste Feed Evaporation Process (FEP) System* in 24590-WTP-MDD-PR-01-002, WTP MDD.

### 3.1.3.9 FEP Evaporator Feed Vessels (FEP-VSL-00017A and FEP-VSL-00017B) Routing

**Unique ID:** BMR-FEP_MR-7

Once solubility has been applied, the *Waste Feed Evaporator Feed Vessels (FEP-VSL-00017A/B)* shall transfer to the *Waste Feed Evaporator (FEP-SEP-00001A)* when one of the downstream receipt vessel *UFP Feed Preparation Vessels (UFP-VSL-00001A/B)* has finished pre-heating operations.

**Basis:** This model requirement is based on the description in Section 4.8.2 *Waste Feed Evaporation Process (FEP) System* in 24590-WTP-MDD-PR-01-002, WTP MDD.

### 3.1.3.10 FEP Waste Feed Evaporator Feed Vessels (FEP-VSL-00017A/B) Transfer Complete

**Unique ID:** BMR-FEP_MR-20

The *Waste Feed Evaporator Feed Vessels (FEP-VSL-00017A/B)* shall complete transferring when it has reached its minimum volume.

**Basis:** This model requirement is based on the description in Section 4.8.2 *Waste Feed Evaporation Process (FEP) System* in 24590-WTP-MDD-PR-01-002, WTP MDD.

### 3.1.3.11 FEP-SEP-00001A Concentration End Point

**Unique ID:** BMR-FEP_MR-8

The *FEP Waste Feed Evaporator (FEP-SEP-00001A)* shall concentrate the feed to *FEP Target Concentration Endpoint*.

**Basis:** This model requirement is based on the description in Section 4.8.2 *Waste Feed Evaporation Process (FEP) System* in 24590-WTP-MDD-PR-01-002, WTP MDD.

### 3.1.3.12 FEP Waste Feed Evaporator (FEP-SEP-00001A) Water Boil Off

**Unique ID:** BMR-FEP_MR-11

The rate of water boiled off in the *FEP Waste Feed Evaporator (FEP-SEP-00001A)* shall not exceed the target *FEP maximum boil-off rate*.

**Basis:** This model requirement is based on the description in Section 4.8.2 *Waste Feed Evaporation Process (FEP) System* in 24590-WTP-MDD-PR-01-002, WTP MDD.
3.1.3.13 FEP Waste Feed Evaporator (FEP-SEP-00001A) Offgas Component Splits

Unique ID: BMR-FEP_MR-10

The amount of contaminants carried into the vapor stream from the Waste Feed Evaporator (FEP-SEP-00001A) shall be calculated based on the partition coefficients and the method described in RPP-RPT-52097, Evaporator Partition Coefficients (see FEP-SEP-00001A Dynamic Decontamination Factors).

Basis: The splits for the FEP evaporator follow the recommendations in RPP-RPT-52097, Evaporator Partition Coefficients and are dynamic based on the WVR.

3.1.3.14 FEP Waste Feed Evaporator (FEP-SEP-00001A) Routing

Unique ID: BMR-FEP_MR-9

The Waste Feed Evaporator (FEP-SEP-00001A) shall send vapors to the Waste Feed Evaporator Demister (FEP-DMST-00001A) unit and the liquid concentrate to one of the UFP Feed Preparation Vessels (UFP-VSL-00001A/B) when it has completed pre-heating.

Basis: This model requirement is based on the description in Section 4.8.2 Waste Feed Evaporation Process (FEP) System in 24590-WTP-MDD-PR-01-002, WTP MDD.

3.1.3.15 FEP Waste Feed Evaporator Demister (FEP-DMST-00001A) Routing

Unique ID: BMR-FEP_MR-12

The Waste Feed Evaporator Demister (FEP-DMST-00001A) vapor shall be routed to the WTP-Stack and condensate shall be routed to the RLD-VSL-00006A - Process Condensate Vessel.

Basis: This model requirement is based on the description in Section 4.8.2 Waste Feed Evaporation Process (FEP) System in 24590-WTP-MDD-PR-01-002, WTP MDD with the model simplification that the offgas is routed directly to the WTP stack and the condensate is routed directly to RLD-VSL-00006A. The gaseous output from the FEP system is actually sent to the process ventilation system caustic scrubber (PVP-SCB-00001); however, TOPsim does not currently model the PVP system, so the offgas is routed directly to the PT stack. In addition, as a modeling simplification, the intermediate tank FEP-VSL-00005A which collects condensate from the demister is not model and the condensate is routed directly to RLD-VSL-00006A.

3.1.3.16 FEP Waste Feed Evaporator Demister (FEP-DMST-00001A) Splits

Unique ID: BMR-FEP_MR-16

The predicted component splits in the Waste Feed Evaporator Demister (FEP-DMST-00001A) offgas and condensate shall be based on the FEP-DMST-00001A Split Factors.

Basis: This model requirement is based on the description in Section 4.8.2 Waste Feed Evaporation Process (FEP) System in 24590-WTP-MDD-PR-01-002, WTP MDD.

3.1.3.17 FEP Waste Feed Evaporator Demister (FEP-DMST-00001A) Water Addition

Unique ID: BMR-FEP_MR-13

The Waste Feed Evaporator Demister (FEP-DMST-00001A) shall include the FEP-DMST-00001A Water Addition when operating.
**Basis:** This model requirement is based on the description in Section 4.8.2 Waste Feed Evaporation Process (FEP) System and Table B-2 Chemical Reagents for FEP in 24590-WTP-MDD-PR-01-002, WTP MDD.

### 3.1.3.18 The FEP Waste Feed Evaporator Demister (FEP-DMST-00001A) Air Addition

**Unique ID:** BMR-FEP_MR-14

The *FEP Waste Feed Evaporator Demister (FEP-DMST-00001A)* shall include an addition of air (*FEP-DMST-00001A Air Addition*) when operating.

**Basis:** This model requirement is based on the description in Section 4.8.2 Waste Feed Evaporation Process (FEP) System and Table B-2 Chemical Reagents for FEP in 24590-WTP-MDD-PR-01-002, WTP MDD.

### 3.1.3.19 FEP Waste Feed Evaporator Demister (FEP-DMST-00001A) Offgas Saturation

**Unique ID:** BMR-FEP_MR-15

Offgas from *Waste Feed Evaporator Demister (FEP-DMST-00001A)* shall be discharged at the saturation conditions of the condenser outlet which is calculated using the *Mole Fraction of Water at Saturation* calculation at the FEP-DMST-00001A Outlet Conditions.

**Basis:** This model requirement is based on Section 2.2.3.15 Condenser Outlet Temperatures in the BARD (24590-WTP-RPT-PT-02-005, BARD Rev. 8).

### 3.1.3.20 FEP System Recycle Back-UP (e.g. Water-Locked) Routing

**Unique ID:** BMR-FEP_MR-17

If the pretreatment water lock situation occurs, the concentrate from the *Waste Feed Evaporator (FEP-SEP-00001A)* shall be routed to an available LAW waste feed receipt vessels (FRP-VSL-00002A/B/C/D).

**Basis:** This requirement is based on the statement "A piping route from FEP to FRP-VSL-00002A will be included in the design, but jumpers to enable use of the route will not be designed. In the event that use of the route is desired, the acceptability of sending FEP concentrate to FRP-VSL-00002A will require evaluation." Section 4.1 Service Provided (Production) in the FEP System Description. This route is necessary for modeling purposes to provide an outlet when a pretreatment water lock situation occurs during modeling.

### 3.1.4 Technical Requirements

#### 3.1.4.1 FEP-VSL-00017A and FEP-VSL-00017B Vessel Parameters

**Unique ID:** BMR-FEP_TR-1

The *Waste Feed Evaporator Feed Vessels (FEP-VSL-00017A/B)* shall each have the following parametric values.

<table>
<thead>
<tr>
<th>Vessel #</th>
<th>Maximum Volume (gal)</th>
<th>Upper Set Volume (gal)</th>
<th>Minimum Volume (gal)</th>
<th>Maximum Flow rate (gpm)</th>
<th>Temperature (C)</th>
</tr>
</thead>
</table>
3.1.4.2 FEP Waste Feed Evaporator (FEP-SEP-00001A) Parameters

Unique ID: BMR-FEP_TR-10

For simplification, the Waste Feed Evaporator (FEP-SEP-00001A) shall be modeled as a splitter which does not have the actual physical attributes of the vessel associated with it.

Basis: This is a modeling simplification. To model the evaporator for flowsheet purposes the actual physical volume is not required.

3.1.4.3 FEP Waste Feed Evaporator Demister (FEP-DMST-00001A) Vessel Parameters

Unique ID: BMR-FEP_TR-2

The Waste Feed Evaporator Demister (FEP-DMST-00001A) shall have the following parametric values.

<table>
<thead>
<tr>
<th>Vessel #</th>
<th>Maximum Volume (gal)</th>
<th>Upper Volume (gal)</th>
<th>Set Volume (gal)</th>
<th>Minimum Volume (gal)</th>
<th>Flow rate (gpm)</th>
<th>Temperature (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>FEP-DMST-00001A</td>
<td>1,300</td>
<td>1,300</td>
<td>850</td>
<td>50</td>
<td>80</td>
<td>30 (outlet)</td>
</tr>
</tbody>
</table>

Basis: The parameters for the FEP demister are based on the values in Table E-1 in 24590-WTP-MDD-PR-01-002, WTP MDD. The temperature is based on the value specified in Section 2.2.3.15 Condenser Outlet Temperatures in the BARD (24590-WTP-RPT-PT-02-005, BARD Rev. 8).

3.1.4.4 FEP Waste Feed Evaporator (FEP-SEP-00001A) Dynamic Decontamination Factors

Unique ID: BMR-FEP_TR-9

The partition factors from the "EVAP-SEP" tab of SVF-1778, Rev. 8 shall be applied to the Waste Feed Evaporator (FEP-SEP-00001A).

Basis: The partitioning of contaminants in the FEP evaporator is based on equation 6 in RPP-RPT-52097, Recommendation for Updating Evaporator Partition Coefficients and the updated partition factors in Table 5 of this report. The partition coefficients are summarized in the "EVAP-SEP" tab in SVF-1778.

*The maximum pump rate is 50 gpm but the actual pump rate is limited by the boil-off rate.

Basis: The vessel parameters are based on the values in Table E-1: Vessel Parameters in the 24590-WTP-MDD-PR-01-002, WTP MDD and the temperature is based on the value for the super tank solubility application in Table 6, Solubility Application in the 24590-WTP-MDD-PR-01-002, WTP MDD.
3.1.4.5 **FEP Evaporator Target Concentration Endpoint**

**Unique ID:** BMR-FEP_TR-4

*The Waste Feed Evaporator (FEP-SEP-00001A) target concentration endpoint is a SpG of 1.27 or 8.9 wt% solids, whichever threshold is reached first.*

**Basis:** This requirement is based on the description in Section 4.8.2 *Waste Feed Evaporation Process (FEP) System* in 24590-WTP-MDD-PR-01-002, WTP MDD.

3.1.4.6 **FEP Maximum Boil-Off Rate**

**Unique ID:** BMR-FEP_TR-3

The maximum boil-off rate for the *Waste Feed Evaporator (FEP-SEP-00001A)* is 28 gpm.

**Basis:** This requirement is based on the value specified in Section 4.8.2 *Waste Feed Evaporation Process (FEP) System* in 24590-WTP-MDD-PR-01-002, WTP MDD. This is the boil off rate of 30 gpm with 2 gpm used for the evaporator recycle spray resulting in a modeled boil off rate of 28 gpm.

3.1.4.7 **FEP Waste Feed Evaporator Demister (FEP-DMST-00001A) Water Addition**

**Unique ID:** BMR-FEP_TR-6

The *Waste Feed Evaporator Demister (FEP-DMST-00001A)* water addition shall be 0.96 gpm of water.

**Basis:** The value of the water addition is based on the description in Section 4.8.2 *Waste Feed Evaporation Process (FEP) System* and Table B-2 *Chemical Reagents for FEP* in 24590-WTP-MDD-PR-01-002, WTP MDD.

3.1.4.8 **FEP Waste Feed Evaporator Demister (FEP-DMST-00001A) Air Addition**

**Unique ID:** BMR-FEP_TR-5

The *Waste Feed Evaporator Demister (FEP-DMST-00001A)* air addition shall be at a flow rate of 5 ft³/min (@ 70 °F and 14.7 psi).

**Basis:** This model requirement is based on the value specified in Table B-2 *Chemical Reagents for FEP* in 24590-WTP-MDD-PR-01-002, WTP MDD.

3.1.4.9 **FEP Waste Feed Evaporator Demister (FEP-DMST-00001A) Outlet Conditions**

**Unique ID:** BMR-FEP_TR-7

The *Waste Feed Evaporator Demister (FEP-DMST-00001A)* outlet conditions shall be 30 C and 810 Torr (1.06579 atm., 1079.91 millibars) (24590-PTF-3YD-FEP-00001J).

**Basis:** The temperature is based on the value specified in Section 2.2.3.15 *Condenser Outlet Temperatures* in the BARD (24590-WTP-RPT-PT-02-005, BARD Rev. 8) and the pressure is specified in Section 6.5.8 *Overhead System (Condensers and Vacuum System)* of 24590-PTF-3YD-FEP-00001. The pressure and temperature of the after condenser is used.
3.1.4.10 FEP Waste Feed Evaporator Demister (FEP-DMST-00001A) Split Factors

**Unique ID:** BMR-FEP_TR-8

The split factors from the tab "FEP-DMST-00001A" in SVF-1778, Rev. 8 shall be applied to the Waste Feed Evaporator Demister (FEP-DMST-00001A).

**Basis:** The splits are specified in SVF-1778 and are based on the values in Table D-2: FEP-DMST-00001 Splits in 24590-WTP-MDD-PR-01-002, WTP MDD.

3.1.5 FEP Figures and Diagrams

3.1.5.1 FEP Functional Requirements Diagram

**Unique ID:** BMR-FEP_FIG-1

![FEP Functional Requirements Diagram](image-url)
3.2 WASTE TREATMENT AND IMMOBILIZATION PLANT FEED RECEIPT PROCESS

The primary function of the LAW Feed Receipt Process (FRP) system is to receive LAW from the East DSTs and to supply this feed to downstream WTP processes. The FRP system can also provide lag storage capacity for intermediate pretreated LAW melter feed and process recycles. The waste feed receipt system consists of four LAW Waste Receipt Vessels (FRP-VSL-
00002A/B/C/D), each with a working volume of 375,000 gal (1.5 Mgal total). Each vessel is equipped with pulse jet mixers to agitate the waste, and the tanks are connected for limited blending.

After the initial PT startup date; LAW is transferred from tank farms to WTP in batches up to 1.125 Mgal (including line flush). A LAW batch fills three of the four FRP-VSL-00002A/B/C/D. The pre-transfer warming flush is sent to the first receiving vessel prior to the batch delivery while the post-transfer flush is sent to the last receiving vessel. The post-transfer flush also includes a portion that is sent to HLW Effluent Transfer Vessel (PWD-VSL-00043). Separate batches will not mix in the same vessel except for the residual material remaining in the heel.

After the three vessels have been filled, solubility is applied at 25°C and the sample time is applied before the waste is sent downstream to the Ultrafiltration Feed Preparation Vessel (UFP-VSL-00001A/B). Vessels are pumped in the order in which they receive waste. Once three of the four Waste Feed Receipt Vessels are empty, another batch may be delivered from the Tank Farm.

Concentrate from the Waste Feed Evaporator (FEP-SEP-00001A) may be sent to a FRP-VSL-00002A/B/C/D when the pretreatment water lock situation occurs.

3.2.1 System Requirements

3.2.1.1 FRP LAW Feed Receipt

Unique ID: BMR-FRP_SR-1

The FRP shall receive LAW and associated flushes from the Hanford tank farms, and transfer this feed downstream to the WTP PT Facility.

Basis: The FRP system requirement is based on the description in Section 2.1.1 of 24590-WTP-RPT-PT-02-005.

3.2.2 Functional Requirements

Overall Functional Requirement Diagram:
3.2.2.1 FRP Receive from DST's

**Unique ID:** BMR-FRP_FR-1

The FRP shall have the capability to receive LAW and associated flushes from Tank Farms DSTs in accordance with WTP Contract Requirements.

**Basis:** This functional requirement is based on the WTP SOW (DE-AC27-01RV14136, WTP/DOE Statement of Work), Section C.7(b)(4).

3.2.2.2 FRP Store LAW

**Unique ID:** BMR-FRP_FR-6

The FRP shall have the capability to store LAW in accordance with WTP Contract Requirements.

**Basis:** This functional requirement is based on the functions identified in Section 3.2 Store Waste Feed in 24590-PTF-3YD-FRP-00001, FRP System Description.

3.2.2.3 FRP Waste Transfer

**Unique ID:** BMR-FRP_FR-3

The FRP shall have the capability to transfer to the UFP.

**Basis:** This functional requirement is based on the functions identified in Section 3.5 Transfer System Contents in 24590-PTF-3YD-FRP-00001, FRP System Description.

3.2.2.4 FRP Receipts from FEP

**Unique ID:** BMR-FRP_FR-2

The FRP shall have the capability to receive and store excess recycles from the FEP.

**Basis:** This functional requirement is based on the statement "A piping route from FEP to FRP-VSL-00002A will be included in the design, but jumpers to enable use of the route will not
be designed. In the event that use of the route is desired, the acceptability of sending FEP concentrate to FRP-VSL-00002A will require evaluation." Section 4.1 Service Provided (Production) in the FEP System Description (also in the 24590-PTF-3YD-FRP-00001, FRP System Description). This route is necessary for modeling purposes to provide an outlet when a pretreatment water lock situation occurs during modeling.

3.2.2.5 FRP Sampling

Unique ID: BMR-FRP_FR-4

The FRP shall have the capability to sample the stored LAW.

Basis: This functional requirement is based on the functions identified in Section 3.4 Sample System Contents in 24590-PTF-3YD-FRP-00001, FRP System Description.

3.2.2.6 FRP System Internal Line Flush

Unique ID: BMR-FRP_FR-5

The FRP shall have the capability to flush system components to downstream vessels.

Basis: This functional requirement is based on the discussion in Section 2.1.2 Process Description in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

3.2.3 Model Requirements

3.2.3.1 FRP Waste Feed Receipt Vessels (FRP-VSL-00002A/B/C/D)

Unique ID: BMR-FRP_MR-1

The FRP shall consist of four vessels identified as FRP-VSL-00002A, FRP-VSL-00002B, FRP-VSL-00002C, FRP-VSL-00002D.

Basis: This model requirement is based on Section 2.1.2 FRP Process Description of the BARD (24590-WTP-RPT-PT-02-005, BARD Rev. 8) and Section 4.8.1 Waste Feed Receipt Process (FRP) System in 24590-WTP-MDD-PR-01-002, WTP MDD.

3.2.3.2 FRP Waste Feed Receipt Vessels (FRP-VSL-00002A/B/C/D) Trigger Receipt of a New LAW Batch

Unique ID: BMR-FRP_MR-2

After the WTP Pretreatment Facility start date has passed and at least three LAW waste feed receipt vessels (FRP-VSL-00002A/B/C/D) are at or below their minimum volume, the FRP shall trigger a new LAW feed batch from the DST System. (see FRP Vessel Filling Logic Diagram).

Basis: This model requirement is based on the description in Section 4.8.1 Waste Feed Receipt Process (FRP) System in 24590-WTP-MDD-PR-01-002, WTP MDD.

3.2.3.3 FRP LAW Batch Pre-Warming Flush Volume

Unique ID: BMR-FRP_MR-8

Once a new batch of LAW has been triggered, the LAW Batch Pre-Warming Flush shall be received into the first of the three LAW waste feed receipt vessels (FRP-VSL-00002A/B/C/D) to
be filled prior to the start of the LAW batch transfer from Tanks Farms (see FRP Vessel Filling Logic Diagram).

**Basis:** This model requirement is based the description in Section 4.7.13 Line Flushes in 24590-WTP-MDD-PR-01-002, WTP MDD.

### 3.2.3.4 FRP - Receive LAW Batch from Tank Farms

**Unique ID:** BMR-FRP_MR-12

After the pre-warming flush has occurred, the target LAW Batch Size transfer shall be received in the LAW waste feed receipt vessels (FRP-VSL-00002A/B/C/D) from an East Area DST.

**Basis:** This model requirement is based the description in Section 2.1.2 Process Description in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

### 3.2.3.5 FRP LAW Batch Post Transfer Flush - Part 1

**Unique ID:** BMR-FRP_MR-9

After the LAW batch has been received, the LAW Batch Post Transfer Flush - Part 1 Volume shall be received into the last LAW waste feed receipt vessels (FRP-VSL-00002A/B/C/D) which received the waste from the completed LAW batch transfer, even if the contents of the vessel exceed the set volume.

**Basis:** This model requirement is based the description in Section 4.7.13 Line Flushes in 24590-WTP-MDD-PR-01-002, WTP MDD.

### 3.2.3.6 FRP - LAW Batch Post Transfer Flush - Part 2

**Unique ID:** BMR-FRP_MR-13

After the Part 1 of the post transfer flush is complete, the PWD - LAW Batch Post Transfer Flush - Part 2 Volume shall be received into the HLW Effluent Transfer Vessel (PWD-VSL-00043).

**Basis:** This model requirement is based the description in Section 4.7.13 Line Flushes in 24590-WTP-MDD-PR-01-002, WTP MDD. As a model simplification the full post transfer flush to PWD is directed to PWD-VSL-00043. The 100 gallons sent to the vessel PWD-VSL-00033 is included in the total volume sent to PWD-VSL-00043.

### 3.2.3.7 FRP Waste Feed Receipt Vessels (FRP-VSL-00002A/B/C/D) Complete Filling

**Unique ID:** BMR-FRP_MR-5

A single LAW waste feed receipt vessel (FRP-VSL-00002A/B/C/D) shall complete filling when it has reached its set volume or the full LAW batch transfer and flushes has been received (see FRP Vessel Filling Logic Diagram).

**Basis:** This model requirement is based the description in Section 4.8.1 Waste Feed Receipt Process (FRP) System in 24590-WTP-MDD-PR-01-002, WTP MDD.
3.2.3.8 FRP Waste Feed Receipt Vessels (FRP-VSL-00002A/B/C/D) Solubility Application

*Unique ID:* BMR-FRP_MR-6

After a *LAW* waste feed receipt vessels (FRP-VSL-00002A/B/C/D) has completed filling, solubility shall be applied at the vessel temperature.

*Basis:* This model requirement is based the description in Section 4.8.1 *Waste Feed Receipt Process (FRP) System* and Section 4.7.16.3; Table 6 *Solubility Application* in 24590-WTP-MDD-PR-01-002, WTP MDD.

3.2.3.9 FRP Waste Feed Receipt Vessels (FRP-VSL-00002A/B/C/D) Sampling

*Unique ID:* BMR-FRP_MR-7

After solubility has been applied in a FRP-VSL-00002A/B/C/D vessel, the *FRP Sampling Time* shall be applied.

*Basis:* This model requirement is based the description in Section 2.1.2 *Process Description* in 24590-WTP-RPT-PT-02-005, BARD Rev. 8 and is also identified in Appendix B of the BARD.

3.2.3.10 FRP Waste Feed Receipt Vessels (FRP-VSL-00002A/B/C/D) Discharge

*Unique ID:* BMR-FRP_MR-4

After the sample time has elapsed, the *LAW* waste feed receipt vessels (FRP-VSL-00002A/B/C/D) shall transfer to one of the *UFP Feed Preparation Vessels (UFP-VSL-00001A/B)* at the pump rate.

*Basis:* This model requirement is based the description in Section 2.1.2 *Process Description* in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

3.2.3.11 FRP Waste Feed Receipt Vessels (FRP-VSL-00002A/B/C/D) Discharge Order

*Unique ID:* BMR-FRP_MR-3

The *LAW* waste feed receipt vessels (FRP-VSL-00002A/B/C/D) shall discharge in the order in which they were filled.

*Basis:* This model requirement is based the description in Section 4.8.1 *Waste Feed Receipt Process (FRP) System* in 24590-WTP-MDD-PR-01-002, WTP MDD.

3.2.3.12 FRP - LAW waste feed receipt vessels (FRP-VSL-00002A/B/C/D) Complete Discharge

*Unique ID:* BMR-FRP_MR-14

The *LAW* waste feed receipt vessels (FRP-VSL-00002A/B/C/D) shall complete discharging when its volume has reached the minimum volume.

*Basis:* This model requirement is based the description in Section 4.8.1 *Waste Feed Receipt Process (FRP) System* in 24590-WTP-MDD-PR-01-002, WTP MDD.
3.2.3.13 FRP Receive Waste from FEP

Unique ID: BMR-FRP_MR-10

The concentrate from the Waste Feed Evaporator (FEP-SEP-00001A) shall be sent to an available LAW waste feed receipt vessels (FRP-VSL-00002A/B/C/D) when the pretreatment water lock situation occurs. If required the LAW waste feed receipt vessels (FRP-VSL-00002A/B/C/D) may exceed the set point volume but must stay below the maximum volume. An available LAW waste feed receipt vessels (FRP-VSL-00002A/B/C/D) is one that is at or below the set point volume (see pretreatment water lock).

Basis: This functional requirement is based on the statement "A piping route from FEP to FRP-VSL-00002A will be included in the design, but jumpers to enable use of the route will not be designed. In the event that use of the route is desired, the acceptability of sending FEP concentrate to FRP-VSL-00002A will require evaluation." Section 4.1 Service Provided (Production) in the FEP System Description (also in the 24590-PTF-3YD-FRP-00001, FRP System Description). This route is necessary for modeling purposes to provide an outlet when a pretreatment water lock situation occurs during modeling.

3.2.3.14 FRP Internal Line Flush

Unique ID: BMR-FRP_MR-11

After each LAW waste feed receipt vessels (FRP-VSL-00002A/B/C/D) transfer to UFP is complete, the FRP Internal Line Flush Volume shall be added to the UFP Feed Preparation Vessels (UFP-VSL-00001A/B). The line flush shall use process condensate from the Process Condensate Vessel (RLD-VSL-00006A) if available or Water.

Basis: N/A

3.2.4 Technical Requirements

3.2.4.1 FRP Waste Feed Receipt Vessel (FRP-VSL-00002A/B/C/D) Parameters

Unique ID: BMR-FRP_TR-1

The LAW waste feed receipt vessels (FRP-VSL-00002A/B/C/D) shall each have the following parametric values.

<table>
<thead>
<tr>
<th>Vessel #</th>
<th>Maximum Volume (gal)</th>
<th>Upper Set Volume (gal)</th>
<th>Set Volume (gal)</th>
<th>Minimum Volume (gal)</th>
<th>Flow Rate (gpm)</th>
<th>Temperature (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>FRP-VSL-00002A,B,C&amp;D</td>
<td>403,592</td>
<td>379,391</td>
<td>369,391</td>
<td>4,391</td>
<td>125</td>
<td>25</td>
</tr>
</tbody>
</table>

Basis: This requirement is based on the values in Table E-1 Vessel Parameters found in 24590-WTP-MDD-PR-01-002, WTP MDD. The temperature is based on the discussion in Section 4.8.1 Waste Feed Receipt Process (FRP) System in the same document.
3.2.4.2 FRP- LAW Batch Size

Unique ID: BMR-FRP_TR-3

Each LAW batch shall target a total of 1.095 million gallons (365,000 gallons per FRP tank); except during final Tanks Farm cleanout. The total batch shall not exceed 1.125 million gallons and shall be greater than 840,000 gallons. During final Tank Farm cleanout the batch size can vary as needed to complete the cleanout.

Basis: The 365,000 gallon batch size is based on the values in Table E-1 Vessel Parameters found in 24590-WTP-MDD-PR-01-002, WTP MDD. The set volume of 369,391 gallons - 4,391 gallons = 365,000 gallons. The maximum batch size is from the WTP SOW contract requirements Section C.7(b)(1). The minimum volume is a modeling simplification and is based on filling two tanks plus 1/3 of the third (356 kgal x 2.3 = 840 kgal).

3.2.4.3 FRP - LAW Batch Pre-Warming Flush

Unique ID: BMR-FRP_TR-4

The pre-warming flush to the LAW waste feed receipt vessels (FRP-VSL-00002A/B/C/D) shall consist of 2,500 gallons of Inhibited Water.

Basis: This model requirement is based on the description in Section 4.7.13 Line Flushes in 24590-WTP-MDD-PR-01-002, WTP MDD.

3.2.4.4 FRP LAW Batch Post Transfer Flush - Part 1 Volume

Unique ID: BMR-FRP_TR-5

The LAW batch post transfer flush - Part 1 shall consist of 2,000 gallons of Inhibited Water.

Basis: This model requirement is based on the description in Section 4.7.13 Line Flushes in 24590-WTP-MDD-PR-01-002, WTP MDD.

3.2.4.5 FRP Sampling Time

Unique ID: BMR-FRP_TR-2

The LAW waste feed receipt vessels (FRP-VSL-00002A/B/C/D) sample time shall be 37.8 hours (see FRP-VSL-00002A/B/C/D Logic Diagram).

Basis: This model requirement is based on the description in Section 2.1.2 Process Description in 24590-WTP-RPT-PT-02-005, BARD Rev. 8 and is also identified in Appendix B of the BARD.

3.2.4.6 FRP to UFP - Internal Line Flush Volume

Unique ID: BMR-FRP_TR-6

The LAW waste feed receipt vessels (FRP-VSL-00002A/B/C/D) internal line flush shall be 157 gallons.

Basis: N/A
3.2.5 FRP Figures and Diagrams

3.2.5.1 FRP Functional Requirement Diagram

Unique ID: BMR-FRP_FIG-1
3.2.5.2 FRP Vessel Filling Logic Diagram

**Unique ID:** BMR-FRP_FIG-2

- **Fill - Start**
  - **Has the initial LAW delivery date been met?**
    - **No**
    - **Yes**
      - **Are there 3 empty LAW feed receipt vessels?**
        - **No**
          - **Receive pre-warming flush into first available LAW feed receipt vessel**
        - **Yes**
          - **Receive LAW batch from TF-LAW-Feed-Tanks**
          - **Has the full LAW batch volume been received?**
            - **Yes**
              - **Transfer Post Transfer Flush - Part 1 to the last tank which received LAW**
            - **No**
              - **Is FRP tank at the set point?**
                - **Yes**
                  - **Switch to next available FRP**
                - **No**

- **Fill - End**
3.2.5.3 FRP Water Lock Logic Diagram

Unique ID: BMR-FRP_FIG-3

3.2.5.4 FRP Vessels Modeling Diagram

Unique ID: BMR-FRP_FIG-4

3.3 WASTE TREATMENT AND IMMOBILIZATION PLANT HIGH-LEVEL WASTE FEED RECEIPT

There are three primary functions of the HLP. The first is to receive HLW feed from Hanford Tank Farms, the second is to receive and stage pretreated process slurries of HLW solids, and
the third is to mix intermediate product streams, such as cesium (Cs) concentrate, with HLW slurries for subsequent vitrification. The system has been divided into the HLP - HLW Feed Receipt system which performs the first function and the HLP - Lag Storage and Feed Blending system which performs the second and third functions.

The HLP - HLW Feed Receipt system has one HLW Feed Receipt Vessel (HLP-VSL-00022) which receives HLW feed from the tank farms, and stores it pending transfer to Ultrafiltration Feed Preparation Vessels (UFP-VSL-00001A/B). After the initial PT startup date; HLW is transferred from tank farms via the TWCS capability (or DSTs) to WTP in batches up to 145,000 Mgal (including line flush). The pre-transfer inhibited water flush is first received into the vessel prior to the batch delivery followed by the post-transfer flush. The post-transfer flush also includes a portion which is routed to the PWD system. After the vessel has received the waste and flushes, solubility and a sample time are applied before the waste is sent downstream to the UFP-VSL-00001A & B vessels.

3.3.1 System Requirements

3.3.1.1 HLP HLW Feed Receipt and Transfer

Unique ID: BMR-HLP_SR-2

The HLP shall receive and store HLW and associated flushes from Tank Farms, allow for sampling and supply this feed to downstream WTP Pretreatment processes.

Basis: This HLP system requirement is based on the description in Section 2.4.1 of the BARD (24590-WTP-RPT-PT-02-005, BARD Rev. 8).

3.3.2 Functional Requirements

3.3.2.1 HLP HLW Feed Receipt

Unique ID: BMR-HLP_FR-6

The HLP shall have the capability to receive, without interruption, HLW feed and associated flushes from Tank Farms DSTs in accordance with WTP Contract Requirements.

Basis: This functional requirement is based on the WTP SOW (DE-AC27-01RV14136, WTP/DOE Statement of Work), Section C.7(b)(5).

3.3.2.2 HLP Receive Flushes from Tank Farms

Unique ID: BMR-HLP_FR-8

The HLP shall have the capability to receive flushes from Tank Farms.

Basis: This functional requirement is based on the discussion in Section 4.1 Services Provided in 24590-PTF-3YD-HLP-00001, HLP System Description.

3.3.2.3 HLP Transfer of HLW Feed

Unique ID: BMR-HLP_FR-7

The HLP shall have the capability to transfer the HLW feed received from Tank Farms to the UFP.
Basis: This functional requirement is based on the discussion in Section 3.7 Transfer Process Fluids in 24590-PTF-3YD-HLP-00001, HLP System Description.

3.3.2.4 HLP Line Flushes

Unique ID: BMR-HLP_FR-9

The HLP shall have the capability to flush the system lines to prevent solids accumulation.

Basis: This functional requirement is based on the discussion in Section 2.4.2 Process Description in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

3.3.2.5 HLP Sampling

Unique ID: BMR-HLP_FR-10

The HLP shall have the capability to have the stored untreated HLW (from tank farms) sampled.

Basis: This functional requirement is based on the discussion in Section 4.2.1 Source Inventory Receipt Acceptance Program in 24590-PTF-3YD-HLP-00001, HLP System Description.

3.3.3 Model Requirements

3.3.3.1 HLP Feed Receipt Vessel (HLP-VSL-00022)

Unique ID: BMR-HLP_MR-1

The HLP feed receipt shall consist of HLW Feed Receipt Vessel (HLP-VSL-00022).

Basis: This model requirement is based on Section 2.4.2 HLP Process Description of the BARD (24590-WTP-RPT-PT-02-005, BARD Rev. 8) and Section 4.8.12 HLW Lag Storage and Feed Blending Process System in 24590-WTP-MDD-PR-01-002, WTP MDD.

3.3.3.2 HLP Feed Receipt Vessel (HLP-VSL-00022) Trigger Receipt of a New HLW Batch

Unique ID: BMR-HLP_MR-2

After the WTP Pretreatment Facility start date has passed and the HLW Feed Receipt Vessel (HLP-VSL-00022) is at or below the minimum volume, a new HLW feed batch from the DST or TWCS shall be triggered. (see HLP-VSL-00022 Fill Logic Diagram).

Basis: This model requirement is based on the description in Section 4.8.12 HLW Lag Storage and Feed Blending Process System in 24590-WTP-MDD-PR-01-002, WTP MDD.

3.3.3.3 HLP HLW Batch Pre-Warming Flush Volume

Unique ID: BMR-HLP_MR-4

A pre-warming flush shall be received into HLW Feed Receipt Vessel (HLP-VSL-00022) prior to the start of the HLW batch transfer from Tanks Farms (see HLP-VSL-00022 Fill Logic Diagram).

Basis: This model requirement is based on the description in Section 4.7.13 Lines Flushes in 24590-WTP-MDD-PR-01-002, WTP MDD.
3.3.3.4 HLP - Receive HLW Batch from Tank Farms

Unique ID: BMR-HLP_MR-10

After the pre-warming flush has occurred, the target HLW Batch Size shall be received in HLW Feed Receipt Vessel (HLP-VSL-00022) from a DST or TWCS vessel. The transfer shall be greater than HLP Feed Receipt Minimum Solids Concentration and shall not exceed the HLP Feed Receipt Maximum Solids Concentration.

Basis: This model requirement is based on Section 2.4.2 HLP Process Description of the BARD (24590-WTP-RPT-PT-02-005, BARD Rev. 8) and the solids requirements are identified in the WTP SOW, Section 8.2.2.1 Composition (DE-AC27-01RV14136, WTP/DOE Statement of Work).

3.3.3.5 HLP HLW Batch Post Transfer Flush - Part 1

Unique ID: BMR-HLP_MR-5

After the HLW waste has been received, the HLW Batch Post Transfer Flush - Part 1 shall be received into HLW Feed Receipt Vessel (HLP-VSL-00022). Note Part 2 is routed to the PWD and is included with this system (HLW Batch Post Transfer Flush - Part 2 Volume)

Basis: This model requirement is based on the description in Section 4.7.13 Lines Flushes in 24590-WTP-MDD-PR-01-002, WTP MDD.

3.3.3.6 HLP HLW Batch Post Transfer Flush - Part 2

Unique ID: BMR-HLP_MR-11

After the Part 1 of the post transfer flush is complete, the HLW Batch Post Transfer Flush - Part 2 Volume shall be received into the HLW Effluent Transfer Vessel (PWD-VSL-00043).

Basis: This model requirement is based on the description in Section 4.7.13 Lines Flushes in 24590-WTP-MDD-PR-01-002, WTP MDD. As a model simplification the full post transfer flush to PWD is directed to PWD-VSL-00043. The 100 gallons sent to the vessel PWD-VSL-00033 is included in the total volume sent to PWD-VSL-00043.

3.3.3.7 HLP Feed Receipt Vessel (HLP-VSL-00022) Complete Filling

Unique ID: BMR-HLP_MR-3

The HLW Feed Receipt Vessel (HLP-VSL-00022) shall complete filling when it has reached its upper set volume or the full HLW batch and flush has been received (see HLP-VSL-00022 Fill Logic Diagram).

Basis: This model requirement is based on the description in Section 4.8.12 HLW Lag Storage and Feed Blending Process System in 24590-WTP-MDD-PR-01-002, WTP MDD.

3.3.3.8 HLP Feed Receipt Vessel (HLP-VSL-00022) Solubility Application

Unique ID: BMR-HLP_MR-6

After the HLW Feed Receipt Vessel (HLP-VSL-00022) has completed filling, solubility shall be applied at the vessel temperature.
3.3.3.9 **HLP Feed Receipt Vessel (HLP-VSL-00022) Sampling**

**Unique ID:** BMR-HLP_MR-7

After solubility has been applied, the *HLP-VSL-00022 Sampling Time* shall be applied to *HLW Feed Receipt Vessel (HLP-VSL-00022)*.

**Basis:** This model requirement is based on the description in Section 4.8.12 *HLW Lag Storage and Feed Blending Process System* and Section 4.7.16.3; Table 6 *Solubility Application* in 24590-WTP-MDD-PR-01-002, WTP MDD.

3.3.3.10 **HLP Feed Receipt Vessel (HLP-VSL-00022) Discharge**

**Unique ID:** BMR-HLP_MR-8

After the sample time has elapsed, the *HLW Feed Receipt Vessel (HLP-VSL-00022)* shall transfer to one of the *UFP Feed Preparation Vessels (UFP-VSL-00001A/B)* at the equipment's pump rate.

**Basis:** This model requirement is inferred from the description in Section 2.4.2 *Process Description* in 24590-WTP-RPT-PT-02-005, BARD Rev. 8 and is also identified in Appendix B of the BARD.

3.3.3.11 **HLW Feed Receipt Vessel (HLP-VSL-00022) Complete Discharge**

**Unique ID:** BMR-HLP_MR-12

The *HLW Feed Receipt Vessel (HLP-VSL-00022)* shall complete discharging when its volume has reached the minimum volume.

**Basis:** This model requirement is inferred from the description in Section 4.8.12 *HLW Lag Storage and Feed Blending Process System* in 24590-WTP-MDD-PR-01-002, WTP MDD.

3.3.3.12 **HLP Feed Receipt Vessel (HLP-VSL-00022) Internal Line Flush**

**Unique ID:** BMR-HLP_MR-9

After the *HLW Feed Receipt Vessel (HLP-VSL-00022)* vessel has completed discharging, the *HLP-VSL-00022 Internal Line Flush Volume* shall be added to the destination *UFP Feed Preparation Vessel (UFP-VSL-00001A/B)*. The line flush shall use *process condensate* from the *Process Condensate Vessel (RLD-VSL-00006A)* if available or *Water*.

**Basis:** N/A

3.3.4 **Technical Requirements**

3.3.4.1 **HLP Feed Receipt Vessel (HLP-VSL-00022) Parameters**

**Unique ID:** BMR-HLP_TR-1

The *HLW Feed Receipt Vessel (HLP-VSL-00022)* shall have the following parametric values.
### Table E-1 Vessel Parameters

<table>
<thead>
<tr>
<th>Vessel #</th>
<th>Maximum Volume (gal)</th>
<th>Upper Set Volume (gal)</th>
<th>Set Volume (gal)</th>
<th>Minimum Volume (gal)</th>
<th>Flow rate (gpm)</th>
<th>Temperature (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>HLP-VSL-00022</td>
<td>232,261</td>
<td>174,763</td>
<td>170,000</td>
<td>29,763</td>
<td>150</td>
<td>25</td>
</tr>
</tbody>
</table>

**Basis:** This requirement is based on the values in Table E-1 Vessel Parameters found in 24590-WTP-MDD-PR-01-002, WTP MDD. The temperature is based on the discussion in Section 4.8.12 HLW Lag Storage and Feed Blending Process System in the same document.

#### 3.3.4.2 HLP- HLW Batch Size

**Unique ID:** BMR-HLP_TR-2

Each HLW batch including the line flush shall target 145,000 gallons with a minimum batch size equal to 50,000 gallons; except during final Tanks Farm cleanout.

- If the batch originates from the TWCS, then the batch shall consist of 143,200 of waste and the HLP-VSL-00022 portion of the flush is 1,800 gallons,
- If the batch originates from the DST, then the batch shall consist of 140,500 of waste and the HLP-VSL-000022 portion of the flush is 4,500 gallons.
- During final Tank Farm cleanout the batch size can vary as needed to complete the cleanout.

**Basis:** The batch size is based on the values in Table 1 Requirements for the Waste Feed Interface found in 24590-WTP-ICD-MG-01-019, ICD-19. The minimum volume is a modeling simplification and is based on approximately 1/3 of the batch volume.

#### 3.3.4.3 HLW Batch Pre-Warming Flush Size

**Unique ID:** BMR-HLP_TR-6

The pre-warming flush to the HLW Feed Receipt Vessel (HLP-VSL-00022) shall consist of:

- 2,500 gallons of Inhibited Water if the waste transfer is from a DST or
- 1,000 gallons of Inhibited Water if the waste transfer is from TWCS.

**Basis:** The flush volume from a DST is based on the description in Section 4.7.13 Line Flushes in 24590-WTP-MDD-PR-01-002, WTP MDD. The flush volume from the TWCSF to WTP is based on the ICD requirement not to exceed three times the line volume. The TWCSF volume is based on the following:

- TWCSF location consistent with Site 5 from RPP-54668, 15 acres of greenfield located between East Area tank farms and the WTP HLW Vitrification Facility
- 1,800 foot distance from center of proposed TWCSF location to PT pipe tunnel (per RPP H-14-014365) multiplied by 1.15 to account for thermal expansion joints (per Wes Bryan)
- 417 foot internal piping length from PT wall to HLP-VSL-00022
- 3 inch nominal pipe diameter
• 3X line volume flush per ICD-19 maximum  
• This equates to approximately 2700 gallons rounded to 3,000 gallons  
• The division of the pre-warming flush was taken to be the same ratio as the DST flush so  
\[
\frac{2500}{7500} = \frac{1}{3} \ast 3000 = 1,000 \text{ gallons.}
\]

3.3.4.4 HLP Feed Receipt Maximum Solids Concentration  
Unique ID: BMR-HLP_TR-7  
The HLW batches delivered to *HLW Feed Receipt Vessel (HLP-VSL-00022)* shall not exceed the maximum solids concentration of 200 grams solids per liter.  
**Basis:** The maximum solids concentration for an HLW batch is specified in The WTP SOW Section C.8, Specification 7.2.2.1 (DE-AC27-01RV14136, WTP/DOE Statement of Work).

3.3.4.5 HLP HLW Batch Post Transfer Flush - Part 1 Volume  
Unique ID: BMR-HLP_TR-3  
The *HLW* batch post transfer flush - Part 1 shall consist of:  
• 2,000 gallons of *Inhibited Water* if the waste transfer was from a *DST* or  
• 800 gallons of *Inhibited Water* if the waste transfer was from *TWCS*.  
**Basis:** The flush volume from a DST is based on the description in *Section 4.7.13 Line Flushes* in *24590-WTP-MDD-PR-01-002, WTP MDD*. The TWCSF volume is based on the following;  
• TWCSF location consistent with Site 5 from RPP-54668, 15 acres of greenfield located between East Area tank farms and the WTP HLW Vitrification Facility  
• 1,800 foot distance from center of proposed TWCSF location to PT pipe tunnel (per RPP H-14-014365) multiplied by 1.15 to account for thermal expansion joints (per Wes Bryan)  
• 417 foot internal piping length from PT wall to HLP-VSL-00022  
• 3 inch nominal pipe diameter  
• 3X line volume flush per ICD-19 maximum  
• This equates to approximately 2700 gallons rounded to 3,000 gallons  
• The division of the pre-warming flush was taken to be the same ratio as the DST flush so  
\[
\frac{2000}{7500} = 0.2667 \ast 3000 = 800 \text{ gallons.}
\]

3.3.4.6 HLP Feed Receipt Vessel (HLP-VSL-00022) Sampling Time  
Unique ID: BMR-HLP_TR-4  
The *HLW Feed Receipt Vessel (HLP-VSL-00022)* sample time shall be 43.7 hours.  
**Basis:** This sample time is specified in *Section 2.4.2 Process Description* in *24590-WTP-RPT-PT-02-005, BARD Rev. 8* and is also identified in Appendix B of the BARD.
3.3.4.7  HLP Feed Receipt Vessel (HLP-VSL-00022) Internal Line Flush Volume

**Unique ID:** BMR-HLP_TR-5

The *HLW Feed Receipt Vessel (HLP-VSL-00022)* internal line flush shall be 253.5 gallons.

**Basis:** N/A

3.3.4.8  HLP Feed Receipt Vessel (HLP-VSL-00022) Start Date

**Unique ID:** BMR-HLP_TR-8

The *HLW Feed Receipt Vessel (HLP-VSL-00022)* shall receive its first transfer on 12/31/2033.

**Basis:** The start date is based on the current System Plan Rev. 8 Baseline Assumptions (ORP-11242, System Plan Rev. 8).

3.3.4.9  HLP Feed Receipt Minimum Solids Concentration

**Unique ID:** BMR-HLP_TR-9

The HLW batches delivered to *HLW Feed Receipt Vessel (HLP-VSL-00022)* shall contain at least 10 grams solids per liter.

**Basis:** The minimum solids concentration for an HLW batch is specified in The WTP SOW Section C.8, Specification 7.2.2.1 (DE-AC27-01RV14136, WTP/DOE Statement of Work). Note - The minimum does not apply to the initial AZ-101 and AZ-102 batches.
3.3.5 HLP Figures and Diagrams

3.3.5.1 HLP-VSL-00022 Fill Logic Diagram

Unique ID: BMR-HLP_FIG-1
3.3.5.2 HLP-VSL-00022 Modeling Diagram

Unique ID: BMR-HLP FIG-2

3.3.5.3 HLP Feed Receipt Functional Requirements

Unique ID: BMR-HLP FIG-3

3.4 WASTE TREATMENT AND IMMOBILIZATION PLANT HIGH-LEVEL WASTE LAG STORAGE AND FEED BLENDING PROCESS

There are three primary functions of the HLP. The first is to receive HLW feed from Hanford Tank Farms, the second is to receive and stage pretreated process slurries of HLW solids, and the third is to mix intermediate product streams, such as cesium (Cs) concentrate, with HLW slurries for subsequent vitrification. The system has been divided into the HLP - HLW Feed Receipt system which performs the first function and the HLP - Lag Storage and Feed Blending system which performs the second and third functions.

The HLP - Lag Storage and Feed Blending system consist of three vessels (see diagram below); The two HLW lag Storage vessels (HLP-VSL-00027A and HLP-VSL-00027B) and the HLW feed blending vessel (HLP-VSL-00028). The HLW lag storage vessels, receive the leached and washed solids from the Ultrafiltration Feed Vessels (UFP-VSL-00002A/B). The HLP-VSL-
00027A and HLP-VSL-00027B vessels receive multiple batches of solids until they are filled and then transfer to the HLP Feed blending Vessel (HLP-VSL-00028).

The vessels HLP-VSL-00027B and HLP-VSL-00028 also receive CNP evaporator concentrate from the Cesium Concentrate Storage Vessel (CNP-VSL-00003). Before the CNP evaporator concentrate can be transferred into either HLP-VSL-00028 or HLP-VSL-00027B vessel, caustic is added to the receiving vessel to neutralize the acidic cesium product. There is a reaction time and volume dependent cooling time applied after the CNP material is received. After HLP-VSL-00028 has been filled it is discharged in batches which are determined based on waste composition and glass formulation.

### 3.4.1 System Requirements

#### 3.4.1.1 HLP Feed Blending and Lag Storage

**Unique ID:** BMR-HLP_SR-3

The HLP shall receive, blend, store, cool, sample and transfer pretreated HLW streams for subsequent vitrification.

**Basis:** This HLP system requirement is based on the description in Section 3.0 of 24590-PTF-3YD-HLP-00001, HLP System Description.

### 3.4.2 Functional Requirements

#### 3.4.2.1 HLP Receive Cesium Product

**Unique ID:** BMR-HLP_FR-13

The HLP shall have the capability to receive the cesium product from the CNP.
Basis: This *HLP* functional requirement is based on the description in Section 3.1 *Receive Waste Feed and other Materials* in 24590-PTF-3YD-HLP-00001, *HLP System Description*.

### 3.4.2.2 HLP Receive Pretreated Process Slurries

**Unique ID:** BMR-HLP_FR-12

The *HLP* shall have the capability to receive *pretreated process slurries* from the *UFP*.

Basis: This *HLP* functional requirement is based on the description in Section 3.1 *Receive Waste Feed and other Materials* in 24590-PTF-3YD-HLP-00001, *HLP System Description*.

### 3.4.2.3 HLP Blending

**Unique ID:** BMR-HLP_FR-14

The *HLP* shall have the capability to blend the *cesium product* and *pretreated process slurries* into the *pretreated HLW slurry*.

Basis: This *HLP* functional requirement is based on the description in Section 3.4 *Blend Process Fluids* in 24590-PTF-3YD-HLP-00001, *HLP System Description*.

### 3.4.2.4 HLP Cesium Product Neutralization

**Unique ID:** BMR-HLP_FR-15

The *HLP* shall have the capability to neutralize the acidic *cesium product*.

Basis: This *HLP* functional requirement is based on the description in Section 3.3 *Mix Process Fluids and Section 6.1.2 HLW LAG Storage and Blending Process Description* in 24590-PTF-3YD-HLP-00001, *HLP System Description*.

### 3.4.2.5 HLP Cooling

**Unique ID:** BMR-HLP_FR-11

The *HLP* shall have the capability to cool the neutralized *cesium product* and *pretreated process slurries*.

Basis: This *HLP* functional requirement is based on the description in Section 3.2 *Cool Process Fluids* in 24590-PTF-3YD-HLP-00001, *HLP System Description*.

### 3.4.2.6 HLP Transfer to HLW Vitrification

**Unique ID:** BMR-HLP_FR-16

The *HLP* shall have the capability to transfer the *pretreated HLW slurry* to the *HFP*.

Basis: This *HLP* functional requirement is based on the description in Section 3.7 *Transfer Process Fluids* in 24590-PTF-3YD-HLP-00001, *HLP System Description*.

### 3.4.2.7 HLP Sampling

**Unique ID:** BMR-HLP_FR-17

The *HLP* shall have the capability to have the *pretreated process slurries* sampled.
Basis: This HLP functional requirement is based on the description in Section 3.3 Mix Process Fluids and Section 4.2.8 Transfers to the HLW Facility in 24590-PTF-3YD-HLP-00001, HLP System Description.

3.4.3 Model Requirements

3.4.3.1 HLP Lag Storage and Blending Vessels

Unique ID: BMR-HLP_MR-13

The HLP lag storage and blending shall consist of the following vessels:

- HLW Lag Storage Vessel (HLP-VSL-00027A)
- HLW Lag Storage Vessel (HLP-VSL-00027B)
- HLW Feed Blending Vessel (HLP-VSL-00028)

Basis: This model requirement is based on Section 4.8.12 HLW Lag Storage and Feed Blending Process System in 24590-WTP-MDD-PR-01-002, WTP MDD.

3.4.3.2 HLP Lag Storage Vessels (HLP-VSL-00027A and B) Trigger Filling

Unique ID: BMR-HLP_MR-22

The HLW Lag Storage Vessel (HLP-VSL-00027A) and HLW Lag Storage Vessel (HLP-VSL-00027B) shall trigger the start of filling when the vessel is empty (is at or below the minimum volume).

Basis: This model requirement is based on the description in Section 4.8.12 HLW Lag Storage and Feed Blending Process System in 24590-WTP-MDD-PR-01-002, WTP MDD.

3.4.3.3 HLP Lag Storage Vessels (HLP-VSL-00027A and B) Parallel Receipt

Unique ID: BMR-HLP_MR-14

The HLW Lag Storage Vessel (HLP-VSL-00027A) and HLW Lag Storage Vessel (HLP-VSL-00027B) shall be capable of receiving pretreated process slurries from a single Ultrafiltration Feed Vessels (UFP-VSL-00002A/B) at the same time.

Basis: This model requirement is inferred from the description in Section 4.8.12 HLW Lag Storage and Feed Blending Process System and the UFP discharge logic in Section 4.8.3 Ultrafiltration Process System in 24590-WTP-MDD-PR-01-002, WTP MDD.

3.4.3.4 HLP Lag Storage Vessels (HLP-VSL-00027A and B) Complete Filling

Unique ID: BMR-HLP_MR-21

The HLW Lag Storage Vessel (HLP-VSL-00027A) and HLW Lag Storage Vessel (HLP-VSL-00027B) shall complete filling when the volume is between the lower and upper set volume.

Basis: This model requirement is based on the description in Section 2.4. Process Description in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.
3.4.3.5  HLP Lag Storage Vessels (HLP-VSL-00027A and B) Solubility Application

Unique ID: BMR-HLP_MR-16

Solubility shall be applied to the HLW Lag Storage Vessel (HLP-VSL-00027A) and the HLW Lag Storage Vessel (HLP-VSL-00027B) at the vessel temperature when it has completed filling and prior to discharge (see HLP-VSL-00027A Model Logic Diagram and HLP-VSL-00027B Modeling Diagram).

Basis: This model requirement is based on Section 4.7.16.3; Table 6 Solubility Application in 24590-WTP-MDD-PR-01-002, WTP MDD.

3.4.3.6  HLP Lag Storage Vessels (HLP-VSL-00027A and B) Discharge

Unique ID: BMR-HLP_MR-15

The HLW Lag Storage Vessel (HLP-VSL-00027A) and the HLW Lag Storage Vessel (HLP-VSL-00027B) vessel shall each transfer to the HLW Feed Blending Vessel (HLP-VSL-00028). See HLP-VSL-00027A Model Logic Diagram and HLP-VSL-00027B Modeling Diagram.

Basis: This model requirement is based on the description in Section 4.8.12 HLW Lag Storage and Feed Blending Process System in 24590-WTP-MDD-PR-01-002, WTP MDD.

3.4.3.7  HLP Feed Blending Vessels (HLP-VSL-00028) Trigger Filling

Unique ID: BMR-HLP_MR-23

The HLW Feed Blending Vessel (HLP-VSL-00028) shall trigger filling when it is at or below the minimum volume.

Basis: This model requirement is inferred based on the description in Section 4.8.12 HLW Lag Storage and Feed Blending Process System in 24590-WTP-MDD-PR-01-002, WTP MDD.

3.4.3.8  HLP Feed Blending Vessel (HLP-VSL-00028) Complete Filling

Unique ID: BMR-HLP_MR-28

The HLP-VSL-00028 - HLW Feed Blending Vessel shall complete filling when the volume is between the lower and upper set volume.

Basis: This model requirement is based on the description in Section 2.4. Process Description in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

3.4.3.9  HLP Feed Blending Vessel (HLP-VSL-00028) Solubility Application

Unique ID: BMR-HLP_MR-17

Solubility shall be applied to the HLW Feed Blending Vessel (HLP-VSL-00028) at the vessel temperature when it has completed filling and prior to the sampling (see HLP-VSL-00028 Model Diagram).

Basis: This model requirement is based on Section 4.7.16.3; Table 6 Solubility Application in 24590-WTP-MDD-PR-01-002, WTP MDD.
3.4.3.10 HLP Feed Blending Vessel (HLP-VSL-00028) Sampling

Unique ID: BMR-HLP_MR-18

A specified sample time shall be applied to the HLW Feed Blending Vessel (HLP-VSL-00028) after solubility has been applied and prior to discharge (see HLP-VSL-00028 Model Diagram).

Basis: This model requirement is based on the description in Section 2.4. Process Description in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

3.4.3.11 HLP Feed Blending Vessel (HLP-VSL-00028) Discharge

Unique ID: BMR-HLP_MR-19

The HLW Feed Blending Vessel (HLP-VSL-00028) shall transfer to the HLW Melter Feed Preparation Vessels (HFP-VSL-00001_5) as discrete batches after the sample time has elapsed. Batch size will vary depending on the results of the glass formulation calculation (See HLW Melter Feed Preparation Batch Volume).

Basis: This model requirement is based on the description in Section 2.4. Process Description in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

3.4.3.12 HLP Cesium Product Destination Selection

Unique ID: BMR-HLP_MR-20

The HLW Feed Blending Vessel (HLP-VSL-00028) or HLW Lag Storage Vessel (HLP-VSL-00027B) shall receive cesium product from the Cesium Concentrate Storage Vessel (CNP-VSL-00003). The receiving vessel shall be selected according to the following priorities:

1. HLW Feed Blending Vessel (HLP-VSL-00028) when the vessel is filling, the volume is > 30,700 gallons and there is sufficient volume to receive the Cesium Concentrate Storage Vessel (CNP-VSL-00003) batch and the required volume of neutralization caustic.

2. HLW Lag Storage Vessel (HLP-VSL-00027B) when the vessel is filling, the volume is > 30,300 gallons and there is sufficient volume to receive the Cesium Concentrate Storage Vessel (CNP-VSL-00003) batch and the required volume of neutralization caustic.

3. Wait until one of the conditions is true.

Basis: This model requirement is based on the description in Section 4.8.12 HLW Lag Storage and Feed Blending Process System in 24590-WTP-MDD-PR-01-002, WTP MDD.

3.4.3.13 HLP Caustic Addition to the Cesium Product Destination

Unique ID: BMR-HLP_MR-24

Prior to receiving the cesium product from Cesium Concentrate Storage Vessel (CNP-VSL-00003) into HLW Feed Blending Vessel (HLP-VSL-00028) or HLW Lag Storage Vessel (HLP-VSL-00027B) enough caustic shall be added to achieve an OH- to H+ ratio of 1.1 (excluding the OH- already in the vessel). See HLP-VSL-00028 Model Diagram and HLP-VSL-00027B Modeling Diagram.

Basis: This model requirement is based on the description in Section 4.8.12 HLW Lag Storage and Feed Blending Process System in 24590-WTP-MDD-PR-01-002, WTP MDD.
3.4.3.14  **HLP Cesium Product Receipt Vessel Neutralization Reaction**

**Unique ID:** BMR-HLP_MR-25

After the *cesium product* from *Cesium Concentrate Storage Vessel (CNP-VSL-00003)* has been received into the selected receipt vessel (*HLW Feed Blending Vessel (HLP-VSL-00028)* or *HLW Lag Storage Vessel (HLP-VSL-00027B)*) the neutralization reactions (*RXN-WTP-H-OH-NEUT* and *RXN-NH4-NEUTRALIZATION*) and reaction time (*HLP Cesium Receipt Vessel Neutralization Reaction Time*) shall be applied.

**Basis:** This model requirement is based on the description in Section 4.8.12 *HLW Lag Storage and Feed Blending Process System* in 24590-WTP-MDD-PR-01-002, WTP MDD.

3.4.3.15  **HLP Cesium Product Receipt Vessel Cooling Time**

**Unique ID:** BMR-HLP_MR-26

After neutralization reaction and reaction time have elapsed, the selected receipt vessel (*HLW Feed Blending Vessel (HLP-VSL-00028)* or *HLW Lag Storage Vessel (HLP-VSL-00027B)*) shall be cooled according to equations given below.

- Cool Time  = Cool down time (hrs)
- \( V = \text{Vessel volume after acid transfer and caustic addition (gal)} \)

For *HLW Lag Storage Vessel (HLP-VSL-00027B)*

- Cool Time  = -6.0E-10 * \( V^2 \) + 1.16E-4 * \( V \) + 4.0034

For *HLW Feed Blending Vessel (HLP-VSL-00028)* if Volume >30,700 and volume is < 34,800 gallons

- Cool Time  = - 1.95E-4 * \( V \) + 13.69

For *HLW Feed Blending Vessel (HLP-VSL-00028)* if Volume > 34,800 gallons

- Cool Time  = - 5.2E-10 * \( V^2 \) + 9.55E-5 * \( V \) + 4.201

**Basis:** This model requirement is based on the description in Section 4.8.12 *HLW Lag Storage and Feed Blending Process System* in 24590-WTP-MDD-PR-01-002, WTP MDD.

3.4.3.16  **HLP Cesium Product Receipt Vessel Continue to Fill**

**Unique ID:** BMR-HLP_MR-27

After the selected receipt vessel (*HLW Feed Blending Vessel (HLP-VSL-00028)* or *HLW Lag Storage Vessel (HLP-VSL-00027B)*) has been cooled and if the volume is less than the set volume, then the vessel is available to receive additional waste, but should not receive additional *cesium product* from the *Cesium Concentrate Storage Vessel (CNP-VSL-00003)*. If the vessel is at or above the upper set volume then filling is complete.

**Basis:** This model requirement is based on the description in Section 4.8.12 *HLW Lag Storage and Feed Blending Process System* in 24590-WTP-MDD-PR-01-002, WTP MDD.
3.4.4 Technical Requirements

3.4.4.1 HLP Lag Storage Vessels (HLP-VSL-00027A & B) Parameters

Unique ID: BMR-HLP_TR-10

*HLW Lag Storage Vessel (HLP-VSL-00027A)* and *HLW Lag Storage Vessel (HLP-VSL-00027B)* shall have the following parametric values.

<table>
<thead>
<tr>
<th>Vessel #</th>
<th>Maximum Volume (gal)</th>
<th>Upper Set Volume (gal)</th>
<th>Set Volume (gal)</th>
<th>Minimum Volume (gal)</th>
<th>Flow rate (gpm)</th>
<th>Temperature (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>HLP-VSL-00027A</td>
<td>112,082</td>
<td>91,418</td>
<td>71,418</td>
<td>9,418</td>
<td>90</td>
<td>25</td>
</tr>
<tr>
<td>HLP-VSL-00027B</td>
<td>112,082</td>
<td>91,418</td>
<td>71,418</td>
<td>9,418</td>
<td>90</td>
<td>25</td>
</tr>
</tbody>
</table>

*Basis:* This requirement is based on the values in *Table E-1 Vessel Parameters* found in *24590-WTP-MDD-PR-01-002, WTP MDD*. The temperature is based on the values in *Section 4.7.16.3; Table 6 Solubility Application* in *24590-WTP-MDD-PR-01-002, WTP MDD*.

3.4.4.2 HLP Feed Blending Vessel (HLP-VSL-00028) Parameters

Unique ID: BMR-HLP_TR-11

The *HLW Feed Blending Vessel (HLP-VSL-00028)* shall have the following parametric values.

<table>
<thead>
<tr>
<th>Vessel #</th>
<th>Maximum Volume (gal)</th>
<th>Upper Set Volume (gal)</th>
<th>Set Volume (gal)</th>
<th>Minimum Volume (gal)</th>
<th>Flow rate (gpm)</th>
<th>Temperature (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>HLP-VSL-00028</td>
<td>124,750</td>
<td>101,863</td>
<td>90,863</td>
<td>20,863</td>
<td>56</td>
<td>25</td>
</tr>
</tbody>
</table>

*Basis:* This requirement is based on the values in *Table E-1 Vessel Parameters* found in *24590-WTP-MDD-PR-01-002, WTP MDD*. The temperature is based on the values in *Section 4.7.16.3; Table 6 Solubility Application* in *24590-WTP-MDD-PR-01-002, WTP MDD*.

3.4.4.3 HLP Feed Blending Vessel (HLP-VSL-00028) Sampling Time

Unique ID: BMR-HLP_TR-12

The *HLW Feed Blending Vessel (HLP-VSL-00028)* sample time shall be 24.8 hours.

*Basis:* This sample time is based on the value specified in *Section 2.4. Process Description* in *24590-WTP-RPT-PT-02-005, BARD Rev. 8* (also is in Table B-1).

3.4.4.4 HLP Cesium Receipt Vessel Neutralization Reaction Time

Unique ID: BMR-HLP_TR-13

The neutralization reaction time in the selected *cesium product* receipt vessel (HLW Feed Blending Vessel (HLP-VSL-00028) or HLW Lag Storage Vessel (HLP-VSL-00027B)) shall be 30 minutes.

*Basis:* The reaction time is based on the value specified in *Section 4.8.12 HLW Lag Storage and Feed Blending Process System* in *24590-WTP-MDD-PR-01-002, WTP MDD*. 
3.4.5 HLP - Lag Storage and Feed Blending Figures and Diagrams

3.4.5.1 HLP Functional Requirements Diagram

Unique ID: BMR-HLP_FIG-4
3.4.5.2 HLP-VSL-00027A Model Logic Diagram

Unique ID: BMR-HLP FIG-5

3.4.5.3 HLP-VSL-00027B Modeling Diagram

Unique ID: BMR-HLP FIG-6
3.4.5.4 HLP-VSL-00028 Model Diagram

Unique ID: BMR-HLP_FIG-7

3.4.5.5 HLP Feed Blending Vessel (HLP-VSL-00028) Line Flush to HLW - This Item is a Future Model Improvement

Unique ID: BMR-HLP-82

An internal line flush to the **HLW Melter Feed Preparation Vessels (HFP-VSL-00001,5)** and the **HLW Effluent Transfer Vessel (PWD-VSL-00043)** shall follow each transfer of the **HLW Feed Blending Vessel (HLP-VSL-00028)**. The line flush shall use process condensate from the **Process Condensate Vessel (RLD-VSL-00006A)** if available or Water. (see HLP-VSL-00028 Model Diagram).

3.4.5.6 HLP Feed Blending Vessel (HLP-VSL-00028) Line Flush to HLW Volume - This Item is a Future Model Improvement

Unique ID: BMR-HLP-83

The **HLW Feed Blending Vessel (HLP-VSL-00028)** internal line flush following each transfer shall be 411 gallons to **HLW Melter Feed Preparation Vessels (HFP-VSL-00001,5)** and 822 gallons to **HLW Effluent Transfer Vessel (PWD-VSL-00043)**.
3.4.5.7 HLP Lag Storage Vessels (HLP-VSL-00027A and B) Internal Line Flush - This Item is a Future Model Improvement

Unique ID: BMR-HLP-81

An internal line flush to HLW Feed Blending Vessel (HLP-VSL-00028) shall follow each transfer of the HLW Lag Storage Vessel (HLP-VSL-00027A) and the HLW Lag Storage Vessel (HLP-VSL-00027B) vessel. The line flush shall use process condensate from the Process Condensate Vessel (RLD-VSL-00006A) if available or Water. (see HLP-VSL-00027A Model Logic Diagram and HLP-VSL-00027B Modeling Diagram).

3.4.5.8 HLP Lag Storage Vessels (HLP-VSL-00027a and B) Internal Line Flush Volume - This Item is a Future Model Improvement

Unique ID: BMR-HLP-84

The HLW Lag Storage Vessel (HLP-VSL-00027A) and HLW Lag Storage Vessel (HLP-VSL-00027B) internal line flush volume following each transfer to HLW Feed Blending Vessel (HLP-VSL-00028) are as follows:

- 160 gallons for HLW Lag Storage Vessel (HLP-VSL-00027A), and
- 138 gallons for HLW Lag Storage Vessel (HLP-VSL-00027B).

3.5 WASTE TREATMENT AND IMMOBILIZATION PLANT ULTRAFILTRATION PROCESS

The purpose of the UFP system is to concentrate solids by separating solids from liquids by way of ultrafilters, dissolve select species by caustic leaching and oxidative leaching, and to treat permeate streams to prevent post-filtration precipitation. The UFP has two identical trains consisting of the Ultrafiltration Feed Preparation Vessels (UFP-VSL-00001A/B), the Ultrafiltration Feed Vessels (UFP-VSL-00002A/B) and Permeate Collection Vessels (UFP-VSL-00062A/B/C).

LAW feeds from the LAW Feed Receipt Vessel (FRP-VSL-00002A/B/C/D) are blended with HLW feeds from the HLW Feed Receipt Vessel (HLP-VSL-00022) in one of two Ultrafilter Preparation Tanks (UFP-VSL-00001A/B). The ratio of LAW to HLW undissolved solids is established to support both LAW and HLW glass production rates. The blended feed is heated, and then any available concentrated recycled are added from the FEP system. The UFP-VSL-00001A and UFP-VSL-00001B vessels operate in an alternating fashion, e.g., one will not discharge until the other is “empty”.

The heated and blended waste from UFP-VSL-00001A/B is sent to one of two Ultrafiltration Feed Vessels (UFP-VSL-00002A/B) to separate the LAW liquid stream (permeate) and concentrate the slurry. The UFP-VSL-00002A/B can receive from either UFP-VSL-00001A/B vessel and are designed to operate in parallel. As the slurry is received into the UFP-VSL-00002A/B vessels, permeate is sent to the Permeate Collection Vessels (UFP-VSL-00062A/B/C) until the slurry is concentrated to the target weight percent solids. Once the desired solids level is met, the concentrated slurry undergoes the following steps:

1. Steam condensate is added to simulate heating to the leach temperature.
2. Caustic is added to simulate leaching the aluminum and other key solid components.
3. Caustic leach reactions, a reaction time and a cooling time are applied.
4. The leached slurry is washed with process condensate from the RLD system or water.
5. The slurry is re-concentrated to the target solids content by removing additional permeate.
6. If the chromium level is greater than the threshold, oxidative leaching is performed by adding sodium permanganate and sodium hydroxide and applying the reactions and reaction time.
7. If oxidative leaching was applied then the remaining slurry is washed with process condensate from the RLD system or water and re-concentrated if needed.
8. The filters are flushed after each solids discharge and an acid cleaning is performed periodically prior to receiving the next batch of slurry.

The permeate collection vessels UFP-VSL-00062A/B and C receive permeate and the initial wash solution, as the wash solution becomes more dilute it is sent to PWD-VSL-00015 and 16. Permeate and wash solution collected in UFP-VSL-00062A/B and C is transferred to the Cesium Ion Exchange Caustic Rinse Collection Vessel (CXP-VSL-00004).

3.5.1 System Requirements

3.5.1.1 UFP Blend Waste

Unique ID: BMR-UFP_SR-1

The UFP shall blend HLW and LAW feeds along with concentrated plant recycles.

Basis: This system requirement is based on the description in Section 2.3 Basic Operational Overview of 24590-PTF-3ZD-UFP-00001, UFP System Description.

3.5.1.2 UFP Filter Solids from Supernatant

Unique ID: BMR-UFP_SR-2

The UFP shall separate solids from supernatant using ultrafiltration.

Basis: This system requirement is based on the description in Section 2.3 Basic Operational Overview of 24590-PTF-3ZD-UFP-00001, UFP System Description.
3.5.1.3 UFP Wash and Leaching

Unique ID: BMR-UFP_SR-3

The UFP shall dissolve soluble species that limit the IHLW waste loading using water washing and chemical leaching.

Basis: This system requirement is based on the description in Section 2.3.1 Function and Requirements of 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

3.5.1.4 UFP Minimize Solids Re-Precipitating

Unique ID: BMR-UFP_SR-5

The UFP shall minimize solids from re-precipitating in the ultrafilter permeate.

Basis: This system requirement is based on the description in Section 2.3.1 Function and Requirements of 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

3.5.1.5 UFP Facility Availability Impact

Unique ID: BMR-UFP_SR-6

The UFP shall add a factor to impact the overall Pretreatment Facility availability (Facility Availability).

Basis: This system requirement is based on the requirements for PT Facility Availability in DE-AC27-01RV14136, WTP/DOE Statement of Work and the approach documented in RPP-RPT-58581, HTWOS Facility Availability.

3.5.1.6 UFP Support Ion Exchange Displacement

Unique ID: BMR-UFP_SR-7

The UFP System shall be capable of receiving waste from the CXP System during ion exchange displacement.

Basis: This system requirement is based on the description in Section 2.1 System Functions/Safety Functions of 24590-PTF-3ZD-UFP-00001, UFP System Description.

3.5.2 Functional Requirements

3.5.2.1 UFP Receive HLW

Unique ID: BMR-UFP_FR-20

The UFP shall have the capability to receive HLW feed from the HLP - HLW Feed Receipt system.

Basis: This functional requirement is based on the description in Section 2.1 System Functions/Safety Functions of 24590-PTF-3ZD-UFP-00001, UFP System Description.

3.5.2.2 UFP Receive LAW

Unique ID: BMR-UFP_FR-19

The UFP shall have the capability to receive LAW feed from the FRP.
Basis: This functional requirement is based on the description in Section 2.1 System Functions/Safety Functions of 24590-PTF-3ZD-UFP-00001, UFP System Description.

3.5.2.3 UFP Feed Blending

Unique ID: BMR-UFP_FR-1

The UFP shall have the capability to blend the received LAW and HLW feeds prior to filtration.

Basis: This functional requirement is based on the description in Section 2.1 System Functions/Safety Functions of 24590-PTF-3ZD-UFP-00001, UFP System Description.

3.5.2.4 UFP Receive Concentrated Recycle

Unique ID: BMR-UFP_FR-13

The UFP shall have the capability to receive concentrated recycles from FEP.

Basis: This functional requirement is based on the description in Section 2.1 System Functions/Safety Functions of 24590-PTF-3ZD-UFP-00001, UFP System Description.

3.5.2.5 UFP Receive Ion Exchange Displacement Waste

Unique ID: BMR-UFP_FR-23

The UFP shall have the capability to receive waste from the IX resin regeneration displacement step waste.

Basis: This functional requirement is based on the description in Section 2.1 System Functions/Safety Functions of 24590-PTF-3ZD-UFP-00001, UFP System Description.

3.5.2.6 UFP Dilution

Unique ID: BMR-UFP_FR-16

The UFP shall have the capability of diluting the permeate.

Basis: This functional requirement is based on the description in Section 2.1 System Functions/Safety Functions of 24590-PTF-3ZD-UFP-00001, UFP System Description.

3.5.2.7 UFP Heating

Unique ID: BMR-UFP_FR-2

The UFP shall have the capability to heat the waste.

Basis: This functional requirement is based on the description in Section 2.1 System Functions/Safety Functions of 24590-PTF-3ZD-UFP-00001, UFP System Description.

3.5.2.8 UFP Cooling

Unique ID: BMR-UFP_FR-15

The UFP shall have the capability to cool the waste.

Basis: This functional requirement is based on the description in Section 2.1 System Functions/Safety Functions of 24590-PTF-3ZD-UFP-00001, UFP System Description.
3.5.2.9 UFP Filtration

Unique ID: BMR-UFP_FR-3

The UFP shall have the capability to separate supernatant from the solids using two trains of ultra filters.

Basis: This functional requirement is based on the description in Section 2.1 System Functions/Safety Functions of 24590-PTF-3ZD-UFP-00001, UFP System Description.

3.5.2.10 UFP Solids Accumulation

Unique ID: BMR-UFP_FR-21

The UFP shall have the capability to accumulate the filtered solids for subsequent treatment.

Basis: This functional requirement is based on the description in Section 2.1 System Functions/Safety Functions of 24590-PTF-3ZD-UFP-00001, UFP System Description.

3.5.2.11 UFP Wash and Dilution Source

Unique ID: BMR-UFP_FR-14

The UFP shall have the capability of using process condensate and/or inhibited water for solids washing and waste dilution.

Basis: This functional requirement is based on the description in Section 2.1 System Functions/Safety Functions of 24590-PTF-3ZD-UFP-00001, UFP System Description.

3.5.2.12 UFP Caustic Leaching

Unique ID: BMR-UFP_FR-5

The UFP shall have the capability of performing back-end caustic leaching on the filtered or unfiltered solids.

Basis: This functional requirement is based on the description in Section 2.1 System Functions/Safety Functions of 24590-PTF-3ZD-UFP-00001, UFP System Description.

3.5.2.13 UFP Oxidative Leaching

Unique ID: BMR-UFP_FR-6

The UFP shall have the capability of performing oxidative leaching on the filtered solids.

Basis: This functional requirement is based on the description in Section 2.1 System Functions/Safety Functions of 24590-PTF-3ZD-UFP-00001, UFP System Description.

3.5.2.14 UFP Solids Washing

Unique ID: BMR-UFP_FR-4

The UFP shall have the capability to perform solids washing.

Basis: This functional requirement is based on the description in Section 2.1 System Functions/Safety Functions of 24590-PTF-3ZD-UFP-00001, UFP System Description.
3.5.2.15 UFP Slurry Transfer to HLP

Unique ID: BMR-UFP_FR-7

The *UFP* shall have the capability to transfer *pretreated process slurries* to the HLP - Lag Storage and Feed Blending system.

Basis: This functional requirement is based on the description in Section 2.1 System Functions/Safety Functions of 24590-PTF-3ZD-UFP-00001, UFP System Description.

3.5.2.16 UFP Permeate Storage

Unique ID: BMR-UFP_FR-18

The *UFP* shall have the capability to store the waste *permeate* prior to sending it downstream to the CXP.

Basis: This functional requirement is based on the description in Section 2.1 System Functions/Safety Functions of 24590-PTF-3ZD-UFP-00001, UFP System Description.

3.5.2.17 UFP Transfer to CXP

Unique ID: BMR-UFP_FR-8

The *UFP* shall have the capability to transfer waste *permeate* and initial *solids washing* fluids to the CXP.

Basis: This functional requirement is based on the description in Section 2.1 System Functions/Safety Functions of 24590-PTF-3ZD-UFP-00001, UFP System Description.

3.5.2.18 UFP Dilute Solution Transfer to PWD

Unique ID: BMR-UFP_FR-9

The *UFP* shall have the capability to transfer to the *PWD*.

Basis: This functional requirement is based on the description in Section 2.1 System Functions/Safety Functions of 24590-PTF-3ZD-UFP-00001, UFP System Description.

3.5.2.19 UFP Prevent Undissolved Solids Formation

Unique ID: BMR-UFP_FR-17

The *UFP* shall have the capability to chemically adjust the ultrafilter *permeate* to prevent undissolved solids from forming.

Basis: This functional requirement is based on the description in Section 2.1 System Functions/Safety Functions of 24590-PTF-3ZD-UFP-00001, UFP System Description.

3.5.2.20 UFP Filter Cleaning

Unique ID: BMR-UFP_FR-10

The *UFP* shall have the capability to back pulse and clean the ultrafilter units.

Basis: This functional requirement is based on the description in Section 2.1 System Functions/Safety Functions of 24590-PTF-3ZD-UFP-00001, UFP System Description.
3.5.2.21 UFP Sampling

**Unique ID:** BMR-UFP_FR-11

The **UFP** shall have the capability to sample the waste.

**Basis:** This functional requirement is based on the description in Section 2.1 *System Functions/Safety Functions* of 24590-PTF-3ZD-UFP-00001, *UFP System Description*.

3.5.2.22 UFP-Facility Availability Impacts

**Unique ID:** BMR-UFP_FR-22

The **UFP** shall have the capability to simulate delays from the WTP Pretreatment Facility downtimes due to equipment reliability, availability, maintainability, and inspectability issues, such that the overall integrated WTP Facility Availability meets a targeted value.

**Basis:** This functional requirement is based on the requirements for PT Facility Availability in DE-AC27-01RV14136, *WTP/DOE Statement of Work* and the approach documented in *RPP-RPT-58581, HTWOS Facility Availability*.

3.5.3 Model Requirements

3.5.3.1 UFP Feed Preparation Vessels (UFP-VSL-00001A and UFP-VSL-00001B)

**Unique ID:** BMR-UFP_MR-1

The **UFP** shall include two identical feed preparation vessels identified as UFP-VSL-00001A and UFP-VSL-00001B (see the **UFP Overall Process Diagram**).

**Basis:** This model requirement is based on *Section 2.3.2 UFP Process Description/Figure 2.3-1 of the BARD (24590-WTP-RPT-PT-02-005, BARD Rev. 8)* and *Section 4.8.3 Ultrafiltration Process (UFP) System in 24590-WTP-MDD-PR-01-002, WTP MDD*.

3.5.3.2 UFP Feed Vessels (UFP-VSL-00002A and UFP-VSL-00002B)

**Unique ID:** BMR-UFP_MR-2

The **UFP** shall include two identical feed vessels identified as UFP-VSL-00002A and UFP-VSL-00002B which represent the feed vessels and cross-flow filter functionality (see the **UFP Overall Process Diagram**).

**Basis:** This model requirement is based on *Section 2.3.2 UFP Process Description/Figure 2.3-1 of the BARD (24590-WTP-RPT-PT-02-005, BARD Rev. 8)* and *Section 4.8.3 Ultrafiltration Process (UFP) System in 24590-WTP-MDD-PR-01-002, WTP MDD*.

3.5.3.3 UFP Permeate Vessels (UFP-VSL-000062A, UFP-VSL-00062B and UFP-VSL-000062C)

**Unique ID:** BMR-UFP_MR-3

The **UFP** shall include three identical permeate receipt vessels identified as UFP-VSL-000062A, UFP-VSL-00062B and UFP-VSL-00062C (see the **UFP Overall Process Diagram**).
Basis: This model requirement is based on Section 2.3.2 Ultrafiltration Process (UFP) System in 24590-WTP-MDD-PR-01-002, WTP MDD.

3.5.3.4 UFP Feed Preparation Vessels (UFP-VSL-00001A/B) - Feed Receipt

Unique ID: BMR-UFP_MR-4

The UFP Feed Preparation Vessels (UFP-VSL-00001A/B) shall each receive feeds from the LAW waste feed receipt vessels (FRP-VSL-00002A/B/C/D), HLW Feed Receipt Vessel (HLP-VSL-00022), and Waste Feed Evaporator (FEP-SEP-00001A).

Basis: This model requirement is based on the description in Section 4.8.3 Ultrafiltration Process (UFP) System in 24590-WTP-MDD-PR-01-002, WTP MDD.

3.5.3.5 UFP Feed Preparation Vessels (UFP-VSL-00001A/B) - Initiate Filling

Unique ID: BMR-UFP_MR-11

The UFP Feed Preparation Vessels (UFP-VSL-00001A/B) shall be available to receive a new batch of waste when its volume is at or below (e.g. initial filling) the minimum volume plus or minus the downstream UFP Feed Vessels (UFP-VSL-00002A/B) - Sawtooth Volume.

Basis: This model requirement is based on the description in Section 4.8.3 Ultrafiltration Process (UFP) System in 24590-WTP-MDD-PR-01-002, WTP MDD.

3.5.3.6 UFP Feed Preparation Vessels (UFP-VSL-00001A/B) - Blending when HLW and LAW are Available

Unique ID: BMR-UFP_MR-44

When there is available HLW in HLW Feed Receipt Vessel (HLP-VSL-00022) and LAW in LAW waste feed receipt vessels (FRP-VSL-00002A/B/C/D) feed blending in UFP Feed Preparation Vessels (UFP-VSL-00001A/B) shall proceed as follows:

1. Fill the vessel with the amount of HLW determined by the UFP Feed Preparation Vessels (UFP-VSL-00001A/B) Blending Equation.
2. Top off with LAW to the lower set point.
3. Proceed to heating (UFP Feed Preparation Vessel (UFP-VSL-00001) - Heat Steam Condensate Addition).

Basis: This model requirement is based on the description in Section 4.8.3 Ultrafiltration Process (UFP) System in 24590-WTP-MDD-PR-01-002, WTP MDD Rev. 12.

3.5.3.7 UFP Feed Preparation Vessels (UFP-VSL-00001A/B) - Blending when Insufficient HLW Feed is Available

Unique ID: BMR-UFP_MR-45

If there is no HLW available in HLW Feed Receipt Vessel (HLP-VSL-00022) but LAW is available in the LAW waste feed receipt vessels (FRP-VSL-00002A/B/C/D) then the feed blending in the UFP Feed Preparation Vessels (UFP-VSL-00001A/B) shall use only LAW to fill the vessel to the set volume.
**Basis**: This model requirement is based on the description in Section 4.8.3 *Ultrafiltration Process (UFP) System* in 24590-WTP-MDD-PR-01-002, WTP MDD Rev. 12.

### 3.5.3.8 UFP Feed Preparation Vessels (UFP-VSL-00001A/B) - Blending when Insufficient LAW is Available

**Unique ID:** BMR-UFP_MR-50

If there is *HLW* available in *HLW Feed Receipt Vessel (HLP-VSL-00022)* but there is no *LAW* in the *LAW waste feed receipt vessels (FRP-VSL-00002A/B/C/D)* then the feed blending in the *UFP Feed Preparation Vessels (UFP-VSL-00001A/B)* shall use only *HLW* to fill the vessel to the set volume.

**Basis**: This model requirement is based on the description in Section 4.8.3 *Ultrafiltration Process (UFP) System* in 24590-WTP-MDD-PR-01-002, WTP MDD Rev. 12.

### 3.5.3.9 UFP Feed Preparation Vessels (UFP-VSL-00001A/B) - Filling No HLW and LAW Feeds

**Unique ID:** BMR-UFP_MR-49

If there is no *HLW* available in *HLW Feed Receipt Vessel (HLP-VSL-00022)* and no *LAW* available in the *LAW waste feed receipt vessels (FRP-VSL-00002A/B/C/D)* then the *UFP Feed Preparation Vessels (UFP-VSL-00001A/B)* shall fill as follows:

1. If one of the Waste Feed Evaporator Feed Vessels (FEP-VSL-00017A/B) is full, then UFP Feed Preparation Vessels (UFP-VSL-00001A/B) shall receive the concentrated recycle from Waste Feed Evaporator (FEP-SEP-00001A) until the Waste Feed Evaporator Feed Vessels (FEP-VSL-00017A/B) is empty or UFP Feed Preparation Vessels (UFP-VSL-00001A/B) reaches its upper set point.

2. If neither of the Waste Feed Evaporator Feed Vessels (FEP-VSL-00017A/B) is full the UFP Feed Preparation Vessels (UFP-VSL-00001A/B) shall wait for available feed, either HLW, LAW, or from *FEP*.

**Basis**: This model requirement is based on the description in Section 4.8.3 *Ultrafiltration Process (UFP) System* in 24590-WTP-MDD-PR-01-002, WTP MDD Rev. 12.

### 3.5.3.10 UFP Feed Preparation Vessel (UFP-VSL-00001A/B) - No Heat Condition

**Unique ID:** BMR-UFP_MR-47

If the *UFP Feed Preparation Vessels (UFP-VSL-00001A/B)* has been filled with only concentrate from *Waste Feed Evaporator (FEP-SEP-00001A)* then no heating is required.

**Basis**: This model requirement is based on the interpretation of Section 4.8.3 *Ultrafiltration Process (UFP) System* in 24590-WTP-MDD-PR-01-002, WTP MDD Rev. 12.

### 3.5.3.11 UFP Feed Preparation Vessel (UFP-VSL-00001A/B) - Heat Steam Condensate Addition

**Unique ID:** BMR-UFP_MR-5

After the *UFP Feed Preparation Vessels (UFP-VSL-00001A/B)* has been filled with available HLW and/or LAW feed, it shall be heated to the vessel temperature by adding *Water* to
simulate the steam condensate addition. The water addition shall be calculated per *UFP Feed Preparation Vessels (UFP-VSL-00001A/B) Heating Volume Equation*.

**Basis:** This model requirement is based on the description in Section 4.8.3 *Ultrafiltration Process (UFP) System* in 24590-WTP-MDD-PR-01-002, WTP MDD Rev. 13.

### 3.5.3.12 UFP Feed Preparation Vessel (UFP-VSL-00001A/B) - Heat Time

**Unique ID:** BMR-UFP_MR-46

After the *UFP Feed Preparation Vessel (UFP-VSL-00001) - Heating Steam Condensate Addition* step is complete, the heating time determined by the *UFP Feed Preparation Vessels (UFP-VSL-00001A/B) Heating Time Equation* shall be applied.

**Basis:** This model requirement is based on the description in Section 4.8.3 *Ultrafiltration Process (UFP) System* in 24590-WTP-MDD-PR-01-002, WTP MDD Rev. 13.

### 3.5.3.13 UFP Feed Preparation Vessels (UFP-VSL-00001A/B) - Recycle Concentrate Addition

**Unique ID:** BMR-UFP_MR-6

After a *UFP Feed Preparation Vessels (UFP-VSL-00001A/B)* has been heated the vessel shall receive any available concentrate from *Waste Feed Evaporator (FEP-SEP-00001A)* to the upper set point. If there is no available concentrate (e.g. neither of the *Waste Feed Evaporator Feed Vessels (FEP-VSL-00017A/B)* are ready to empty) and a *UFP Feed Vessels (UFP-VSL-00002A/B)* is ready to receive then the *UFP Feed Preparation Vessel (UFP-VSL-00001A/B)* shall transfer without being topped off with concentrate from FEP.

**Basis:** This model requirement is based on the description in Section 4.8.3 *Ultrafiltration Process (UFP) System* in 24590-WTP-MDD-PR-01-002, WTP MDD Rev. 13.

### 3.5.3.14 UFP Feed Preparation Vessels (UFP-VSL-00001A/B) - Solubility

**Unique ID:** BMR-UFP_MR-7

After the *UFP Feed Preparation Vessels (UFP-VSL-00001A/B)* has completed heating and received any available concentrate, solubility shall be applied at the vessel temperature.

**Basis:** This model requirement is based on the logic listed in Table 6 *Solubility Applications of 24590-WTP-MDD-PR-01-002, WTP MDD Rev. 13.*

### 3.5.3.15 UFP Feed Preparation Vessel (UFP-VSL-00001A/B) - Discharge

**Unique ID:** BMR-UFP_MR-8

After the *UFP Feed Preparation Vessel (UFP-VSL-00001A/B)* has completed the solubility application the vessel shall transfer to either of the *UFP Feed Vessels (UFP-VSL-00002A/B)* at the specified rate until it reaches its minimum volume plus or minus the *UFP Feed Vessels (UFP-VSL-00002A/B) Sawtooth Volume*.

**Basis:** This model requirement is based on the description in Section 4.8.3 *Ultrafiltration Process (UFP) System* in 24590-WTP-MDD-PR-01-002, WTP MDD Rev. 13.
3.5.3.16 UFP Feed Preparation Vessel (UFP-VSL-00001A/B) - Alternate Operation

Unique ID: BMR-UFP_MR-9

The UFP Feed Preparation Vessels (UFP-VSL-00001A/B) shall operate in an alternating fashion, e.g. one will not start to discharge until the other has completed discharging.

Basis: This model requirement is based on the description in Section 4.8.3 Ultrafiltration Process (UFP) System in 24590-WTP-MDD-PR-01-002, WTP MDD Rev. 13.

3.5.3.17 UFP Feed Vessels (UFP-VSL-00002A/B) - Initiate Filling

Unique ID: BMR-UFP_MR-10

If the UFP Feed Vessels (UFP-VSL-00002A/B) is at or less than the minimum volume it shall initiate filling with waste from the UFP Feed Preparation Vessels (UFP-VSL-00001A/B) to the upper sawtooth volume at the UFP Feed Preparation Vessels (UFP-VSL-00001A/B) maximum pump rate.

Basis: This model requirement is based on the description in Section 4.8.3 Ultrafiltration Process (UFP) System in 24590-WTP-MDD-PR-01-002, WTP MDD Rev. 13.

3.5.3.18 UFP Feed Vessel (UFP-VSL-00002A/B) - Initial Solids Concentration

Unique ID: BMR-UFP_MR-18

After one of the UFP Feed Vessels (UFP-VSL-00002A/B) has been filled to the upper sawtooth volume, then permeate shall be transferred to one of the UFP Permeate Receipt Vessels (UFP-VSL-00002A/B/C) to the set point (e.g. sawtooth) at the calculated rate (UFP Feed Vessels (UFP-VSL-00002A/B) Filter Flux Rate). This continues until the weight percent solids is greater than or equal to the UFP Feed Vessels (UFP-VSL-00002A/B) - Initial Solids Concentration Endpoint value.

Basis: This model requirement is based on the description in Section 4.8.3 Ultrafiltration Process (UFP) System in 24590-WTP-MDD-PR-01-002, WTP MDD Rev. 13.

3.5.3.19 UFP Feed Vessel (UFP-VSL-00002A/B) - Oxidative Leach Sample

Unique ID: BMR-UFP_MR-42

If oxidative leaching is required then the time between the start of solids washing and the start of oxidative leaching mush be at least the UFP-VSL-00002A/B - Sample Time. If the solids washing has completed before the sample time has elapsed the oxidative leaching mush wait until the sample time is complete.

Basis: This model requirement is based on the description in Section 4.8.3 Ultrafiltration Process (UFP) System in 24590-WTP-MDD-PR-01-002, WTP MDD Rev. 13.

3.5.3.20 UFP Feed Vessels (UFP-VSL-00002A/B) - Parallel Operation Constraints

Unique ID: BMR-UFP_MR-35

- The two UFP Feed Vessels (UFP-VSL-00002A/B) can fill, concentrate, heat, caustic leach, oxidative leach, or wash forward at the same time.
- The two *UFP Feed Vessels (UFP-VSL-00002A/B)* cannot simultaneously perform wash recycle or oxidative leach washing at the same time to reduce the chances of the PT from becoming backed up with recycles.

- The two *UFP Feed Vessels (UFP-VSL-00002A/B)* cannot simultaneously discharge to the same *UFP Permeate Receipt Vessels (UFP-VSL-00062A/B/C)*.

- The two *UFP Feed Vessels (UFP-VSL-00002A/B)* can simultaneously perform solids discharge but cannot simultaneously send the slurry to the same vessel. For example, UFP-VSL-00002A could be sending the slurry to *HLW Lag Storage Vessel (HLP-VSL-00027A)* and UFP-VSL-00002B could be transferring to *HLW Lag Storage Vessel (HLP-VSL-00027B)* or visa versa, but both *UFP Feed Vessels (UFP-VSL-00002A/B)* could not be transferring slurry to the same HLP tank.

**Basis:** This model requirement is based on the description in Section 4.8.3 *Ultrafiltration Process (UFP) System* in 24590-WTP-MDD-PR-01-002, WTP MDD Rev. 13 with clarification from WTP personnel.

### 3.5.3.21 UFP Feed Vessels (UFP-VSL-00002A/B) - Post Initial Solids Concentration Solubility Application

**Unique ID:** BMR-UFP_MR-12

After the initial solids concentration, solubility shall be applied in the *UFP Feed Vessels (UFP-VSL-00002A/B)* at the vessel temperature.

**Basis:** This model requirement is based on the information in Table 6 in 24590-WTP-MDD-PR-01-002, WTP MDD Rev. 13.

### 3.5.3.22 UFP Feed Vessels (UFP-VSL-00002A/B) - Caustic Leach Criteria

**Unique ID:** BMR-UFP_MR-41

Batches in *UFP Feed Vessels (UFP-VSL-00002A/B)* shall undergo caustic leaching if there is any solid gibbsite (*Al(OH)₃*) or boehmite (*AlOOH*) present or if the sum of the leach factors are greater than zero. If caustic leach is not required then skip to *UFP Feed Vessels (UFP-VSL-00002A/B) - Determine if Oxidative Leaching is Required* (heating and caustic leach steps are not required).

**Basis:** This model requirement is based on the System Plan Rev. 8 starting assumption A1.3.2.6 documented in ORP-11242, System Plan Rev. 8 that all solids in UFP will be leached.

### 3.5.3.23 UFP Feed Vessels (UFP-VSL-00002A/B) - Caustic Leach Heating Steam Condensate Addition

**Unique ID:** BMR-UFP_MR-13

After the initial solids concentration and if caustic leach is true then, the contents of *UFP Feed Vessels (UFP-VSL-00002A/B)* shall be heated to *UFP Feed Vessels (UFP-VSL-00002A/B) - Caustic Leach Temperature* by adding *Water*. The water addition volume shall be calculated per *UFP Feed Vessels (UFP-VSL-00002A/B) - Heating Volume*.

**Basis:** This model requirement is based on the description in Section 4.8.3 *Ultrafiltration Process (UFP) System* in 24590-WTP-MDD-PR-01-002, WTP MDD Rev. 13.
3.5.3.24 UFP Feed Vessels (UFP-VSL-00002A/B) - Caustic Leach Heat Time

**Unique ID:** BMR-UFP_MR-48

After the *UFP Feed Vessels (UFP-VSL-00002A/B) - Caustic Leach Heating Steam Condensate Addition* is complete the heating time determined by the *UFP Feed Vessels (UFP-VSL-00002A/B) - Heat Time Equation* shall be applied.

**Basis:** This model requirement is based on the description in Section 4.8.3 *Ultrafiltration Process (UFP) System* in 24590-WTP-MDD-PR-01-002, WTP MDD Rev. 13.

3.5.3.25 UFP Feed Vessels (UFP-VSL-00002A/B) - Caustic Leach Chemical Addition

**Unique ID:** BMR-UFP_MR-14

After the contents of *UFP Feed Vessels (UFP-VSL-00002A/B)* are heated, *19M NaOH* shall be added to perform caustic leaching. The amount of caustic added shall be calculated per *UFP Feed Vessels (UFP-VSL-00002A/B) Caustic Leach Chemical Addition Calculation*.

**Basis:** This model requirement is based on the description in Section 4.8.3 *Ultrafiltration Process (UFP) System* in 24590-WTP-MDD-PR-01-002, WTP MDD Rev. 13.

3.5.3.26 UFP Feed Vessels (UFP-VSL-00002A/B) - Caustic Leach Reactions

**Unique ID:** BMR-UFP_MR-15

After the *caustic leaching* chemical addition is complete, the caustic leach reactions and reaction conversions shall be applied (see *UFP Feed Vessels (UFP-VSL-00002A/B) - Caustic Leach Reactions and Conversions*).

**Basis:** This model requirement is based on the description in Section 4.8.3 *Ultrafiltration Process (UFP) System* in 24590-WTP-MDD-PR-01-002, WTP MDD Rev. 13.

3.5.3.27 UFP Feed Vessels (UFP-VSL-00002A/B) - Caustic Leach Reaction Time

**Unique ID:** BMR-UFP_MR-17

The *caustic leach reaction time* shall be the amount of time required to dissolve the *boehmite (AlOOH)* based on the *Boehmite Kinetic Model* with the following constraints.

- If the *Boehmite Kinetic Model* predicts that no boehmite will be dissolved, or if 99% of the boehmite will be dissolved in less than 4 hours, then the caustic leach reaction time shall be the *UFP Feed Vessels (UFP-VSL-00002A/B) - Caustic Leach Reaction Time Minimum*.

- The time shall not exceed *UFP Feed Vessels (UFP-VSL-00002A/B) - Caustic Leach Reaction Time Maximum*.

**Basis:** This model requirement is based on the description in Section 4.8.3 *Ultrafiltration Process (UFP) System* in 24590-WTP-MDD-PR-01-002, WTP MDD Rev. 13.
3.5.3.28 **UFP Feed Vessels (UFP-VSL-00002A/B) - Caustic Leach Cooling Time**

**Unique ID:** BMR-UFP_MR-16

After the caustic leach reaction time is applied the vessel shall be cooled to the vessel temperature. The vessel cooling is simulated by applying the leach cooling time (see *UFP Feed Vessels (UFP-VSL-00002A/B) - Caustic Leach Cooling Time*).

**Basis:** This model requirement is based on the description in Section 4.8.3 *Ultrafiltration Process (UFP) System* in 24590-WTP-MDD-PR-01-002, WTP MDD Rev. 13.

3.5.3.29 **UFP Feed Vessels (UFP-VSL-00002A/B) - Post Caustic Leach Solubility**

**Unique ID:** BMR-UFP_MR-39

After the caustic leach cooling time has been applied then solubility shall be applied at the vessel temperature.

**Basis:** This requirement is based on Table 6 in 24590-WTP-MDD-PR-01-002, WTP MDD Rev. 13.

3.5.3.30 **UFP Feed Vessels (UFP-VSL-00002A/B) - Post Leach Solids Concentration**

**Unique ID:** BMR-UFP_MR-19

After the post caustic leach solubility has been applied and if the wt.% solids is less then the *UFP Feed Vessels (UFP-VSL-00002A/B) - Post Caustic Leach Solids Concentration Endpoint* then the solids shall be concentrated by removing liquid (permeate) to one of the *UFP Permeate Receipt Vessels (UFP-VSL-00062A/B/C)* until the *UFP Feed Vessels (UFP-VSL-00002A/B) - Post Caustic Leach Solids Concentration Endpoint* has been reached. The permeate shall be removed at the calculated rate - see *UFP Feed Vessels (UFP-VSL-00002A/B) - Filter Flux Rate*.

**Basis:** This requirement is based on the description in Section 4.8.3 *Ultrafiltration Process (UFP) System* in 24590-WTP-MDD-PR-01-002, WTP MDD Rev. 13.

3.5.3.31 **UFP Feed Vessels (UFP-VSL-00002A/B) - Determine if Oxidative Leaching is Required**

**Unique ID:** BMR-UFP_MR-20

Oxidative leaching is required in the *UFP Feed Vessels (UFP-VSL-00002A/B)* if the remaining slurry (after post leach concentration) contains greater than the maximum mass fraction solid chromium (see *UFP Feed Vessels (UFP-VSL-00002A/B) - Oxidative Leach Trigger - Maximum Chromium*).

**Basis:** This requirement is based on the Assumption A1.3.2.8 of the System Plan rev. 8; *ORP-11242, System Plan Rev. 8*. This value is based on the allowable limit for Cr in the melter feed.

3.5.3.32 **UFP Feed Vessels (UFP-VSL-00002A/B) - Solids Wash Forward**

**Unique ID:** BMR-UFP_MR-21

After it has been determined if oxidative leaching is required, solids washing shall proceed. Solids washing shall be performed in two parts: *Wash Forward and Wash Recycle*. The *Wash Forward* occurs first and the steps are as follows:
1. Note the current volume after the post caustic leach solids concentration ($V_r$).

2. Add the UFP Feed Vessels (UFP-VSL-00002A/B) Sawtooth Volume of process condensate (first choice) from the Process Condensate Vessel (RLD-VSL-00006A) if available or Water (second choice).

3. If the UFP Feed Vessels (UFP-VSL-00002A/B) - Solids Washing Chemical Addition End Condition has not been met then apply solubility at the vessel temperature and add 19M NaOH if needed to prevent the formation of gibbsite ($\text{Al(OH)}_3$).

4. Check if the Wash Recycle Criteria or UFP Solids Washing End Points has been met.

5. Decant the wash permeate to UFP Permeate Receipt Vessels (UFP-VSL-00062A/B/C) until the starting volume ($V_r$) at the calculated rate (see UFP Feed Vessels (UFP-VSL-00002A/B) - Filter Flux Rate),

6. If the UFP Solids Washing End Points have been met then washing is complete.

7. If the Wash Recycle Criteria has been met switch to Wash Recycle,

8. Else return to step 2.

**Basis:** This requirement is based on the description in Section 4.8.3 Ultrafiltration Process (UFP) System in 24590-WTP-MDD-PR-01-002, WTP MDD Rev. 13.

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3.5.3.33 UFP Feed Vessels (UFP-VSL-00002A/B) - Solids Wash Recycle

**Unique ID:** BMR-UFP_MR-40

Once the Wash Recycle Criteria has been met then the destination of the wash solution shall be switched to one of the Acidic/Alkaline Effluent Vessels (PWD-VSL-00015 and PWD-VSL-00016). The Wash Recycle shall continue to sawtooth as follows:

1. Add the UFP Feed Vessels (UFP-VSL-00002A/B) Sawtooth Volume of process condensate (first choice) from the Process Condensate Vessel (RLD-VSL-00006A) if available or Water (second choice).

2. If the UFP Feed Vessels (UFP-VSL-00002A/B) - Solids Washing Chemical Addition End Condition has not been met apply solubility at the vessel temperature and 19M NaOH if needed to prevent the formation of gibbsite ($\text{Al(OH)}_3$).

3. Check if the UFP Solids Washing End Points have been met.

4. Decant the wash permeate to Acidic/Alkaline Effluent Vessels (PWD-VSL-00015 and PWD-VSL-00016) until the starting volume ($V_r$) has been met at the calculated rate (see UFP Feed Vessels (UFP-VSL-00002A/B) - Filter Flux Rate),

5. If the UFP Solids Washing End Points have been met then washing is complete.

6. Else return to step 1.

**Basis:** This requirement is based on the description in Section 4.8.3 Ultrafiltration Process (UFP) System in 24590-WTP-MDD-PR-01-002, WTP MDD Rev. 13.
3.5.3.34 UFP Feed Vessels (UFP-VSL-00002A/B) - Oxidative Leaching Chemical Addition

Unique ID: BMR-UFP_MR-37

After the post wash solids concentration and if oxidative leaching is required (see Determine if Oxidative Leaching is Required) then add the following chemical additions.

- Add 1.0M sodium permanganate (NaMnO₄) to the waste until a MnO₄⁻ to solid chromium (total) ratio of 1.1:1 is achieved.
- Add enough 2.0M NaOH so that the [OH⁻] in vessel is above 0.2 M.

Basis: This requirement is based on the description in Section 4.8.3 Ultrafiltration Process (UFP) System in 24590-WTP-MDD-PR-01-002, WTP MDD Rev. 13.

3.5.3.35 UFP Feed Vessels (UFP-VSL-00002A/B) - Oxidative Leaching Reactions

Unique ID: BMR-UFP_MR-22

After the oxidative leach chemicals have been added then the oxidative leach reactions shall be applied at the designated conversions (see UFP Feed Vessels (UFP-VSL-00002A/B) - Oxidative Leach Reactions and Conversions).

Basis: This requirement is based on the description in Section 4.8.3 Ultrafiltration Process (UFP) System in 24590-WTP-MDD-PR-01-002, WTP MDD Rev. 13.

3.5.3.36 UFP Feed Vessels (UFP-VSL-00002A/B) - Oxidative Leaching Reaction Time

Unique ID: BMR-UFP_MR-38

After the oxidative leach reactions have been applied the oxidative leach reaction time (Oxidative Leach Reaction Time) shall be applied.

Basis: This requirement is based on the description in Section 4.8.3 Ultrafiltration Process (UFP) System in 24590-WTP-MDD-PR-01-002, WTP MDD Rev. 13.

3.5.3.37 UFP Feed Vessels (UFP-VSL-00002A/B) - Post Oxidative Leaching - Solubility

Unique ID: BMR-UFP_MR-36

After the oxidative leach reaction time has been applied then solubility shall be applied at the vessel temperature.

Basis: This requirement is based on Table 6 in 24590-WTP-MDD-PR-01-002, WTP MDD Rev. 13.

3.5.3.38 UFP Feed Vessels (UFP-VSL-00002A/B) - Oxidative Leach Washing

Unique ID: BMR-UFP_MR-23

Following oxidative leaching, oxidative leach washing shall be performed and the wash solution is sent to one of the Acidic/Alkaline Effluent Vessels (PWD-VSL-00015 and PWD-VSL-00016). The steps for washing are as follows:

1. Note the current volume after the oxidative leaching (V₀),
2. Add the sawtooth volume of process condensate (first choice) from the Process Condensate Vessel (RLD-VSL-00006A) if available or Water (second choice).

3. Apply solubility at the vessel temperature,

4. Check if the Oxidative Leach Washing Volume has been met,

5. Decant the wash permeate to Acidic/Alkaline Effluent Vessels (PWD-VSL-00015 and PWD-VSL-00016) until the starting volume ($V_{ox}$) has been met at the calculated rate (see UFP Feed Vessels (UFP-VSL-00002A/B) - Filter Flux Rate),

6. If the Oxidative Leach Washing Volume have been met then washing is complete,

7. else go to Step 1.

Basis: This requirement is based on the description in Section 4.8.3 Ultrafiltration Process (UFP) System in 24590-WTP-MDD-PR-01-002, WTP MDD Rev. 13.

3.5.3.39 UFP Feed Vessels (UFP-VSL-00002A/B) - Final Solids Concentration

Unique ID: BMR-UFP_MR-24

After the oxidative leach wash or if oxidative leach was not required, then after the solids washing, the remaining slurry in UFP Feed Vessels (UFP-VSL-00002A/B) shall be concentrated to the Final Solids Concentration Endpoint if the slurry is less than the Final Solids Concentration Endpoint.

Basis: This requirement is based on the description in Section 4.8.3 Ultrafiltration Process (UFP) System in 24590-WTP-MDD-PR-01-002, WTP MDD Rev. 13.

3.5.3.40 UFP Feed Vessels (UFP-VSL-00002A/B) - Final Solids Concentration Permeate Routing

Unique ID: BMR-UFP_MR-51

During the UFP Feed Vessels (UFP-VSL-00002A/B) final solids concentration the permeate shall be transferred to one of the Acidic/Alkaline Effluent Vessels (PWD-VSL-00015 and PWD-VSL-00016) at the calculated rate (see UFP Feed Vessels (UFP-VSL-00002A/B) - Filter Flux Rate).

Basis: This requirement is based on the description in Section 4.8.3 Ultrafiltration Process (UFP) System in 24590-WTP-MDD-PR-01-002, WTP MDD Rev. 13.

3.5.3.41 UFP Feed Vessels (UFP-VSL-00002A/B) - UFP Solids Discharge

Unique ID: BMR-UFP_MR-25

After the final solids concentration the slurry remaining in UFP Feed Vessels (UFP-VSL-00002A/B) shall be sent to one of the HLW Lag Storage Vessel (HLP-VSL-00027A) or the HLW Lag Storage Vessel (HLP-VSL-00027B). The UFP Feed Vessels (UFP-VSL-00002A/B) shall transfer to it's minimum volume at the UFP Feed Vessels (UFP-VSL-00002A/B) - Pump Rate to HLP-VSL-00027A/B.

Basis: This requirement is based on the description in Section 4.8.3 Ultrafiltration Process (UFP) System in 24590-WTP-MDD-PR-01-002, WTP MDD Rev. 13.
3.5.3.42 UFP Feed Vessels (UFP-VSL-00002A/B) - UFP Power Flush

Unique ID: BMR-UFP_MR-26

After the solids discharge, UFP Feed Vessels (UFP-VSL-00002A/B) shall be power flushed with inhibited water as follows:

1. Add the UFP Feed Vessels (UFP-VSL-00002A/B) Inhibited Water Power Flush Volume to UFP Feed Vessels (UFP-VSL-00002A/B),
2. Apply the UFP Feed Vessels (UFP-VSL-00002A/B) Power Flush Wait Time,
3. Transfer the flush solution to HLW Lag Storage Vessel (HLP-VSL-00027A) or HLW Lag Storage Vessel (HLP-VSL-00027B) at the UFP Feed Vessels (UFP-VSL-00002A/B) - Pump Rate to HLP-VSL-00027A/B to the minimum volume.

Basis: This requirement is based on the description in Section 4.8.3 Ultrafiltration Process (UFP) System in 24590-WTP-MDD-PR-01-002, WTP MDD Rev. 13.

3.5.3.43 UFP Feed Vessels (UFP-VSL-00002A/B) - UFP Acid Cleaning

Unique ID: BMR-UFP_MR-27

If after the solids discharge and power flush, the UFP Feed Vessels (UFP-VSL-00002A/B) operating hours is less than the Filter Cleaning Trigger, then UFP Feed Vessels (UFP-VSL-00002A/B) is available to start a new fill cycle, else

If the UFP Feed Vessels (UFP-VSL-00002A/B) operating hours is greater than the Filter Cleaning Trigger, then a filter cleaning sequence shall be initiated as follows:

1. Complete a second UFP Power Flush identical to the pervious one.
2. Add the UFP Feed Vessels (UFP-VSL-00002A/B) Cleaning Acid Volume,
3. Apply the UFP Feed Vessels (UFP-VSL-00002A/B) Acid Cleaning Wait Time,
4. Transfer the contents to one of the Acidic/Alkaline Effluent Vessels (PWD-VSL-00015 and PWD-VSL-00016) at the UFP Feed Vessels (UFP-VSL-00002A/B) - Pump Rate to PWD-VSL-00015/16 for Filter Cleaning until the minimum volume is reached,
5. Add UFP Feed Vessels (UFP-VSL-00002A/B) Heel Neutralization Caustic Volume,
6. Apply the NEUT-REACTION,
7. Apply the UFP Feed Vessels (UFP-VSL-00002A/B) Acid Neutralization Wait Time
8. The UFP Feed Vessels (UFP-VSL-00002A/B) is available to start a new fill cycle.
9. Reset the UFP Feed Vessels (UFP-VSL-00002A/B) operating hour counter.

Basis: This requirement is based on the description in Section 4.8.3 Ultrafiltration Process (UFP) System in 24590-WTP-MDD-PR-01-002, WTP MDD Rev. 13.
3.5.3.44 UFP Feed Vessels (UFP-VSL-00002A/B) - Track Operational Hours

**Unique ID:** BMR-UFP_MR-28

The time which each *UFP Feed Vessels (UFP-VSL-00002A/B)* is operating shall be tracked. The filter operating times include times when *permeate* is being generated which occurs during the following modes (idle times and downtimes should not be included):

- Initial solids concentration,
- Post leach solids concentration,
- Solids washing,
- Oxidative leach solids washing,
- Final solids concentration

**Basis:** This requirement is needed to enable the trigger for filter cleaning which is every 500 hours of operation specified in the description in Section 4.8.3 *Ultrafiltration Process (UFP) System* in 24590-WTP-MDD-PR-01-002, WTP MDD Rev. 13.

3.5.3.45 UFP Feed Vessels (UFP-VSL-00002A/B) - Facility Availability Wait Time

**Unique ID:** BMR-UFP_MR-54

Prior to starting the next fill cycle in *UFP-VSL-00002A/B*, a wait time shall be applied to simulate the effects from facility downtimes. The wait time value is designated in the technical requirement *UFP-VSL-00002A/B - Facility Availability Factor*.

**Basis:** This functional requirement is based on the requirements for PT Facility Availability in DE-AC27-01 RV14136, *WTP/DOE Statement of Work* and the approach documented in RPP-RPT-58581, HTWOS Facility Availability.

3.5.3.46 Track UFP Feed Vessels (UFP-VSL-00002A/B) Cycles

**Unique ID:** BMR-UFP_MR-43

The number of cycles that have occurred in each *UFP Feed Vessels (UFP-VSL-00002A/B)* shall be tracked. A cycle is defined as start of filling in a single *UFP Feed Vessels (UFP-VSL-00002A/B)* to the start of the next filling.

**Basis:** This requirement is needed to enable the trigger for filter cleaning which occurs once in at least every four UFP2 cycles specified in the description in Section 4.8.3 *Ultrafiltration Process (UFP) System* in 24590-WTP-MDD-PR-01-002, WTP MDD Rev. 13.

3.5.3.47 UFP Permeate Receipt Vessels (UFP-VSL-00062A/B/C) Sources

**Unique ID:** BMR-UFP_MR-56

The *UFP Permeate Receipt Vessels (UFP-VSL-00062A/B/C)* shall receive from the following sources:

1. Permeate and wash solution from UFP-VSL-00002A/B - UFP Feed Vessels
2. Displacement waste from CXP-IXC-00001/2/3/4 - Cesium Ion Exchange Columns
3. 19 M NaOH Chemical addition
5. Water for dilution.
Basis: This requirement is based on the description in Section 4.8.3 *Ultrafiltration Process (UFP) System* in 24590-WTP-MDD-PR-01-002, WTP MDD Rev. 13. Note that in TOPSim the three UFP-VSL-00062A/B/C vessels and CXP-VSL-00004 are modeled independently and not as a combined "super tank" as is done in the WTP G2 model. The "super tank" approach would require simultaneous transfers in and out of the vessel which is a limitation of the TOPSim event based platform. For this reason the vessels are modeled independently and assumptions are based on the description in 24590-WTP-MDD-PR-01-002, WTP MDD Rev. 13; however some modifications, based on engineering judgment were required to adopt the "super tank" approach to the individual tanks.

3.5.3.48 UFP Permeate Receipt Vessels (UFP-VSL-00062A/B/C) - Initiate Filling

**Unique ID:** BMR-UFP_MR-30

The *UFP Permeate Receipt Vessels (UFP-VSL-00062A/B/C)* shall initiate filling when the volume is equal to or less than the minimum volume.

Basis: This requirement is based on the description in Section 4.8.3 *Ultrafiltration Process (UFP) System* in 24590-WTP-MDD-PR-01-002, WTP MDD Rev. 13. Note that in TOPSim the three UFP-VSL-00062A/B/C vessels and CXP-VSL-00004 are modeled independently and not as a combined "super tank" as is done in the WTP G2 model. The "super tank" approach would require simultaneous transfers in and out of the vessel which is a limitation of the TOPSim event based platform. For this reason the vessels are modeled independently and assumptions were made based on engineering judgment.

3.5.3.49 UFP Permeate Receipt Vessels (UFP-VSL-00062A/B/C) - Filling Sequence

**Unique ID:** BMR-UFP_MR-29

The *UFP Permeate Receipt Vessels (UFP-VSL-00062A/B/C)* shall fill and empty sequentially with waste (e.g. permeate and wash solution). For example, UFP-VSL-000062A fills, then UFP-VSL-000062B fills, then UFP-VSL-000062C fills.

Basis: This requirement is based on the description in Section 4.8.3 *Ultrafiltration Process (UFP) System* in 24590-WTP-MDD-PR-01-002, WTP MDD Rev. 13. Note that in TOPSim the three UFP-VSL-00062A/B/C vessels and CXP-VSL-00004 are modeled independently and not as a combined "super tank" as is done in the WTP G2 model. The "super tank" approach would require simultaneous transfers in and out of the vessel which is a limitation of the TOPSim event based platform. For this reason the vessels are modeled independently and assumptions were based on the description in 24590-WTP-MDD-PR-01-002, WTP MDD Rev. 13; however some modifications, based on engineering judgment were required to adopt the "super tank" approach to the individual tanks.

3.5.3.50 UFP Permeate Receipt Vessels (UFP-VSL-00062A/B/C) Receipt Constraint

**Unique ID:** BMR-UFP_MR-52

The *UFP Permeate Receipt Vessels (UFP-VSL-00062A/B/C)* shall receive from one source at a time and not receive simultaneous transfers.

Basis: This requirement is based on the description in Section 4.8.3 *Ultrafiltration Process (UFP) System* in 24590-WTP-MDD-PR-01-002, WTP MDD Rev. 13. Note that in TOPSim the three UFP-VSL-00062A/B/C vessels and CXP-VSL-00004 are modeled independently and not
as a combined "super tank" as is done in the WTP G2 model. The "super tank" approach would require simultaneous transfers in and out of the vessel which is a limitation of the TOPSim event based platform. For this reason the vessels are modeled independently and assumptions are based on the description in 24590-WTP-MDD-PR-01-002, WTP MDD Rev. 13; however some modifications, based on engineering judgment were required to adopt the "super tank" approach to the individual tanks.

3.5.3.51 The UFP Permeate Receipt Vessels (UFP-VSL-00062A/B/C) - Receipt from UFP-VSL-00002A/B Intermediate Fill Limit

Unique ID: BMR-UFP_MR-32

Each of the UFP Permeate Receipt Vessels (UFP-VSL-00062A/B/C) shall complete filling from UFP Feed Vessels (UFP-VSL-00002A/B) when it has reached the set volume (Note - other sources are allowed to fill to the upper set volume).

Basis: This requirement is based on the description in Section 4.8.3 Ultrafiltration Process (UFP) System in 24590-WTP-MDD-PR-01-002, WTP MDD Rev. 13. Note that in TOPSim the three UFP-VSL-00062A/B/C vessels and CXP-VSL-00004 are modeled independently and not as a combined "super tank" as is done in the WTP G2 model. The "super tank" approach would require simultaneous transfers in and out of the vessel which is a limitation of the TOPSim event based platform. For this reason the vessels are modeled independently and assumptions are based on the description in 24590-WTP-MDD-PR-01-002, WTP MDD Rev. 13; however some modifications, based on engineering judgment were required to adopt the "super tank" approach to the individual tanks.

3.5.3.52 UFP Permeate Receipt Vessels (UFP-VSL-00062A/B/C) - Receipt from CXP-IXC-00001/2/3/4 Fill Limit

Unique ID: BMR-UFP_MR-55

Receipt of displacement waste from the CXP-IXC-00001/2/3/4 - Cesium Ion Exchange Columns into the UFP Permeate Receipt Vessels (UFP-VSL-00062A/B/C) shall not exceed the upper set volume of the UFP Permeate Receipt Vessels (UFP-VSL-00062A/B/C).

Basis: This requirement is based on the description in Section 4.8.3 Ultrafiltration Process (UFP) System in 24590-WTP-MDD-PR-01-002, WTP MDD Rev. 13. Note that in TOPSim the three UFP-VSL-00062A/B/C vessels and CXP-VSL-00004 are modeled independently and not as a combined "super tank" as is done in the WTP G2 model. The "super tank" approach would require simultaneous transfers in and out of the vessel which is a limitation of the TOPSim event based platform. For this reason the vessels are modeled independently and assumptions are based on the description in 24590-WTP-MDD-PR-01-002, WTP MDD Rev. 13; however some modifications, based on engineering judgment were required to adopt the "super tank" approach to the individual tanks.

3.5.3.53 UFP Permeate Receipt Vessel (UFP-VSL-00062A/B/C) - Dilution and/or Chemical Addition

Unique ID: BMR-UFP_MR-31

Prior to discharge the following iterative logic shall be applied:
1. If the sodium molarity is greater than the UFP Permeate Receipt Vessel (UFP-VSL-00062A/B/C) Target Sodium Molarity than dilute with process condensate (first choice) from the Process Condensate Vessel (RLD-VSL-00006A) if available or Water (second choice) shall be added until the target sodium molarity is achieved or up to the upper set volume.

2. Add 19M NaOH as needed to prevent aluminate (Al(OH)4) precipitation, up to the upper set volume. Note addition volumes less then WTP Minimum Chemical Addition Volume are considered too small and are not required.

3. Apply solubility

4. If the sodium molarity is greater than the UFP Permeate Receipt Vessel (UFP-VSL-00062A/B/C) Target Sodium Molarity and the vessel is less than the upper set volume - repeat, else the chemical adjustment is complete.

Basis: This requirement is based on the description in Section 4.8.3 Ultrafiltration Process (UFP) System and Table 6 in 24590-WTP-MDD-PR-01-002, WTP MDD Rev. 13. Note that in TOPSim the three UFP-VSL-00062A/B/C vessels and CXP-VSL-00004 are modeled independently and not as a combined "super tank" as is done in the WTP G2 model. The "super tank" approach would require simultaneous transfers in and out of the vessel which is a limitation of the TOPSim event based platform. For this reason the vessels are modeled independently and assumptions are based on the description in 24590-WTP-MDD-PR-01-002, WTP MDD Rev. 13; however some modifications, based on engineering judgment were required to adopt the "super tank" approach to the individual tanks.

3.5.3.54 UFP Permeate Receipt Vessels (UFP-VSL-00062A/B/C) - Discharge

Unique ID: BMR-UFP_MR-33

Once the chemical adjustment is complete, the UFP Permeate Receipt Vessels (UFP-VSL-00062A/B/C) shall transfer to the Cesium Ion Exchange Feed Vessel (CXP-VSL-00004) at the vessel pump rate until its minimum volume is reached (note the Cesium Ion Exchange Feed Vessel (CXP-VSL-00004) vessel is able to simultaneously receive and transfer).

Basis: This requirement is based on the description in Section 4.8.3 Ultrafiltration Process (UFP) System in 24590-WTP-MDD-PR-01-002, WTP MDD Rev. 13. Note that in TOPSim the three UFP-VSL-00062A/B/C vessels and CXP-VSL-00004 are modeled independently and not as a combined "super tank" as is done in the WTP G2 model. The "super tank" approach would require simultaneous transfers in and out of the vessel which is a limitation of the TOPSim event based platform. For this reason the vessels are modeled independently and assumptions are based on the description in 24590-WTP-MDD-PR-01-002, WTP MDD Rev. 13; however some modifications, based on engineering judgment were required to adopt the "super tank" approach to the individual tanks.

3.5.3.55 UFP Feed Vessels (UFP-VSL-00002A/B) - Post Wash Solids Concentration

Unique ID: BMR-UFP_MR-53

After the solids washing and if the wt.% solids is less then the UFP-VSL-00002A/B - Post Wash Solids Concentration Endpoint then the solids shall be concentrated by removing liquid (permeate) to one of the UFP Permeate Receipt Vessels (UFP-VSL-00062A/B/C) until the
**UFP-VSL-00002A/B - Post Wash Solids Concentration Endpoint** has been reached. The permeate shall be removed at the calculated rate - see **UFP Feed Vessels (UFP-VSL-00002A/B) - Filter Flux Rate**.

**Basis:** This requirement is based on the description in Section 4.8.3 *Ultrafiltration Process (UFP)* System in 24590-WTP-MDD-PR-01-002, WTP MDD Rev. 13.

### 3.5.3.56 UFP Feed Vessels (UFP-VSL-00002A/B) - UFP Feed Vessels Solids Removal

**Unique ID:** BMR-UFP_MR-34

The **UFP Feed Vessels (UFP-VSL-00002A/B)** shall remove solids at the **UFP-VSL-00002A/B - UFP Feed Vessels Solids Removal Efficiency**.

**Basis:** This requirement is based on the description in Section 4.8.3 *Ultrafiltration Process (UFP)* System in 24590-WTP-MDD-PR-01-002, WTP MDD Rev. 13.

### 3.5.4 Technical Requirements

#### 3.5.4.1 UFP Feed Preparation Vessel (UFP-VSL-00001A/B) Parameters

**Unique ID:** BMR-UFP_TR-1

The **UFP Feed Preparation Vessels (UFP-VSL-00001A/B)** shall have the following parametric values.

<table>
<thead>
<tr>
<th>Vessel #</th>
<th>Maximum Volume (gal)</th>
<th>Upper Set Volume (gal)</th>
<th>Set Volume (gal)</th>
<th>Minimum Volume (gal)</th>
<th>Flow Rate (gpm)</th>
<th>Temperature (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>UFP-VSL-00001A</td>
<td>64,373</td>
<td>52,704</td>
<td>28,300</td>
<td>7,704</td>
<td>140</td>
<td>45</td>
</tr>
<tr>
<td>UFP-VSL-00001B</td>
<td>64,373</td>
<td>52,704</td>
<td>28,300</td>
<td>7,704</td>
<td>140</td>
<td>45</td>
</tr>
</tbody>
</table>

**Basis:** The vessel parameters are based on *Table B-1; Facility Item Database*, in 24590-WTP-RPT-PT-02-005, BARD Rev. 8; however the set volume is based on the fill volume noted in 2.3.4.2 Baseline Back-End Caustic Leaching G2 Model Parameters (also consistent with the 24590-WTP-MDD-PR-01-002, WTP MDD). The temperature is based on the value for the super tank solubility application in *Table 6, Solubility Application* in the 24590-WTP-MDD-PR-01-002, WTP MDD.

#### 3.5.4.2 UFP Feed Vessel (UFP-VSL-00002A/B) Parameters

**Unique ID:** BMR-UFP_TR-2

The **UFP Feed Vessels (UFP-VSL-00002A/B)** shall have the following parametric values.

<table>
<thead>
<tr>
<th>Vessel #</th>
<th>Maximum Volume (gal)</th>
<th>Upper Set Volume (gal)</th>
<th>Upper Sawtooth Volume (gal)</th>
<th>Set Volume (lower sawtooth volume)</th>
<th>Minimum Volume (gal)</th>
<th>Flow Rate (gpm)</th>
<th>Temp. (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
To calculate the flux rate, during filter use, the flow rate must be calculated.

To HLP-VSL-00027A or B = 55 gpm
To PWD-VSL-00015 & 16 during filter cleaning = 94 gpm

<table>
<thead>
<tr>
<th>Vessel #</th>
<th>Maximum Volume (gal)</th>
<th>Upper Set Volume (gal)</th>
<th>Set Volume (gal)</th>
<th>Minimum Volume (gal)</th>
<th>Flow rate (gpm)</th>
<th>Temperature (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>UFP-VSL-00062A</td>
<td>29,993</td>
<td>25,105</td>
<td>12,000</td>
<td>3,305</td>
<td>70</td>
<td>45</td>
</tr>
<tr>
<td>UFP-VSL-00062B</td>
<td>29,993</td>
<td>25,105</td>
<td>12,000</td>
<td>3,305</td>
<td>70</td>
<td>45</td>
</tr>
<tr>
<td>UFP-VSL-00062C</td>
<td>29,993</td>
<td>25,105</td>
<td>12,000</td>
<td>3,305</td>
<td>70</td>
<td>45</td>
</tr>
</tbody>
</table>

*Flow rate is dependent on mode of operation and flux rate and is identified within the model requirements.

**Basis:** The vessel parameters are based on Table B-1: Facility Item Database, in 24590-WTP-RPT-PT-02-005, BARD Rev. 8; however, the minimum and set volumes are based on the fill volume noted in 2.3.4.2 Baseline Back-End Caustic Leaching G2 Model Parameters and 24590-WTP-MDD-PR-01-002, WTP MDD. The temperature is based on the value for the super tank solubility application in Table 6, Solubility Application in the 24590-WTP-MDD-PR-01-002, WTP MDD.

### 3.5.4.3 UFP Permeate Receipt Vessels (UFP-VSL-00062A/B/C) Parameters

**Unique ID:** BMR-UFP_TR-3

The *UFP Permeate Receipt Vessels (UFP-VSL-00062A/B/C)* shall have the following parametric values.

<table>
<thead>
<tr>
<th>Vessel #</th>
<th>Maximum Volume (gal)</th>
<th>Upper Set Volume (gal)</th>
<th>Set Volume (gal)</th>
<th>Minimum Volume (gal)</th>
<th>Flow rate (gpm)</th>
<th>Temperature (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>UFP-VSL-00062A</td>
<td>29,993</td>
<td>25,105</td>
<td>12,000</td>
<td>3,305</td>
<td>70</td>
<td>45</td>
</tr>
<tr>
<td>UFP-VSL-00062B</td>
<td>29,993</td>
<td>25,105</td>
<td>12,000</td>
<td>3,305</td>
<td>70</td>
<td>45</td>
</tr>
<tr>
<td>UFP-VSL-00062C</td>
<td>29,993</td>
<td>25,105</td>
<td>12,000</td>
<td>3,305</td>
<td>70</td>
<td>45</td>
</tr>
</tbody>
</table>

**Basis:** Volumes are from the BARD (24590-WTP-RPT-PT-02-005, BARD Rev. 8) and MDD (24590-WTP-MDD-PR-01-002, WTP MDD Rev. 13). The upper set volume is the batch volume from the BARD plus the minimum volume (21,800 + 3,305 = 25,105 gal). The set volume is the volume listed in the MDD as the set point for the combined "super-tank" and gives headspace for dilution and caustic addition.
3.5.4.4 UFP Feed Vessels (UFP-VSL-00002A/B) - Pump Rate to HLP-VSL-00027A/B

Unique ID: BMR-UFP_TR-27

The pump-out rate of UFP Feed Vessels (UFP-VSL-00002A/B) to either HLW Lag Storage Vessel (HLP-VSL-00027A) or HLW Lag Storage Vessel (HLP-VSL-00027B) shall be 55 gpm.

Basis: The pump out rate is based on the Non-Newtonian fluid rate for UFP2 given in Section 4.8.3 Ultrafiltration Process (UFP) System in 24590-WTP-MDD-PR-01-002, WTP MDD Rev. 13.

3.5.4.5 UFP Feed Vessels (UFP-VSL-00002A/B) - Pump Rate to PWD-VSL-00015/16 for Filter Cleaning

Unique ID: BMR-UFP_TR-28

The pump out rate of UFP Feed Vessels (UFP-VSL-00002A/B) to either of the Acidic/Alkaline Effluent Vessels (PWD-VSL-00015 and PWD-VSL-00016) shall be 94 gpm during filter cleaning operations.

Basis: The pump out rate is based on the Newtonian fluid rate for UFP2 given in Section 4.8.3 Ultrafiltration Process (UFP) System in 24590-WTP-MDD-PR-01-002, WTP MDD Rev. 13.

3.5.4.6 UFP Feed Preparation Vessels (UFP-VSL-00001A/B) - Feed Blending Weight Percent Solids Goal

Unique ID: BMR-UFP_TR-4

The feed blending weight percent solids goal for the UFP Feed Preparation Vessels (UFP-VSL-00001A/B) shall be 7.0 %.

Basis: The feed blending weight percent solids goal is based on the steps in Section 2.3.4.2 Baseline Back-End Caustic Leaching G2 Model Parameters in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

3.5.4.7 UFP Feed Preparation Vessels (UFP-VSL-00001A/B) Blending Equation

Unique ID: BMR-UFP_TR-20

The UFP Feed Preparation Vessels (UFP-VSL-00001A/B) Blending Equation:(equation is mathematically derived and is simplified by assuming volumes are additive)

If \( WPCT_{HLW} < WPCT_{goal} \) then \( V_{HLW} = V_{set} - V_{heel} \) and \( V_{LAW} = 0 \)

Else

\[
V_{HLW} = \left( \frac{WPCT_{goal} - WPCT_{Law}}{WPCT_{Law} - WPCT_{heel}} \right) \times V_{set} + \left( \frac{WPCT_{Law} - WPCT_{heel}}{WPCT_{Law} - WPCT_{heel}} \right) \times V_{heel}
\]

\[
V_{LAW} = V_{set} - V_{HLW} - V_{heel}
\]

Where:

\( V_{HLW} \) = Volume contribution from the HLW feed (gal)
\[ V_{\text{LAW}} = \text{Volume contribution from the LAW feed (gal)} \]
\[ V_{\text{set}} = \text{Set volume of UFP1 (gal)} \]
\[ V_{\text{heel}} = \text{Heel volume of UFP1(gal)} \]
\[ WPCT_{\text{goal}} = \text{Feed blending wt\% solid goal} \]
\[ WPCT_{\text{LAW}} = \text{wt\% LAW} \]
\[ WPCT_{\text{HLW}} = \text{wt\% HLW} \]

**Basis:** This requirement is based on Equations 26 and 27 in Section 4.8.3 Ultrafiltration Process (UFP) System in 24590-WTP-MDD-PR-01-002, WTP MDD Rev. 12.

### 3.5.4.8 UFP Feed Preparation Vessels (UFP-VSL-00001A/B) Heating Volume Equation

**Unique ID:** BMR-UFP_TR-21

The UFP Feed Preparation Vessels (UFP-VSL-00001A/B) heating steam condensate volume shall be determined by equation numbers 26 in the WTP MDD (25490-WTP-MDD-PR-01-002, Rev. 13) which is given below:

\[ V_{\text{water}} = 2.540 \times \left( \frac{V_{\text{feed}}}{49.562} \right) \]

Where:
\[ V_{\text{water}} = \text{Volume of water which simulates the condensate in gallons added for heating the vessel to 45°C} \]
\[ V_{\text{feed}} = \text{Volume of tank contents} \]

**Basis:** This requirement is based on Equation 26 in Section 4.8.3 Ultrafiltration Process (UFP) System in 24590-WTP-MDD-PR-01-002, WTP MDD Rev. 13.

### 3.5.4.9 UFP Feed Preparation Vessels (UFP-VSL-00001A/B) Heating Time Equation

**Unique ID:** BMR-UFP_TR-24

The UFP Feed Preparation Vessels (UFP-VSL-00001A/B) heat time shall be determined by equation number 27 in the WTP MDD (25490-WTP-MDD-PR-01-002, Rev. 13) which is given below:

\[ t_{\text{heat}} = 3.0 \times \left( \frac{V_{\text{feed}}}{49.562} \right) \]

Where:
\[ V_{\text{feed}} = \text{Volume of tank contents} \]
\[ t_{\text{heat}} = \text{Time in hours required to heat the vessel} \]

**Basis:** This requirement is based on Equation 27 in Section 4.8.3 Ultrafiltration Process (UFP) System in 24590-WTP-MDD-PR-01-002, WTP MDD Rev. 13.

### 3.5.4.10 UFP Feed Vessels (UFP-VSL-00002A/B) - UFP Feed Vessels Solids Removal Efficiency

**Unique ID:** BMR-UFP_TR-41

The solids removal efficiency of the UFP Feed Vessels (UFP-VSL-00002A/B) is 99.99\% (i.e. 0.01 percent of the solids are transferred out with the permeate and wash solution during solids concentration and washing).

**Basis:** This model requirement is based on the description in Section 2.3.5.2.2 Solids Removal Efficiency in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

### 3.5.4.11 UFP Feed Vessels (UFP-VSL-00002A/B) - Initial Solids Concentration Endpoint

**Unique ID:** BMR-UFP_TR-13

The initial solids concentration endpoint shall be greater than or equal to 20 wt\%.

**Basis:** This requirement is based on the description in Section 4.8.3 Ultrafiltration Process (UFP) System in 24590-WTP-MDD-PR-01-002, WTP MDD Rev. 13.

### 3.5.4.12 UFP Feed Vessels (UFP-VSL-00002A/B) - Sawtooth Volume

**Unique ID:** BMR-UFP_TR-29

The UFP Feed Vessels (UFP-VSL-00002A/B) sawtooth volume is 1000 gallons.

**Basis:** This requirement is based on the description in Section 4.8.3 Ultrafiltration Process (UFP) System in 24590-WTP-MDD-PR-01-002, WTP MDD Rev. 13.

### 3.5.4.13 UFP Feed Vessels (UFP-VSL-00002A/B) - Filter Flux Rate

**Unique ID:** BMR-UFP_TR-40

The UFP Feed Vessels (UFP-VSL-00002A/B) rate of discharge to UFP Permeate Receipt Vessels (UFP-VSL-00062A/B/C) or flux rate depends on the mode of operation, temperature, weight percent solids, sodium molarity and effective filter area. The maximum rate through the filters is 115 gpm and the minimum is 1 gpm.

\[
F = A_{\Delta t} \cdot O_{r} \cdot \left[ \exp\left(0.445 \cdot 5\right) \right] \cdot \left\{ \frac{1}{\exp\left(0.445 \cdot C_{Na}\right)} \cdot \exp\left[\frac{1}{2500 \cdot \left(\frac{1}{T_{K}} - \frac{1}{298}\right)}\right] \right\}
\]

**Where:**
F = Filter flux per train (gpm)
A_{eff} = Effective filter area per train 1,451 (ft^2)
C_{Na} = Sodium molarity (gmol/liter)
T_K = Operating temperature (K)
O_F = Operation Factor (gpm/ft^2)
X = Weight percent solids (kg solids /kg slurry)

For solids concentration before caustic leaching:
\[
O_F = 0.014
\]
For solids re-concentration after caustic leaching:
\[
O_F = \frac{2.1 \times 10^{-4}}{X^{1.5}} + 0.0112
\]
For solid wash including wash forward and wash recycle:
\[
O_F = 0.012
\]
For oxidative wash:
\[
O_F = 0.008
\]

**Basis:** This requirement is based on the Equations 28-32 in Section 4.8.3 Ultrafiltration Process (UFP) System of 24590-WTP-MDD-PR-01-002, WTP MDD Rev. 13.

3.5.4.14 UFP Feed Receipt Vessel (UFP-VSL-00002A/B) - Sample Time

**Unique ID:** BMR-UFP_TR-18

The sample time for UFP Feed Vessels (UFP-VSL-00002A/B) is 14.0 hours.

**Basis:** This requirement is based on the description in Section 4.8.3 Ultrafiltration Process (UFP) System in 24590-WTP-MDD-PR-01-002, WTP MDD Rev. 13.

3.5.4.15 UFP Feed Vessels (UFP-VSL-00002A/B) - Heat Steam Condensate Volume

**Unique ID:** BMR-UFP_TR-22

The UFP Feed Vessels (UFP-VSL-00002A/B) heating steam condensate volume shall be calculated using equation number 33 in the WTP MDD (25490-WTP-MDD-PR-01-002, Rev. 13) which is given below.

\[
V_{Steam\ Condensate} = 5000 \times \left( \frac{(V_{feed} + 4.870)}{24.500} \right) + 400
\]

Where:

\[
V_{Steam\ Condensate} = \text{Volume of steam condensate (water) in gallons added for heating the vessel to 85°C}
\]

\[
V_{feed} = \text{Volume of tank contents}
\]
Basis: This requirement is based on Equation 33 in Section 4.8.3 Ultrafiltration Process (UFP) System of 24590-WTP-MDD-PR-01-002, WTP MDD Rev. 13. The additional 400 gallons is the amount of steam condensate added to maintain temperature during the caustic leach reaction time and is documented in 24590-WTP-MDD-PR-01-002, WTP MDD Rev. 11.

3.5.4.16 UFP Feed Vessels (UFP-VSL-00002A/B) - Heat Time Equation

Unique ID: BMR-UFP_TR-25

The UFP Feed Vessels (UFP-VSL-00002A/B) heating time shall be calculated using equations number 34 in the WTP MDD (24590-WTP-MDD-PR-01-002, Rev. 13) which is given below:

\[ t_{\text{heat}} = 6 \times \left( \frac{V_{\text{feed}} + 4,870}{24,500} \right) \]

Where:

- \( V_{\text{feed}} \) = Volume of tank contents
- \( t_{\text{heat}} \) = Time in hours required to heat the vessel

Basis: This requirement is based on Equation 34 in Section 4.8.3 Ultrafiltration Process (UFP) System of 24590-WTP-MDD-PR-01-002, WTP MDD Rev. 13.

3.5.4.17 UFP Feed Vessels (UFP-VSL-00002A/B) - Caustic Leach Temperature

Unique ID: BMR-UFP_TR-23

The UFP Feed Vessels (UFP-VSL-00002A/B) caustic leach temperature is 85 °C.

Basis: This requirement is based on the description in Section 4.8.3 Ultrafiltration Process (UFP) System in 24590-WTP-MDD-PR-01-002, WTP MDD Rev. 13.

3.5.4.18 UFP Feed Vessels (UFP-VSL-00002A/B) - Caustic Leach Chemical Addition Calculation

Unique ID: BMR-UFP_TR-26

The amount of 19M NaOH to add for caustic leaching in UFP Feed Vessels (UFP-VSL-00002A/B) shall be calculated as follows:

1. Determine the kg-moles of OH required to theoretically dissolve all of the gibbsite (Al(OH)3) and boehmite (AlOOH) using the equations;
   a. 101B-R1 (1.0 Al(OH)3(s) + 1.0 OH-(l) \rightarrow 1.0 Al(OH)4-(l))
   b. BOEHMITE-DISSOLUTION (1.0 AlOOH(s) + 1.0 OH-(l) + 1.0 H2O(l) \rightarrow 1.0 Al(OH)4-(l))
   c. Use solubility to determine the additional amount of NaOH required to keep the aluminum in solution at 45 °C, including the caustic and dissolved aluminum from step 1.
2. Include an additional 10%.
3.5.4.19 UFP Feed Vessels (UFP-VSL-00002A/B) - Caustic Leach Reactions and Conversions

Unique ID: BMR-UFP_TR-16

The following reactions and conversions define the Caustic Leach Reactions and shall be executed in the order listed.

<table>
<thead>
<tr>
<th>Rx#</th>
<th>Reaction</th>
<th>Conversion (fraction)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1.0 Bi+3(s) + 3.0 OH-(l) → 1.0 Bi+3(l) + 3.0 OH-(l)</td>
<td>Per solubility</td>
</tr>
<tr>
<td>2</td>
<td>1.0 Ca+2(s) + 2.0 OH-(l) → 1.0 Ca+2(l) + 2.0 OH-(l)</td>
<td>Per solubility</td>
</tr>
<tr>
<td>3</td>
<td>1.0 Fe+3(s) + 3.0 OH-(l) → 1.0 Fe+3(l) + 3.0 OH-(l)</td>
<td>Per solubility</td>
</tr>
<tr>
<td>4</td>
<td>1.0 Si+4(s) + 4.0 OH-(l) → 1.0 Si+4(l) + 4.0 OH-(l)</td>
<td>Per solubility</td>
</tr>
<tr>
<td>5</td>
<td>1.0 $^{232}$U(s) + 2.0 OH-(l) → 1.0 $^{232}$U(l) + 2.0 OH-(l)</td>
<td>Per solubility</td>
</tr>
<tr>
<td>6</td>
<td>1.0 $^{233}$U(s) + 2.0 OH-(l) → 1.0 $^{233}$U(l) + 2.0 OH-(l)</td>
<td>Per solubility</td>
</tr>
<tr>
<td>7</td>
<td>1.0 $^{234}$U(s) + 2.0 OH-(l) → 1.0 $^{234}$U(l) + 2.0 OH-(l)</td>
<td>Per solubility</td>
</tr>
<tr>
<td>8</td>
<td>1.0 $^{235}$U(s) + 2.0 OH-(l) → 1.0 $^{235}$U(l) + 2.0 OH-(l)</td>
<td>Per solubility</td>
</tr>
<tr>
<td>9</td>
<td>1.0 $^{236}$U(s) + 2.0 OH-(l) → 1.0 $^{236}$U(l) + 2.0 OH-(l)</td>
<td>Per solubility</td>
</tr>
<tr>
<td>10</td>
<td>1.0 $^{238}$U(s) + 2.0 OH-(l) → 1.0 $^{238}$U(l) + 2.0 OH-(l)</td>
<td>Per solubility</td>
</tr>
<tr>
<td>11</td>
<td>1.0 SO$_4^{2-}$(s) + 2.0 Na+(s) → 1.0 SO$_4^{2-}$(l) + 2.0 Na+(l)</td>
<td>Per solubility</td>
</tr>
<tr>
<td>12</td>
<td>2.0 CrOOH(s) + 3.0 NO$_3^-$(l) + 4.0 OH-(l) → 2.0 CrO$_4^{2-}$(l) + 3.0 NO$_2^-$ (l) + 3.0 H$_2$O(l)</td>
<td>Leach factor</td>
</tr>
<tr>
<td>13</td>
<td>1.0 Na+(s) + 1.0 OH-(l) → 1.0 Na+(l) + 1.0 OH-(l)</td>
<td>Per solubility</td>
</tr>
<tr>
<td>14</td>
<td>1.0 PO$_4^{3-}$(s) + 3.0 Na+(s) → 1.0 PO$_4^{3-}$(l) + 3.0 Na+(l)</td>
<td>Per solubility</td>
</tr>
<tr>
<td>15</td>
<td>1.0 Al(OH)$_3$(s) + 1.0 OH-(l) → Al(OH)$_4$ (l)</td>
<td>Per solubility</td>
</tr>
<tr>
<td>16</td>
<td>1.0 AlOOH(s) + 1.0 OH-(l) + 1.0 H$_2$O(l) → Al(OH)$_4$ (l)</td>
<td>Per Boehmite Model</td>
</tr>
</tbody>
</table>

Basis: This requirement is based on the description in Section 4.8.3 Ultrafiltration Process (UFP) System in 24590-WTP-MDD-PR-01-002, WTP MDD Rev. 13 and adjusted for the TOPSim components.

3.5.4.20 UFP - Boehmite Kinetic Model

Unique ID: BMR-UFP_TR-43

The boehmite kinetic model predicts the amount of boehmite (AlOOH) that is leached by the following rate equation.

$$\frac{dM(t)}{dt} = -A_0 \exp(-\frac{E_a}{R} \cdot \frac{T(t)}{1+T(t)}) M(t)^{2/3} (OH - [M_o (1 - M(t))])^n \times \left(1 - \frac{C + [M_o (1 - M(t))]}{a \cdot C_{sat}}\right)$$

Where:
M(t) = fraction of boehmite yet to dissolve

M₀ = contribution of boehmite to the aqueous aluminate concentration if all the initial boehmite were to dissolve (mol/L)

A₀ = pre-exponential rate constant \([1.5063E+07 \text{L}^{0.21}/(\text{mole}^{0.21} \text{hr})]\)

Eₐ = activation energy (60 kJ/mole)

R = ideal gas constant (8.314 J/mole*K)

T = temperature (85 C)

OH = initial molar concentration of hydroxide in solution

N = coefficient (0.21)

C = total concentration of aluminate in solution (mole/L)

C_{Sat} = boehmite equilibrium concentration of aluminate in solution (mole/L)

a = correction factor to C_{Sat} to better represent the equilibrium in Hanford waste (1.12)

\[
C_{Sat} = \frac{C_{Na_2O} \times 2}{MW_{Al(OH)_4}}
\]

\[
C_{Al(OH)_3} = A₁ \times 10^{-6} \times T_c^2 + A₂ \times 10^{-3} \times T_c^2 + A₃ \times 10^{-2} \times T_c + A₄
\]

\[
C_{Na_2O} = \frac{C_{OH} \times MW_{Na_2O}}{2}
\]

Where:

A₁ = -0.0618925*C_{Na_2O} + 1.36953

A₂ = 0.02301*C_{Na_2O} + 0.1707

A₃ = 2.498E-6*C_{Na_2O}³ - 3.106E-4*C_{Na_2O}² + 5.483E-2*C_{Na_2O} - 1.332

A₄ = 3.236E-6*C_{Na_2O}³ - 7.887E-4*C_{Na_2O}² + 0.1584*C_{Na_2O} - 2.518

T_c = Temperature (85 C)
Basis: The boehmite rate equation is based on Equation 20 in RPP-RPT-49389, Comparison of Boehmite Caustic Leach Models which is the expanded version of Equation 1.3-26 in 24590-WTP-RPT-PT-02-005, BARD Rev. 8. The expanded version accounts for changes in hydroxide and aqueous aluminum concentrations due to boehmite dissolution.

3.5.4.21 UFP Feed Vessels (UFP-VSL-00002A/B) - Caustic Leach Reaction Time Maximum

Unique ID: BMR-UFP_TR-5

The maximum caustic reaction time shall be 16 hours.

Basis: This requirement is based on the description in Section 2.3.2.2 Back-End Caustic Leaching in Ultrafiltration Feed Vessels (Baseline) in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

3.5.4.22 UFP Feed Vessels (UFP-VSL-00002A/B) - Caustic Leach Reaction Time Minimum

Unique ID: BMR-UFP_TR-44

The minimum reaction time is 4 hours.

Basis: This requirement is based on the description in Section 2.3.2.2 Back-End Caustic Leaching in Ultrafiltration Feed Vessels (Baseline) in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

3.5.4.23 UFP Feed Vessels (UFP-VSL-00002A/B) - Caustic Leach Cooling Time

Unique ID: BMR-UFP_TR-6

The caustic leach cooling time is 22 hours.

Basis: This requirement is based on the description in Section 4.8.3 Ultrafiltration Process (UFP) System in 24590-WTP-MDD-PR-01-002, WTP MDD Rev. 13.

3.5.4.24 UFP Feed Vessels (UFP-VSL-00002A/B) - Post Caustic Leach Solids Concentration Endpoint

Unique ID: BMR-UFP_TR-14

The post caustic leach solids concentration endpoint shall be greater than or equal to 20 wt%.

Basis: This requirement is based on the description in Section 4.8.3 Ultrafiltration Process (UFP) System in 24590-WTP-MDD-PR-01-002, WTP MDD Rev. 13.

3.5.4.25 UFP Feed Vessels (UFP-VSL-00002A/B) - Oxidative Leach Trigger - Maximum Chromium

Unique ID: BMR-UFP_TR-7

The maximum post-leach mass fraction of solid chromium is 0.005.

Basis: This value is based on the allowable limit for Cr in the melter feed stated in Section 2.3.5.6.1 in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.
3.5.4.26 UFP Feed Vessels (UFP-VSL-00002A/B) - Solids Washing Chemical Addition End Condition

**Unique ID:** BMR-UFP_TR-39

The chemical addition during solids washing to prevent aluminum precipitation shall stop, once at least 92% of the starting aluminate \((\text{Al(OH)}_4^-)\) has been washed out.

**Basis:** This requirement is based on the description in Section 4.8.3 Ultrafiltration Process (UFP) System in 24590-WTP-MDD-PR-01-002, WTP MDD Rev. 13.

3.5.4.27 UFP Feed Vessels (UFP-VSL-00002A/B) - UFP Solids Washing End Points

**Unique ID:** BMR-UFP_TR-38

1. If oxidative leaching is required then the solids washing continues until the \([\text{OH}^-] \leq 0.25M\)

2. If oxidative leaching is not required then the solids washing volume is determined by the following equation:

\[
2.8 \times V_{\text{slurry}} \leq \text{total wash volume} \leq V_{\text{max}}.
\]

Where:

- \(V_{\text{slurry}}\) is the slurry volume at the end of post leach solids concentration (gal) and
- \(V_{\text{max}}\) is the Maximum wash volume (gal).

If the batch is phosphate limiting then (see Phosphate Limiting Determination):

\[
V_{\text{max}} = \text{least of } \{(4.5 \times V_{\text{slurry}}), (\text{volume to dilute to } 0.25M [\text{OH}^-]), (\text{volume to dilute to } 0.1 \times \text{peak } [\text{PO}_4^{3-}])\}
\]

If the batch is not phosphate limiting then (see Phosphate Limiting Determination):

\[
V_{\text{max}} = \text{least of } \{(4.5 \times V_{\text{slurry}}), (\text{volume to dilute to } 0.25M [\text{OH}^-])\}
\]

**Basis:** This requirement is based on the description in Section 4.8.3 Ultrafiltration Process (UFP) System in 24590-WTP-MDD-PR-01-002, WTP MDD Rev. 13.

3.5.4.28 UFP Feed Vessels (UFP-VSL-00002A/B) - Wash Recycle Criteria

**Unique ID:** BMR-UFP_TR-8

The wash recycle criteria met when all of the following conditions are met:

- \([\text{Na}^+] < 3.8M\) and,
- \([\text{Na}^+] < 0.5 \times \text{sodium concentration at end of post leach solids concentration and,}\)
- \([\text{PO}_4^{3-}] < 0.4 \times \text{peak liquid phosphate concentration and,}\)
- \([\text{C}_2\text{O}_4^{2-}] < 0.4 \times \text{peak liquid oxalate concentration}\)

Note - The peak concentration of the species in the liquid may not necessarily occur at the start of washing.

**Basis:** This requirement is based on the description in Section 4.8.3 Ultrafiltration Process (UFP) System in 24590-WTP-MDD-PR-01-002, WTP MDD Rev. 13.
3.5.4.29  UFP Feed Vessels (UFP-VSL-00002A/B) - Phosphate Limiting Determination

**Unique ID:** BMR-UFP_TR-9

The logic on page 58 of *WTP MDD (25490-WTP-MDD-PR-01-002, Rev. 13)* will be used to determine if a batch will form phosphate limiting *IHLW* glass. The equation is presented below.

\[
EG-P = (PO_4(s) + PO_4(l)) \times 70.97 / BC-P_2O_5 \\
EG-0 = MAX(Fe \times 79.84 / MAX(BC-FE_2O_3, 0.1375), \\
Zr \times 123.22 / BC-ZrO_2, \\
U(Total) \times 280.69 / BC-U_3O_8 \\
*Th+*6 5.03 / BC-ThO_2 \\
Ca *56.07 / BC-CaO, \\
Ni *74.69 / BC-NiO, \\
Pb *223.19 / BC-PbO_2, \\
Bi *232.97 / BC-Bi_2O_3, \\
F * 18.99 / BC-F, \\
SO_4 * 80.06 / BC-SO_3, \\
(Na - (2 * C_2O_4(s) * PTWF-C_2O_4)) \times 30.98 + K*47.09) \times BC-Na_2O, \\
(A1(s)) * 50.98 / BC-A1_2O_3, \\
(Cr(s) + Cr(1)) * 75.99 / BC-Cr_2O_3),
\]

IF \( EG-P > 1.01 \times EG-0 \) and \( PO_4(s) > 0.01 \times PO_4(s)*(1-LFPO_4) \),

Then,

Phosphate limited glass = true

Else,

Phosphate limited glass = false

where:

- EG-P is the estimated glass produced from phosphate (kg glass).
- EG-0 is the estimated glass produced from other wastes in solids (kg glass).
- Individual component quantities units are in kmol.
- BC-\( i \) is the HLW glass oxide limiting value set as weight fraction units, not wt%.
- BC-\( i \) coefficients are given in *UFP Feed Vessel (UFP-VSL-00002A/B) Bounding Condition Coefficients*.
- Multiplier values are in kg oxide / kmol element
- PTWF-C_2O_4 is a wash factor for solid oxalate in pretreatment and is equal to 1.
- LFPO_4 is the leach factor for phosphate (unitless).
**Basis:** This requirement is based on the description in Section 4.8.3 Ultrafiltration Process (UFP) System in 24590-WTP-MDD-PR-01-002, WTP MDD Rev. 13.

### 3.5.4.30 UFP Feed Vessel (UFP-VSL-00002A/B) - Bounding Condition Coefficients

**Unique ID:** BMR-UFP_TR-19

The bounding condition constraints for use in UFP Feed Vessels (UFP-VSL-00002A/B) - Phosphate Limiting Determination are as follows:

#### Bounding Condition Coefficients

<table>
<thead>
<tr>
<th>Condition (i)</th>
<th>Upper Limit, Weight Fraction</th>
<th>Condition (i)</th>
<th>Upper Limit, Weight Fraction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Al₂O₃</td>
<td>0.2</td>
<td>NiO</td>
<td>0.03</td>
</tr>
<tr>
<td>Bi₂O₃</td>
<td>0.032</td>
<td>PdO+Rh₂O₃+RuO₂</td>
<td>0.0025</td>
</tr>
<tr>
<td>CaO</td>
<td>0.07</td>
<td>P₂O₅</td>
<td>0.025</td>
</tr>
<tr>
<td>CdO</td>
<td>0.015</td>
<td>X₃CaO·X₅P₂O₅</td>
<td>0.00065ᵃ</td>
</tr>
<tr>
<td>Cl</td>
<td>0.005ᵇ</td>
<td>PbO</td>
<td>0.05</td>
</tr>
<tr>
<td>Cr₂O₃</td>
<td>0.012</td>
<td>SiO₂</td>
<td>0.53</td>
</tr>
<tr>
<td>F</td>
<td>0.02</td>
<td>SO₃</td>
<td>0.005</td>
</tr>
<tr>
<td>Fe₂O₃</td>
<td>0.174</td>
<td>SrO</td>
<td>0.045</td>
</tr>
<tr>
<td>K₂O</td>
<td>0.06</td>
<td>ThO₂</td>
<td>0.06</td>
</tr>
<tr>
<td>MgO</td>
<td>0.06</td>
<td>UO₃</td>
<td>0.063</td>
</tr>
<tr>
<td>MnO</td>
<td>0.07</td>
<td>Zr₂O</td>
<td>0.135</td>
</tr>
<tr>
<td>Na₂O</td>
<td>0.214</td>
<td>Minors</td>
<td>0.045</td>
</tr>
</tbody>
</table>

ᵃ The units for $X_{3CaO}·X_{5P2O5}$ are in (wt fraction)
ᵇ Chlorine is not a species limiting glass in HTWOS but use for estimating glass.

*From Page 54 of WTP MDD (25490-WTP-MDD-PR-01-002, Rev. 13)*

**Basis:** This requirement was extracted from the code on Page 54 of WTP MDD (25490-WTP-MDD-PR-01-002, Rev. 13).

### 3.5.4.31 UFP Feed Vessels (UFP-VSL-00002A/B) - Post Wash Solids Concentration Endpoint

**Unique ID:** BMR-UFP_TR-36

The post wash solids concentration endpoint shall be greater than or equal to 20 wt%.

**Basis:** This requirement is based on the description in Section 4.8.3 Ultrafiltration Process (UFP) System in 24590-WTP-MDD-PR-01-002, WTP MDD Rev. 13.
3.5.4.32 UFP Feed Vessels (UFP-VSL-00002A/B) - Oxidative Leach Reactions and Conversions

**Unique ID:** BMR-UFP_TR-17

The following reactions and conversions define the Oxidative Leach Reactions, reactions shall be executed in the order listed.

**Ultrafiltration Oxidative Leach Reactions**

<table>
<thead>
<tr>
<th>Rx#</th>
<th>Reaction</th>
<th>Conversion (fraction)</th>
</tr>
</thead>
<tbody>
<tr>
<td>OX-CR</td>
<td>1.0 CrOOH(s) + 1.0 MnO₄⁻(l) + 1.0 OH⁻(l) → 1.0 CrO₄²⁻(l) + 1.0 MnO₂(s) +1.0 H₂O(l)</td>
<td>0.876</td>
</tr>
<tr>
<td>OX-CR-2</td>
<td>1.0 MnO₄⁻(l) → 1.0 Mn⁴⁺(s) + 2.0 O(BOUND)(s) + 2.0 O(BOUND)(l)</td>
<td>1</td>
</tr>
<tr>
<td>OX-239-PU</td>
<td>1.0²³⁹Pu(s) + 3.0 OH(BOUND)(s) + 1.0 OH⁻(l) → 1.0²³⁹Pu(l) + 4.0 OH⁺(l)</td>
<td>0.01</td>
</tr>
<tr>
<td>OX-240-PU</td>
<td>1.0²⁴⁰Pu(s) + 3.0 OH(BOUND)(s) + 1.0 OH⁻(l) → 1.0²⁴⁰Pu(l) + 4.0 OH⁺(l)</td>
<td>0.01</td>
</tr>
<tr>
<td>OX-238-PU</td>
<td>1.0²³⁸Pu(s) + 3.0 OH(BOUND)(s) + 1.0 OH⁻(l) → 1.0²³⁸Pu(l) + 4.0 OH⁺(l)</td>
<td>0.01</td>
</tr>
<tr>
<td>OX-241-PU</td>
<td>1.0²⁴¹Pu(s) + 3.0 OH(BOUND)(s) + 1.0 OH⁻(l) → 1.0²⁴¹Pu(l) + 4.0 OH⁺(l)</td>
<td>0.01</td>
</tr>
<tr>
<td>OX-242-PU</td>
<td>1.0²⁴²Pu(s) + 3.0 OH(BOUND)(s) + 1.0 OH⁻(l) → 1.0²⁴²Pu(l) + 4.0 OH⁺(l)</td>
<td>0.01</td>
</tr>
<tr>
<td>OX-PUPLUS4</td>
<td>1.0 Pu⁴⁺(s) + 3.0 OH(BOUND)(s) + 1.0 OH⁻(l) → 1.0 Pu⁴⁺(l) + 4.0 OH⁺(l)</td>
<td>0.01</td>
</tr>
</tbody>
</table>

**Basis:** This requirement is based on the description in Section 4.8.3 Ultrafiltration Process (UFP) System in 24590-WTP-MDD-PR-01-002, WTP MDD Rev. 13 and modified for the TOPSim components.

3.5.4.33 UFP Feed Vessels (UFP-VSL-00002A/B) - Oxidative Leach Reaction Time

**Unique ID:** BMR-UFP_TR-10

The oxidative leach reaction time is 6 hours.

**Basis:** This requirement is based on the description in Section 4.8.3 Ultrafiltration Process (UFP) System in 24590-WTP-MDD-PR-01-002, WTP MDD Rev. 13.

3.5.4.34 UFP Feed Vessels (UFP-VSL-00002A/B) - Oxidative Leach Washing Volume

**Unique ID:** BMR-UFP_TR-37

The volume of oxidative leach wash solution shall be 2.3 times the post-oxidative leach slurry volume.

**Basis:** This is a simplification of the oxidative leach decision logic found in 24590-WTP-MDD-PR-01-002, WTP MDD Rev. 13 which determines if the oxidative wash volume is either 2 or 3 times the slurry volume. Based on WTP G2 modeling results - "Typically 70% of the time it's 2
times the slurry volume, the other 30% of the time it's 3 times the slurry volume." (WRPS-1800088, Email - Oxidative Leach Washing Volume). The weighted average of 2.3 (2 x 70% + 3 x 30%) is used instead of programming the lengthy oxidative logic into TOPSim. The oxidative wash volume being 2 or 3 times the slurry volume has little impact to the overall mission modeling.

3.5.4.35 UFP Feed Vessels (UFP-VSL-00002A/B) - Final Solids Concentration Endpoint

**Unique ID:** BMR-UFP_TR-11

The final solids concentration endpoint shall be greater than or equal to 20 wt%.

**Basis:** This requirement is based on the description in Section 4.8.3 Ultrafiltration Process (UFP) System in 24590-WTP-MDD-PR-01-002, WTP MDD Rev. 13.

3.5.4.36 UFP Feed Vessels (UFP-VSL-00002A/B) - Filter Cleaning Trigger

**Unique ID:** BMR-UFP_TR-12

The filters will be cleaned after 500 hours of cumulative usage or after every four solid discharges.

**Basis:** This requirement is based on the description in Section 4.8.3 Ultrafiltration Process (UFP) System in 24590-WTP-MDD-PR-01-002, WTP MDD Rev. 13.

3.5.4.37 UFP Feed Vessels (UFP-VSL-00002A/B) - Cleaning Acid Volume

**Unique ID:** BMR-UFP_TR-30

The UFP Feed Vessels (UFP-VSL-00002A/B) volume of 2M HNO3 for a filter cleaning shall be 17,076 gallons.

**Basis:** This requirement is based on the description in Section 4.8.3 Ultrafiltration Process (UFP) System in 24590-WTP-MDD-PR-01-002, WTP MDD Rev. 13.

3.5.4.38 UFP Feed Vessels (UFP-VSL-00002A/B) - Inhibited Water Power Flush Volume

**Unique ID:** BMR-UFP_TR-31

The UFP Feed Vessels (UFP-VSL-00002A/B) volume of Inhibited Water for a power flush shall be 2,076 gallons.

**Basis:** This requirement is based on the description in Section 4.8.3 Ultrafiltration Process (UFP) System in 24590-WTP-MDD-PR-01-002, WTP MDD Rev. 13.

3.5.4.39 UFP Feed Vessels (UFP-VSL-00002A/B) - Heel Neutralization Caustic Volume

**Unique ID:** BMR-UFP_TR-32

The **UFP Feed Vessels (UFP-VSL-00002A/B)** volume of 19M NaOH to add for heel neutralization shall be 50 gallons.

**Basis:** This requirement is based on the description in Section 4.8.3 Ultrafiltration Process (UFP) System in 24590-WTP-MDD-PR-01-002, WTP MDD Rev. 13.
3.5.4.40 UFP Feed Vessels (UFP-VSL-00002A/B) - Acid Cleaning Wait Time

Unique ID: BMR-UFP_TR-33

The UFP Feed Vessels (UFP-VSL-00002A/B) acid cleaning wait time is 1.5 hours.

Basis: This requirement is based on the description in Section 4.8.3 Ultrafiltration Process (UFP) System in 24590-WTP-MDD-PR-01-002, WTP MDD Rev. 13.

3.5.4.41 UFP Feed Vessels (UFP-VSL-00002A/B) - Power Flush Wait Time

Unique ID: BMR-UFP_TR-34

The UFP Feed Vessels (UFP-VSL-00002A/B) power flush wait time shall be 0.183 hours.

Basis: This requirement is based on the description in Section 4.8.3 Ultrafiltration Process (UFP) System in 24590-WTP-MDD-PR-01-002, WTP MDD Rev. 13.

3.5.4.42 UFP Feed Vessels (UFP-VSL-00002A/B) - Acid Neutralization Wait Time

Unique ID: BMR-UFP_TR-35

The UFP Feed Vessels (UFP-VSL-00002A/B) acid neutralization wait time shall be 1.5 hours.

Basis: This requirement is based on the description in Section 4.8.3 Ultrafiltration Process (UFP) System in 24590-WTP-MDD-PR-01-002, WTP MDD Rev. 13.

3.5.4.43 UFP Feed Vessels (UFP-VSL-00002A/B) - Facility Availability Factor

Unique ID: BMR-UFP_TR-42

The wait time value representing the Facility Availability factor shall be 120 hours.

Basis: The value for the Facility Availability factor is based on MR-50150, System Plan 8 Case 1: Baseline results which were used for the SP8 Baseline Case. This value will require recalibration when significant flowsheet changes are made.

3.5.4.44 UFP Permeate Receipt Vessel (UFP-VSL-00062A/B/C) Target Sodium Molarity

Unique ID: BMR-UFP_TR-15

The UFP Permeate Receipt Vessels (UFP-VSL-00062A/B/C) target sodium molarity is 8 molar.

Basis: This requirement is based on the description in Section 4.8.3 Ultrafiltration Process (UFP) System in 24590-WTP-MDD-PR-01-002, WTP MDD Rev. 13.
3.5.5 UFP Supplemental Information

3.5.5.1 UFP Overall Process Diagram

Unique ID: BMR-UFP-172
3.5.5.2 Overall UFP-VSL-00001A/B Model Diagram

Unique ID: BMR-UFP-174
3.5.5.3 UFP-VSL-00001A/B Feed Blending Logic

Unique ID: BMR-UFP-173

![UFP Fill Logic Diagram](image)

3.5.5.4 UFP Feed Vessel (UFP-VSL-00002A/B) Modes of Operation

Unique ID: BMR-UFP-176

The UFP Feed Vessels (UFP-VSL-00002A/B) operation shall consist of the following sequential steps (modes); each step is described in subsequent model requirements (See Overall UFP-VSL-00002A Diagram):

1. FILL: Fill with waste to the upper set point,
2. INITIAL-SOLIDS CONCENTRATION, incrementally continue to discharge and fill to the target solids wt%,
3. SOLUBILITY: Apply solubility at the vessel temperature,
4. HEAT: The contents of the vessel are heated with steam.
5. CAUSTIC LEACH: Caustic leach by adding chemicals, applying the reactions and reaction time, then cooling,
6. SOLUBILITY: Apply solubility at the vessel temperature,

7. POST LEACH SOLIDS CONCENTRATION: Concentrate the solids to the target wt.%,

8. SOLIDS WASHING: Solids wash incrementally routing the initial wash solution to UFP Permeate Receipt Vessels (UFP-VSL-00062A/B/C) than as the wash solution is more dilute routing it to Acidic/Alkaline Effluent Vessels (PWD-VSL-00015 and PWD-VSL-00016),

9. If Oxidative leaching is not required go to SOLIDS DISCHARGE, else

10. OXIDATIVE LEACH: Oxidative leach consist of adding chemicals, applying reactions and wait time.

11. SOLUBILITY: Apply solubility at the vessel temperature,

12. OXIDATIVE LEACH WASH: Oxidative leach solids wash

13. FINAL SOLIDS CONCENTRATION: If required concentrate the solids to the target wt.%,

14. SOLIDS DISCHARGE: Discharge solids to HLP vessel,

15. POWER FLUSH, water and air are used to clean filter,

16. ACID CLEAN, If required acid clean the filters.
3.5.5.5 Overall UFP-VSL-00002A Diagram

Unique ID: BMR-UFP-175
3.5.5.6 UFP-VSL-00002A/B/C Cleaning Diagram

Unique ID: BMR-UFP-177

3.6 WASTE TREATMENT AND IMMOBILIZATION PLANT CESIUM NITRIC ACID RECOVERY PROCESS

The Cesium Nitric Acid Recovery Process (CNP) reduces the volume of the Cs eluate stream from the cesium ion exchange process. A cesium concentrate product is produced and nitric acid is recovered for reuse during elution. The cesium nitric acid recovery process (CNP) consists of an evaporator separator vessel, a rectifier, a cesium concentrate storage vessel, and a recovered nitric acid vessel.

The CNP evaporator is initially filled with 5 M nitric acid. Waste from the elution and post-elution column rinses is routed to Cesium Evaporator Separator Vessel (CNP-EVAP-00001). Eluent is boiled off from CNP-EVAP-00001 and is routed to the Nitric Acid Rectifier (CNP-DISTC-00001) at the same rate that the material is fed to the evaporator, thus maintaining a constant level in the evaporator. For simplification, all of the HNO3 in the feed entering the evaporator is sent to the overheads and the cesium, potassium, and sodium accumulates in the evaporator. Once the evaporator reaches the target sodium, influent to the evaporator stops, and all the evaporator contents are sent to the cesium concentrate storage vessel (CNP-VSL-00003). The evaporator then resets itself to recharge with acid. The cesium concentrate storage vessel (CNP-VSL-00003) temporarily stores the Cs concentrate before transfer to the HLW lag storage vessels (HLP-VSL-0027B or HLP-VSL-00028).

The rectifier column produces a dilute HNO3 bottoms product and a water overheads product. The overhead product is sent to Acidic/Alkaline Effluent Vessel (PWD-VSL-00015) and the recovered nitric acid (bottom product) is sent to the Recovered Nitric Acid Vessel (CNP-VSL-00004), which provides the source of nitric acid for subsequent CXP column resin elutions.
3.6.1 System Requirements

3.6.1.1 CNP Cesium Eluate Concentration

Unique ID: BMR-CNP_SR-1

The CNP shall concentrate the cesium rich eluate stream from the CXP and transfer this cesium product downstream to blend with HLW treated slurries.

Basis: This system requirement is based on the description in Section 2.0 Scope in 24590-PTF-3YD-CNP-00001, CNP System Description.

3.6.1.2 CNP Nitric Acid recovery

Unique ID: BMR-CNP_SR-2

The CNP shall recover nitric acid (HNO3) from the cesium eluate for reuse during the CXP elution.

Basis: This system requirement is based on the description in Section 2.0 Scope in 24590-PTF-3YD-CNP-00001, CNP System Description.

3.6.2 Functional Requirements

3.6.2.1 CNP Receive Cesium Eluate

Unique ID: BMR-CNP_FR-1

The CNP shall have the capability to receive dilute cesium eluate from CXP.
Basis: This functional requirement is based on the description in Section 3.1 Receive Eluate Feed of 24590-PTF-3YD-CNP-00001, CNP System Description.

3.6.2.2 CXP Concentrate Eluate

Unique ID: BMR-CNP_FR-2

The CNP shall have the capability to concentrate the dilute eluate using evaporation.

Basis: This functional requirement is based on the description in Section 3.4 Concentrate Dilute Eluate of 24590-PTF-3YD-CNP-00001, CNP System Description.

3.6.2.3 CNP Nitric Acid Recovery

Unique ID: BMR-CNP_FR-3

The CNP shall have the capability to recover nitric acid from the evaporator offgas using an acid rectifier.

Basis: This functional requirement is based on the description in Section 3.5 Recover Acid of 24590-PTF-3YD-CNP-00001, CNP System Description.

3.6.2.4 CNP Offgas Condenser

Unique ID: BMR-CNP_FR-4

The CNP shall have the capability to condense offgas from the acid rectifier.

Basis: This functional requirement is based on the description in Section 3.5 Recover Acid of 24590-PTF-3YD-CNP-00001, CNP System Description.

3.6.2.5 CNP Collect Recovered Acid

Unique ID: BMR-CNP_FR-5

The CNP shall have the capability to collect the recovered nitric acid and to supplement with fresh nitric acid.

Basis: This functional requirement is based on the description in Section 3.6 Collect Recovered Acid of 24590-PTF-3YD-CNP-00001, CNP System Description.

3.6.2.6 CNP Transfer Recovered Acid

Unique ID: BMR-CNP_FR-6

The CNP shall have the capability to transfer the recovered acid to the CXP for elution of the resin.

Basis: This functional requirement is based on the description in Section 3.7 Transfer Recovered Acid of 24590-PTF-3YD-CNP-00001, CNP System Description.

3.6.2.7 CNP Collect Cesium Product Concentrate

Unique ID: BMR-CNP_FR-7

The CNP shall have the capability to collect the concentrated cesium product.

Basis: This functional requirement is based on the description in Section 3.4 Concentrate Dilute Eluate of 24590-PTF-3YD-CNP-00001, CNP System Description.
3.6.2.8 Transfer Concentrated Cesium Product to HLP

Unique ID: BMR-CNP_FR-8

The CNP shall have the capability to transfer the concentrated cesium product to HLP.

Basis: This functional requirement is based on the description in Section 3.8 Transfer Cesium Concentrate of 24590-PTF-3YD-CNP-00001, CNP System Description.

3.6.2.9 CNP Condensate to PWD

Unique ID: BMR-CNP_FR-9

The CNP shall have the capability to transfer condensate to the PWD.

Basis: This functional requirement is based on the description in Section 6.0 CNP Description of 24590-PTF-3YD-CNP-00001, CNP System Description.

3.6.3 Model Requirements

3.6.3.1 CNP Evaporator Separator Vessel Identification

Unique ID: BMR-CNP_MR-1

The CNP shall include an evaporator separator vessel identified as CNP-EVAP-00001.

Basis: This model requirement is based on Section 2.6.2 CNP Process Description of the BARD (24590-WTP-RPT-PT-02-005, BARD Rev. 8) and Section 4.8.5 Cesium Nitric Acid Recovery Process System in 24590-WTP-MDD-PR-01-002, WTP MDD.

3.6.3.2 CNP Evaporator Nitric Acid Rectifier Identification

Unique ID: BMR-CNP_MR-2

The CNP shall include an evaporator nitric acid rectifier unit identified as CNP-DISTC-00001.

Basis: This model requirement is based on Section 2.6.2 CNP Process Description of the BARD (24590-WTP-RPT-PT-02-005, BARD Rev. 8) and Section 4.8.5 Cesium Nitric Acid Recovery Process System in 24590-WTP-MDD-PR-01-002, WTP MDD.

3.6.3.3 CNP Cesium Concentrate Storage Vessel Identification

Unique ID: BMR-CNP_MR-3

The CNP shall include a cesium concentrate storage vessel identified as CNP-VSL-00003.

Basis: This model requirement is based on Section 2.6.2 CNP Process Description of the BARD (24590-WTP-RPT-PT-02-005, BARD Rev. 8) and Section 4.8.5 Cesium Nitric Acid Recovery Process System in 24590-WTP-MDD-PR-01-002, WTP MDD.

3.6.3.4 CNP Cesium Evaporator Recovered Nitric Acid Vessel

Unique ID: BMR-CNP_MR-4

The CNP shall include a cesium evaporator recovered nitric acid vessel identified as CNP-VSL-00004.
Basis: This model requirement is based on Section 2.6.2 CNP Process Description of the BARD (24590-WTP-RPT-PT-02-005, BARD Rev. 8) and Section 4.8.5 Cesium Nitric Acid Recovery Process System in 24590-WTP-MDD-PR-01-002, WTP MDD.

3.6.3.5 CNP Cesium Evaporator Separator Vessel (CNP-EVAP-00001) Initial Acid Charge

Unique ID: BMR-CNP_MR-5

The Cesium Evaporator Separator Vessel (CNP-EVAP-00001) shall be initially filled to the set volume with nitric acid per the CNP-EVAP-00001 Acid Charge Chemical Addition (see CNP Initial Acid Charge Diagram).

Basis: This model requirement is based on the process steps described in Section 4.8.5 Cesium Nitric Acid Recovery Process System in 24590-WTP-MDD-PR-01-002, WTP MDD.

3.6.3.6 Cesium Evaporator Recovered Nitric Acid Vessel (CNP-VSL-00004) Acid Charging

Unique ID: BMR-CNP_MR-10

Initially and after each elution cycle the Cesium Evaporator Recovered Nitric Acid Vessel (CNP-VSL-00004) shall be filled with the CNP-VSL-00004 Acid Charge to the CNP-VSL-00004 set volume. See CNP Initial Acid Charge Diagram.

Basis: This model requirement is based on the process steps described in Section 4.8.5 Cesium Nitric Acid Recovery Process System in 24590-WTP-MDD-PR-01-002, WTP MDD.

3.6.3.7 Cesium Evaporator Separator Vessel (CNP-EVAP-00001) Eluate Receipt

Unique ID: BMR-CNP_MR-6

After the initial acid charge, the Cesium Evaporator Separator Vessel (CNP-EVAP-00001) shall receive the elution waste from the Cesium Ion Exchange Columns (CXP-IXC-00001/2/3/4) at the Column Elution Rate.

Basis: This model requirement is based on the process steps described in Section 4.8.5 Cesium Nitric Acid Recovery Process System in 24590-WTP-MDD-PR-01-002, WTP MDD.

3.6.3.8 Cesium Evaporator Separator Vessel (CNP-EVAP-00001) Component Accumulation

Unique ID: BMR-CNP_MR-7

The Cesium Evaporator Separator Vessel (CNP-EVAP-00001) shall accumulate all of the cesium, 137-Ba, potassium, and sodium entering the vessel (e.g. none of these components are split to the overhead product).

Basis: This model requirement is based on the description in Section 2.6.3.1 Eluate Concentration in 24590-WTP-RPT-PT-02-005, BARD Rev. 8. From the BARD - "A specific design is not available for analysis, nor is equipment available for testing. Therefore, the design specification limiting the mass rate of Cs in condensate to a factor of 10−7 of the mass rate of Cs in the feed is used to describe the transmission of all solutes to the overhead vapor." For model simplicity it is assumed that none of the contaminants are routed to the offgas.
3.6.3.9 Cesium Evaporator Separator Vessel (CNP-EVAP-00001) Overhead Routing

**Unique ID:** BMR-CNP_MR-8

The *Cesium Evaporator Separator Vessel (CNP-EVAP-00001)* shall route the overheads to the *Cesium Evaporator Nitric Acid Rectifier (CNP-DISTC-00001)*. See CNP Elution and Acid Recovery Diagram.

**Basis:** This model requirement is based on the description in Section 2.6.2 *CNP Process Description* in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

3.6.3.10 Cesium Evaporator Separator Vessel (CNP-EVAP-00001) Overhead Composition

**Unique ID:** BMR-CNP_MR-16

Nitric acid (HNO3) and water shall split into the *Cesium Evaporator Separator Vessel (CNP-EVAP-00001)* overheads such that the boil-off rate is equal to the feed rate and the *CNP-EVAP-00001 Overhead Acid Concentration* is met. See CNP Elution and Acid Recovery Diagram.

**Basis:** This model requirement is based on the description in Section 4.8.5 *Cesium Nitric Acid Recovery Process System* in 24590-WTP-MDD-PR-01-002, WTP MDD.

3.6.3.11 Cesium Evaporator Nitric Acid Rectifier (CNP-DISTC-00001) Acid Recovery

**Unique ID:** BMR-CNP_MR-9

The acid entering the *Cesium Evaporator Nitric Acid Rectifier (CNP-DISTC-00001)* shall be routed to the *Cesium Evaporator Recovered Nitric Acid Vessel (CNP-VSL-00004)* at the recovery efficiency. See CNP Elution and Acid Recovery Diagram.

**Basis:** This model requirement is based on the process steps described in Section 4.8.5 *Cesium Nitric Acid Recovery Process System* in 24590-WTP-MDD-PR-01-002, WTP MDD.

3.6.3.12 Cesium Evaporator Nitric Acid Rectifier (CNP-DISTC-00001) Water Removal

**Unique ID:** BMR-CNP_MR-15

Water shall be removed from the *Cesium Evaporator Nitric Acid Rectifier (CNP-DISTC-00001)* feed such that the resulting solution in the *Cesium Evaporator Recovered Nitric Acid Vessel (CNP-VSL-00004)* is equal to the *CNP-VSL-00004 Target Acid Concentration*. See CNP Elution and Acid Recovery Diagram.

**Basis:** This model requirement is based on the process steps described in Section 4.8.5 *Cesium Nitric Acid Recovery Process System* in 24590-WTP-MDD-PR-01-002, WTP MDD.

3.6.3.13 Cesium Evaporator Nitric Acid Rectifier (CNP-DISTC-00001) Distillate Recycle

**Unique ID:** BMR-CNP_MR-17

The remainder of the acid and water removed from the *Cesium Evaporator Nitric Acid Rectifier (CNP-DISTC-00001)* feed shall be routed to one of the *Acidic/Alkaline Effluent*...
Vessels (PWD-VSL-00015 and PWD-VSL-00016). See CNP Elution and Acid Recovery Diagram.

Basis: This model requirement is based on the process steps described in Section 4.8.5 Cesium Nitric Acid Recovery Process System in 24590-WTP-MDD-PR-01-002, WTP MDD.

3.6.3.14 Cesium Evaporator Separator Vessel (CNP-EVAP-00001) Discharge Conditions

Unique ID: BMR-CNP_MR-11

When the sodium concentration in the Cesium Evaporator Separator Vessel (CNP-EVAP-00001) is greater than or equal to the CNP-EVAP-00001 Sodium Trigger then the contents of the CNP-EVAP-00001 shall be discharged to the Cesium Concentrate Storage Vessel (CNP-VSL-00003).

See CNP-EVAP-00001 Discharge Diagram.

Basis: This model requirement is based on the description in 2.6.3.1 Eluate Concentration in the 24590-WTP-RPT-PT-02-005, BARD Rev. 8. Specifically it is stated that "Preliminary calculations in Estimation of Physical Properties of AN-107 Cesium and Technetium Eluate Blend (Choi 2001) indicate that this endpoint is projected to occur at a NaNO3 concentration of 2.64 M for a feed eluate composition derived from AN-107 IX test observations and charge acid concentration of 7.9 M HNO3." Once additional tests were completed a set of equations was developed to predict the saturation point for the evaporator. These equations which are presented in both the WTP BARD and MDD have not been adopted by the TOPsim model because of the cost and benefit of adopting the equation method versus a fixed value. For the current purpose of the TOPsim, the model the frequency of transferring concentrated eluate to the HLP blend tank and recharging the evaporator with acid does not effect the overall mission length.

3.6.3.15 Cesium Evaporator Separator Vessel (CNP-EVAP-00001) Complete Discharge

Unique ID: BMR-CNP_MR-12

The Cesium Evaporator Separator Vessel (CNP-EVAP-00001) shall complete discharging when the vessel is at the minimum volume.

Basis: This model requirement is inferred from the description in Section 2.6.2 CNP Process Description in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

3.6.3.16 Cesium Evaporator Separator Vessel (CNP-EVAP-00001) Acid Recharge

Unique ID: BMR-CNP_MR-13

After the Cesium Evaporator Separator Vessel (CNP-EVAP-00001) has completed discharging, it shall be filled to its set volume with the CNP-EVAP-00001 Acid Charge Chemical Addition.

Basis: This model requirement is based on the process steps described in Section 4.8.5 Cesium Nitric Acid Recovery Process System in 24590-WTP-MDD-PR-01-002, WTP MDD.
3.6.3.17  Cesium Concentrate Storage Vessel (CNP-VSL-00003) Fill Availability

**Unique ID:** BMR-CNP_MR-18

The *Cesium Concentrate Storage Vessel (CNP-VSL-00003)* shall be available to fill if the volume is less than the upper set volume.

**Basis:** This model requirement is inferred from the process steps described in Section 4.8.5 *Cesium Nitric Acid Recovery Process System* in 24590-WTP-MDD-PR-01-002, WTP MDD.

3.6.3.18  Cesium Concentrate Storage Vessel (CNP-VSL-00003) Maximum Discharge Volume

**Unique ID:** BMR-CNP_MR-14

The *Cesium Concentrate Storage Vessel (CNP-VSL-00003)* shall not transfer greater than the *CNP-VSL-00003 Maximum Batch Volume* in a single batch.

**Basis:** This model requirement is based on the process steps described in Section 4.8.5 *Cesium Nitric Acid Recovery Process System* in 24590-WTP-MDD-PR-01-002, WTP MDD.

3.6.3.19  Cesium Concentrate Storage Vessel (CNP-VSL-00003) Trigger Discharge

**Unique ID:** BMR-CNP_MR-19

The *Cesium Concentrate Storage Vessel (CNP-VSL-00003)* shall trigger a discharge to either the *HLW Feed Blending Vessel (HLP-VSL-00028)* or to *HLW Lag Storage Vessel (HLP-VSL-00027B)* when the volume is greater than or equal to the set volume and one of the receipt vessels is available (see *HLP Cesium Product Destination Selection*).

**Basis:** This model requirement is based on the process steps described in Section 4.8.5 *Cesium Nitric Acid Recovery Process System* and Table E-1 *Vessel Parameters* in 24590-WTP-MDD-PR-01-002, WTP MDD.

3.6.3.20  Cesium Evaporator Recovered Nitric Acid Vessel (CNP-VSL-00004) Fill Availability

**Unique ID:** BMR-CNP_MR-20

The *Cesium Evaporator Recovered Nitric Acid Vessel (CNP-VSL-00004)* shall be available to fill if the volume is less than the upper set volume.

**Basis:** This model requirement is based on the process steps described in Section 4.8.5 *Cesium Nitric Acid Recovery Process System* in 24590-WTP-MDD-PR-01-002, WTP MDD.

3.6.3.21  Cesium Evaporator Recovered Nitric Acid Vessel (CNP-VSL-00004) Elution Transfer

**Unique ID:** BMR-CNP_MR-21

The *Cesium Evaporator Recovered Nitric Acid Vessel (CNP-VSL-00004)* shall transfer to the *Cesium Ion Exchange Columns (CXP-IXC-00001/2/3/4)* during column elution in batches to the minimum volume or as needed to make up the required elution volume.

**Basis:** This model requirement is based on the process steps described in Section 4.8.5 *Cesium Nitric Acid Recovery Process System* in 24590-WTP-MDD-PR-01-002, WTP MDD.
3.6.3.22  **Cesium Evaporator Recovered Nitric Acid Vessel (CNP-VSL-00004) Initial Fill**

**Unique ID:** BMR-CNP_MR-22

The *Cesium Evaporator Recovered Nitric Acid Vessel (CNP-VSL-00004)* shall be initially filled with the *CNP-VSL-00004 Acid Charge* to the upper set volume.

**Basis:** This model requirement is a model simplification required since CNP-VSL-00004 and the demister are operated batch wise instead of on a continuous basis. The process steps described in Section 4.8.5 *Cesium Nitric Acid Recovery Process System* in 24590-WTP-MDD-PR-01-002, WTP MDD state to fill this vessel to the lower set-volume leaving room for the condensate from the demister; however since TOPSim is event based, the first event that occurs after the initial fill is the transfer of acid to the columns for elution and it makes more sense to have the most volume available and fill to the upper set volume. There is approximately a 22% volume decrease in the amount of acid returned as condensate for each elution cycle.

### 3.6.4 Technical Requirements

#### 3.6.4.1  **Cesium Evaporator Separator Vessel (CNP-EVAP-00001) Parameters**

**Unique ID:** BMR-CNP_TR-1

The *Cesium Evaporator Separator Vessel (CNP-EVAP-00001)* shall have the following parametric values.

<table>
<thead>
<tr>
<th>Vessel #</th>
<th>Maximum Volume (gal)</th>
<th>Set Volume (gal)</th>
<th>Minimum Volume (gal)</th>
<th>Flow rate (gpm)</th>
<th>Temperature (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CNP-EVAP-00001</td>
<td>2,130</td>
<td>2,128</td>
<td>130</td>
<td>20/10</td>
<td>55</td>
</tr>
</tbody>
</table>

**Basis:** The vessel parameters are based on the values in *Table E-1 Vessel Parameters* found in 24590-WTP-MDD-PR-01-002, WTP MDD. The temperature is based on the value in Section 2.6.3.1; *Eluate Concentration* in 24590-WTP-RPT-PT-02-005, BARD Rev. 8. The discharge rate to CNP-VSL-00003 is 20 gpm and the boil-off rate is 10 gpm.

#### 3.6.4.2  **Cesium Evaporator Nitric Acid Rectifier (CNP-DISTC-00001) Vessel Parameters**

**Unique ID:** BMR-CNP_TR-2

The *Cesium Evaporator Nitric Acid Rectifier (CNP-DISTC-00001)* shall have the following parametric values.

<table>
<thead>
<tr>
<th>Vessel #</th>
<th>Overflow Volume (gal)</th>
<th>Maximum Volume (gal)</th>
<th>Set Volume (gal)</th>
<th>Minimum Volume (gal)</th>
<th>Flow rate (gpm)</th>
<th>Temperature (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CNP-DISTC-00001A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>10</td>
<td>55</td>
</tr>
</tbody>
</table>
**Basis:** The flow rate and temperatures are based on the 10 gpm boil-off rate of the evaporator and the temperature is based on the operating temperature specified in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

### 3.6.4.3 Cesium Concentrate Storage Vessel (CNP-VSL-00003) Parameters

**Unique ID:** BMR-CNP_TR-3

The *Cesium Concentrate Storage Vessel (CNP-VSL-00003)* shall have the following parametric values.

<table>
<thead>
<tr>
<th>Vessel #</th>
<th>Maximum Volume (gal)</th>
<th>Upper Set Volume (gal)</th>
<th>Lower Set Volume (gal)</th>
<th>Minimum Volume (gal)</th>
<th>Maximum Flow rate (gpm)</th>
<th>Temperature (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CNP-VSL-00003</td>
<td>18,750</td>
<td>16,127</td>
<td>6,242</td>
<td>3,627</td>
<td>62</td>
<td>88</td>
</tr>
</tbody>
</table>

**Basis:** This requirement is based on the values in *Table E-1 Vessel Parameters* found in 24590-WTP-MDD-PR-01-002, WTP MDD.

### 3.6.4.4 Cesium Evaporator Recovered Nitric Acid Vessel (CNP-VSL-00004) Parameters

**Unique ID:** BMR-CNP_TR-4

The *Cesium Evaporator Recovered Nitric Acid Vessel (CNP-VSL-00004)* shall have the following parametric values.

<table>
<thead>
<tr>
<th>Vessel #</th>
<th>Maximum Volume (gal)</th>
<th>Upper Set Volume (gal)</th>
<th>Lower Set Volume (gal)</th>
<th>Minimum Volume (gal)</th>
<th>Maximum Flow rate (gpm)</th>
<th>Temperature (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CNP-VSL-00004</td>
<td>10,064</td>
<td>7,342</td>
<td>5,342</td>
<td>1,342</td>
<td>20</td>
<td>25</td>
</tr>
</tbody>
</table>

**Basis:** This requirement is based on the values in *Table E-1 Vessel Parameters* found in 24590-WTP-MDD-PR-01-002, WTP MDD. The temperature is set to the default temperature based on engineering judgement.

### 3.6.4.5 Cesium Evaporator Separator Vessel (CNP-EVAP-00001) Acid Charge Chemical Addition

**Unique ID:** BMR-CNP_TR-5

The *Cesium Evaporator Separator Vessel (CNP-EVAP-00001)* acid charge chemical addition shall be with 5M HNO3.

**Basis:** This model requirement is based on the process steps described in Section 4.8.5 *Cesium Nitric Acid Recovery Process System* in 24590-WTP-MDD-PR-01-002, WTP MDD.

### 3.6.4.6 Cesium Evaporator Separator Vessel (CNP-EVAP-00001) Boil Off Rate

**Unique ID:** BMR-CNP_TR-6

The *Cesium Evaporator Separator Vessel (CNP-EVAP-00001)* boil off rate is 10 gpm.
Basis: The boil off rate is specified in Section 7.2.1 Evaporator Operation in 24590-PTF-3YD-CNP-00001, CNP System Description and also forms the basis for the elution rate.

3.6.4.7 Cesium Evaporator Separator Vessel (CNP-EVAP-00001) Overhead Acid Concentration

Unique ID: BMR-CNP_TR-12

The Cesium Evaporator Separator Vessel (CNP-EVAP-00001) off gas concentration shall be 0.35 M HNO₃.

Basis: Based on the test data presented in the BARD in Tables 2.6.3 and Figures 2.6.2-2.6.4 the condensate concentration remains fairly constant. Data for the 5.32 M charge test was averaged and the average acid concentration in the offgas was 0.35 M with data varying between 0.207 and 0.48.

3.6.4.8 Cesium Evaporator Separator Vessel (CNP-EVAP-00001) Sodium Trigger

Unique ID: BMR-CNP_TR-7

The Cesium Evaporator Separator Vessel (CNP-EVAP-00001) sodium trigger is 2.64 M Na.

Basis: The sodium trigger is based on the description in 2.6.3.1 Eluate Concentration in the 24590-WTP-RPT-PT-02-005, BARD Rev. 8. Specifically it is stated that "Preliminary calculations in Estimation of Physical Properties of AN-107 Cesium and Technetium Eluate Blend (Choi 2001) indicate that this endpoint is projected to occur at a NaNO₃ concentration of 2.64 M for a feed eluate composition derived from AN-107 IX test observations and charge acid concentration of 7.9 M HNO₃." Once additional tests were completed a set of equations was developed to predict the saturation point for the evaporator. These equations which are presented in both the WTP BARD and MDD have not been adopted by the TOPsim model because of the cost and benefit of adopting the equation method versus a fixed value. For the current purpose of the TOPsim, the model the frequency of transferring concentrated eluate to the HLP blend tank and recharging the evaporator with acid does not effect the overall mission length.

3.6.4.9 Cesium Evaporator Nitric Acid Rectifier (CNP-DISTC-00001) Recovery Efficiency

Unique ID: BMR-CNP_TR-8

The Cesium Evaporator Nitric Acid Rectifier (CNP-DISTC-00001) recovery efficiency is 99.5%.

Basis: The recovery efficiency value is identified in Section 4.8.5 Cesium Nitric Acid Recovery Process System in 24590-WTP-MDD-PR-01-002, WTP MDD. Note the BARD gives the maximum recover efficiency of 99.9%; however the value of 99.5% specified in the MDD is used to provide a layer of conservatism..
3.6.4.10 Cesium Evaporator Recovered Nitric Acid Vessel (CNP-VSL-00004) Target Acid Concentration

Unique ID: BMR-CNP_TR-9

The Cesium Evaporator Recovered Nitric Acid Vessel (CNP-VSL-00004) target acid concentration is 0.45 M HNO₃.

**Basis:** The value for the target acid concentration is based on the nitric acid molarity required for the cesium ion exchange elution with is specified as 9,000 gallons 0.45 M HNO₃ supplied from CNP-VSL-00004. This is found in Table 2.5-22 Cs Removal System Process Stream Descriptions for Material Balance Calculations in 24590-WTP-RPT-PT-02-005, BARD Rev. 8. Note the value in the process steps listed in Section 4.8.5 Cesium Nitric Acid Recovery Process System in the WTP MDD is in error.

3.6.4.11 Cesium Evaporator Recovered Nitric Acid Vessel (CNP-VSL-00004) Acid Charge

Unique ID: BMR-CNP_TR-10

The Cesium Evaporator Recovered Nitric Acid Vessel (CNP-VSL-00004) shall be charged with 0.45 M HNO₃.

**Basis:** This value is based on the process steps described in Section 4.8.5 Cesium Nitric Acid Recovery Process System in 24590-WTP-MDD-PR-01-002, WTP MDD.

3.6.4.12 Cesium Concentrate Storage Vessel (CNP-VSL-00003) Maximum Batch Volume

Unique ID: BMR-CNP_TR-11

The maximum volume of a batch that can be discharged from the Cesium Concentrate Storage Vessel (CNP-VSL-00003) is 2,615 gallons.

**Basis:** This model requirement is based on the process steps described in Section 4.8.5 Cesium Nitric Acid Recovery Process System in 24590-WTP-MDD-PR-01-002, WTP MDD and is meant to limit the heat generated during neutralization in the HLP vessels.
3.6.5 CNP Figures and Diagrams

3.6.5.1 CNP Initial Acid Charge Diagram

Unique ID: BMR-CNP FIG-1

![CNP Initial Acid Charge Diagram]

3.6.5.2 CNP Elution and Acid Recovery Diagram

Unique ID: BMR-CNP FIG-2

![CNP Elution and Acid Recovery Diagram]
3.6.5.3 CNP-EVAP-00001 Discharge Diagram

Unique ID: BMR-CNP FIG-3

3.7 WASTE TREATMENT AND IMMOBILIZATION PLANT CESIUM ION EXCHANGE PROCESS

The CXP removes radioactive cesium from the received UFP permeate. The cesium reduced waste is fed downstream for disposal as ILAW and the cesium product is suitable for concentration, storage, and incorporation into feed to the HLW Facility. The CXP process consists of a cesium ion exchange feed vessel, a solids filter, four cesium ion exchange columns, and three treated LAW collection vessels.

The Cesium Ion Exchange Feed Vessel (CXP-VSL-00004) receives permeate and wash solution from the Ultrafiltration Permeate Collection Vessels (UFP-VSL-00062A/B/C). The contents of CXP-VSL-00004 are routed to the ion exchange columns via the solids filter, CXP-FILT-00001. The solid filter removes the solids and is back flushed periodically to Acidic/Alkaline Effluent Vessel (PWD-VSL-00016) using dilute NaOH.

The filtrate from the CXP-FILT-00001 is sent to one of the four ion exchange columns (CXP-IXC-00001, CXP-IXC-00002, CXP-IXC-00003, and CXP-IXC-00004). The cesium ion exchange columns operate in carousel patterned cycles such that the loading columns are in “lead”, “lag”, and “polishing” positions while the regenerating column goes through displacement, pre-elution rinse, elution, post-elution rinse, and regeneration. Once the loading is completed, the lead column enters regeneration, the lag column becomes the lead, the polishing column becomes the lag, and the regenerating column becomes the polishing column. The resin bed is packed with Spherical Resorcinol-Formaldehyde Resin (RF) that is saturated with process sodium (Na+) initially and during regeneration. For every kg-mole of 134-Cs, 137-Cs, 137m-
Ba, Cs+ and K+ captured during ion exchange, 1 kg-mole of Na+ is released from the resin surface (Note for simplicity K+ is not modeled as captured).

Once the lead column has completed loading it stops receiving waste and begins the regeneration cycle and the columns rotate functions. Regeneration consist of the following steps:

1. Displacement - using 0.1 M NaOH to prevent aluminum precipitation during the pre-elution rinse cycle. The displacement solution is routed to UFP-VSL-00062A/B/C.

2. Pre-Elution Rinse - using water to prevent acidic eluant solution from reacting during elution with caustic waste solution residing in the column. The pre-elution rinse is routed to the Acidic/Alkaline Effluent Vessels (PWD-VSL-00015/16).

3. Elution using 0.45 M HNO3 from the Recovered nitric Acid vessel (CNP-VSL-00004), where hydrogen ions replace cesium, potassium, and sodium ions. The elution product is sent to the CNP-EVP-00001.

4. Post-Elution Rinse - with water to prevent caustic waste solution from reacting with acidic eluant solution residing in the column. The post-elution rinse water is sent to the Cesium Evaporator Separator Vessel (CNP-EVAP-00001).

5. Regeneration - using 0.5 M NaOH where ion exchange takes place where sodium ions replace the hydrogen ions to reset the resin. The exiting regeneration solution goes to the Acidic/Alkaline Effluent Vessels (PWD-VSL-00015/16).

6. A regeneration displacement is performed after the regeneration cycle. This is accomplished by diverting the treated LAW products from the current polishing column outlet to the regeneration column.

After a column has gone through several regeneration process, the resin is changed out as specified in the CRP system.

The Treated LAW Collection Vessels (CXP-VSL-00026A,B,C) receive feed from the CXP column that is polishing, where once full the vessel is sampled and held for the prescribed sample time before the vessel can be discharged to the TLP evaporator (TLP-SEP-00001).
3.7.1 System Requirements

3.7.1.1 CXP Cesium Removal

Unique ID: BMR-CXP_SR-1

The \textit{CXP} shall remove radioactive cesium in the \textit{LAW} to meet the WTP Contract requirement in the statement of work (SOW) Section C.7 and C.8, transfer the cesium depleted stream downstream for incorporation into \textit{ILAW}, and transfer the cesium product downstream for incorporation into \textit{IHLW}.

\textbf{Basis:} This system requirement is based on the discussion in \textit{Section 2.5.1 Function and Requirements} of 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

3.7.2 Functional Requirements

3.7.2.1 CXP Feed Receipt

Unique ID: BMR-CXP_FR-1

The \textit{CXP} shall have the capability to receive feed (permeate) from the \textit{UFP}.

\textbf{Basis:} This functional requirement is based on \textit{Section 3.1 Receive Permeate and Resin} in 24590-PTF-3YD-CXP-00001, CXP System Description.
3.7.2.2 CXP Solids Filtration

Unique ID: BMR-CXP_FR-2

The CXP shall have the capability of removing solids from the permeate feed.

Basis: This functional requirement is based on Section 2.3.3 CXP Equipment Option/M3 Modifications in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

3.7.2.3 CXP Cesium Ion Exchange

Unique ID: BMR-CXP_FR-10

The CXP shall use ion exchange resin to remove the $^{137}$Cs in the permeate feed to meet requirements specified in the DOE Statement of Work (C.7).

Basis: This functional requirement is based on Section 2.5.1 Function and Requirements in 24590-WTP-RPT-PT-02-005, BARD Rev. 8. as well as specifications in the DOE Statement of Work (C.7 and C.8).

3.7.2.4 CXP Treated LAW Storage

Unique ID: BMR-CXP_FR-3

The CXP shall have the capability to store the cesium depleted treated LAW.

Basis: This functional requirement is based on Section 3.2 Store treated LAW in 24590-PTF-3YD-CXP-00001, CXP System Description.

3.7.2.5 CXP Sampling

Unique ID: BMR-CXP_FR-9

The CXP shall have the capability to sample the cesium depleted treated LAW.

Basis: This functional requirement is based on Section 3.8 Sample Column Effluents and Treated LAW Product in 24590-PTF-3YD-CXP-00001, CXP System Description.

3.7.2.6 CXP Discharge to TLP

Unique ID: BMR-CXP_FR-4

The CXP shall have the capability to discharge the cesium depleted treated LAW to the TLP.

Basis: This functional requirement is based on Section 3.4 Transfer Materials in 24590-PTF-3YD-CXP-00001, CXP System Description.

3.7.2.7 CXP Column Resotration

Unique ID: BMR-CXP_FR-7

The CXP shall have the capability to remove the cesium from the resin (elution) and to regenerate the resin for further cesium loading.

Basis: This functional requirement is based on Section 4.2.6 Requirements for CS IX Columns (CXP-IXC-00001/2/32/4) as well as Section 3.3 Remove Cesium and Spent resin in 24590-PTF-3YD-CXP-00001, CXP System Description.
3.7.2.8  **CXP Cesium Product Discharge to CNP**

**Unique ID:** BMR-CXP_FR-5

The *CXP* shall have the capability to discharge the *cesium product* stream and post elution rinse (resulting from the *CXP* column elution) to the *CNP*.

**Basis:** This functional requirement is based on *Section 3.4 Transfer Material* in 24590-PTF-3YD-CXP-00001, CXP System Description.

3.7.2.9  **CXP Dilute Waste Transfer to PWD**

**Unique ID:** BMR-CXP_FR-6

The *CXP* shall have the capability to transfer dilute waste generated during column restoration to the *PWD*.

**Basis:** This functional requirement is based on *Section 3.4 Transfer Material* in 24590-PTF-3YD-CXP-00001, CXP System Description.

3.7.2.10  **CXP Resin Replacement**

**Unique ID:** BMR-CXP_FR-8

The *CXP* shall have the capability to replace the *spent resin* (via the *RDP*) with *fresh resin* (via the *CRP*).

**Basis:** This functional requirement is based on *Section 3.1 Receive Permeate and Resin* and *Section 3.4 Transfer Material* in 24590-PTF-3YD-CXP-00001, CXP System Description. The constituents that remain on the spent cesium ion-exchange resin are assumed to be negligible for system planning purposes and will not be modeled at this time.

3.7.3  **Model Requirements**

3.7.3.1  **Cesium Ion Exchange Feed Vessel (CXP-VSL-00004) Identification**

**Unique ID:** BMR-CXP_MR-17

The *CXP* shall include a feed vessel which is identified as CXP-VSL-00004.

**Basis:** This model requirement is based on Section 4.8.4 *Cesium Removal Using ion Exchange Process System* in 24590-WTP-MDD-PR-01-002, WTP MDD.

3.7.3.2  **Cesium Ion Exchange Guard Filter (CXP-FILT-00001) Identification**

**Unique ID:** BMR-CXP_MR-18

The *CXP* shall include a guard filter which is identified as CXP-FILT-00001.

**Basis:** This model requirement is based on Section 4.8.4 *Cesium Removal Using ion Exchange Process System* in 24590-WTP-MDD-PR-01-002, WTP MDD.

3.7.3.3  **Cesium Ion Exchange Columns (CXP-IXC-00001/2/3/4) Identification**

**Unique ID:** BMR-CXP_MR-19

The *CXP* shall include four cesium ion exchange columns identified as CXP-IXC-00001, CXP-IXC-00002, CXP-IXC-00003, CXP-IXC-00004.
**Basis:** This model requirement is based on Section 4.8.4 Cesium Removal Using ion Exchange Process System in 24590-WTP-MDD-PR-01-002, WTP MDD.

### 3.7.3.4 Treated LAW Collection Vessels (CXP-VSL-00026A,B,C) Identification

**Unique ID:** BMR-CXP_MR-20

The CXP shall include three treated LAW collection vessels identified as CXP-VSL-00026A, CXP-VSL-00026B, and CXP-VSL-00026C.

**Basis:** This model requirement is based on Section 4.8.4 Cesium Removal Using ion Exchange Process System in 24590-WTP-MDD-PR-01-002, WTP MDD.

### 3.7.3.5 Cesium Ion Exchange Feed Vessel (CXP-VSL-00004) Feed Receipt

**Unique ID:** BMR-CXP_MR-1

The Cesium Ion Exchange Feed Vessel (CXP-VSL-00004) shall receive feed from the UFP Permeate Receipt Vessels (UFP-VSL-00062A/B/C) when the vessel is below the upper set volume.

**Basis:** This model requirement is loosely based on Section 2.3.2.6 Permeate Receipt Vessel in the BARD (24590-WTP-RPT-PT-02-005, BARD Rev. 8) and Section 4.8.4 Cesium Removal Using ion Exchange Process System in 24590-WTP-MDD-PR-01-002, WTP MDD. The basis documents describe that the permeate from the UFP-VSL-000062A/B/C will discharge to CXP-VSL-00004. CXP-VSL-00004 will then discharge to a heater capable of increasing the temperature of the fluid to 50 C. The majority of the discharge from CXP-VSL-00004 will recirculate back to the permeate receipt vessels (UFP-VSL-00062A/B/C) with a portion bled off to the ion exchange columns. In the WTP model and HTWOS these four vessels are modeled as one super tank; however in TOPsim, which does not model continuous processes well, a different approach was taken, in which each of the four vessels is modeled separately as a straight-forward batch process. The CXP-VSL-00004 is filled to the upper set volume prior to discharge.

### 3.7.3.6 Cesium Ion Exchange Feed Vessel (CXP-VSL-00004) Transfer Downstream

**Unique ID:** BMR-CXP_MR-2

The Cesium Ion Exchange Feed Vessel (CXP-VSL-00004) shall transfer feed at the pump rate to the Cesium Ion Exchange Guard Filter (CXP-FILT-00001) when it is above the minimum volume and one of the Cesium Ion Exchange Columns (CXP-IXC-00001/2/3/4) is actively in the "Loading" mode (see Cesium Ion Exchange Columns (CXP-IXC-00001/2/3/4) Loading).

**Basis:** This model requirement is based on the description in Section 4.8.4 Cesium Removal Using ion Exchange Process System in 24590-WTP-MDD-PR-01-002, WTP MDD.

### 3.7.3.7 The Cesium Ion Exchange Feed Vessel (CXP-VSL-00004) Simultaneous Receipt and Transfer

**Unique ID:** BMR-CXP_MR-3

The Cesium Ion Exchange Feed Vessel (CXP-VSL-00004) shall be capable of simultaneously receiving and transferring when both the source and destination vessels are available.
Basis: This model requirement is loosely based on Section 2.3.2.6 Permeate Receipt Vessel in the BARD (24590-WTP-RPT-PT-02-005, BARD Rev. 8) and Section 4.8.4 Cesium Removal Using ion Exchange Process System in 24590-WTP-MDD-PR-01-002, WTP MDD. The basis documents describe that the permeate from the UFP-VSL-000062A/B/C will discharge to CXP-VSL-00004. CXP-VSL-00004 will then discharge to a heater capable of increasing the temperature of the fluid to 50 C. The majority of the discharge from CXP-VSL-00004 will recirculate back to the permeate receipt vessels (UFP-VSL-000062A/B/C) with a portion bled off to the ion exchange columns. In the WTP model and HTWOS these four vessels are modeled as one super tank; however in TOPsim, which does not model continuous processes well, a different approach was taken, in which each of the four vessels is modeled separately as a straight-forward batch process.

3.7.3.8 Cesium Ion Exchange Guard Filter (CXP-FILT-00001) Solids Accumulation

Unique ID: BMR-CXP_MR-4

The Cesium Ion Exchange Guard Filter (CXP-FILT-00001) shall accumulate solids at the Cesium Ion Exchange Guard Filter (CXP-FILT-00001) Solid Removal Efficiency (see CXP-FILT-00001 Logic Diagram).

Basis: This model requirement is based on the description in Section 4.8.4 Cesium Removal Using ion Exchange Process System in 24590-WTP-MDD-PR-01-002, WTP MDD.

3.7.3.9 Cesium Ion Exchange Guard Filter (CXP-FILT-00001) Transfer Routing

Unique ID: BMR-CXP_MR-5

The Cesium Ion Exchange Guard Filter (CXP-FILT-00001) shall transfer the solid-free waste to the Cesium Ion Exchange Column (CXP-IXC-00001/2/3/4) in the "lead" position (see Simplified Ion-Exchange Diagram).

Basis: This model requirement is based on the description in Section 4.8.4 Cesium Removal Using ion Exchange Process System in 24590-WTP-MDD-PR-01-002, WTP MDD.

3.7.3.10 Cesium Ion Exchange Guard Filter (CXP-FILT-00001) - Back Flush Operation

Unique ID: BMR-CXP_MR-6

Once the CXP-FILT-00001 Back Flush Trigger has been met, then the filter back flush shall proceed as follows (see CXP-FILT-00001 Logic Diagram):

1. Transfers to the Cesium Ion Exchange Guard Filter (CXP-FILT-00001) shall be stopped,
2. Flush with the Cesium Ion Exchange Guard Filter (CXP-FILT-00001) - Back flush Chemical Addition and the resulting liquids and solids shall be routed to PWD-VSL-00016,
3. Apply the Cesium Ion Exchange Guard Filter (CXP-FILT-00001) Back Flush Time,
4. The counter for the UFP cycles shall be reset (see Track UFP Feed Vessels (UFP-VSL-00002A/B) Cycles),
5. Feed to the filter shall resume.
Basis: This model requirement is based on the description in Section 4.8.4 *Cesium Removal Using Ion Exchange Process System* in 24590-WTP-MDD-PR-01-002, WTP MDD.

3.7.3.11 Cesium Ion Exchange Columns (CXP-IXC-00001/2/3/4) Carousel Operation

Unique ID: BMR-CXP_MR-7

The *Cesium Ion Exchange Columns* (CXP-IXC-00001/2/3/4) shall operate in a carousel patterned cycle such that loading columns follows the "lead", "lag", and "polishing" positions, while the fourth is regenerated. Once the loading is complete, the lead column enters the regeneration, the lag becomes the lead, polishing becomes the lag, and the regenerated column becomes the polishing.

Basis: This model requirement is based on the description in Section 4.8.4 *Cesium Removal Using Ion Exchange Process System* in 24590-WTP-MDD-PR-01-002, WTP MDD. This configuration is also discussed in *Section 2.5.2 process Description* in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

3.7.3.12 Cesium Ion Exchange Columns (CXP-IXC-00001/2/3/4) Loading

Unique ID: BMR-CXP_MR-9

The lead *Cesium Ion Exchange Column* (CXP-IXC-00001/2/3/4) shall be loaded with feed from the *Cesium Ion Exchange Feed Vessel* (CXP-VSL-00004) at the *Cesium Ion Exchange Column (CXP-IXC-00001/2/3/4) Loading Rate* until one of the following two conditions are met;

1. The calculated loading volume has been fed through the column (see *Cesium Ion Exchange Columns (CXP-IXC-00001/2/3/4) Loading Volume Equation*) or
2. The *Cesium Ion Exchange Columns (CXP-IXC-00001/2/3/4) Maximum Cesium Accumulation* has been reached.

Basis: This model requirement is based on the description in Section 4.8.4 *Cesium Removal Using Ion Exchange Process System* in 24590-WTP-MDD-PR-01-002, WTP MDD.

3.7.3.13 Cesium Ion Exchange Columns (CXP-IXC-00001/2/3/4) Contaminant Absorbtion

Unique ID: BMR-CXP_MR-8

The cesium and 137m-Ba shall be absorbed onto only the lead column according to the *Cesium Ion Exchange Columns (CXP-IXC-00001/2/3/4) Mass Balance*.

Basis: This model requirement is based on the description in Section 4.8.4 *Cesium Removal Using Ion Exchange Process System* in 24590-WTP-MDD-PR-01-002, WTP MDD.

3.7.3.14 Cesium Ion Exchange Columns (CXP-IXC-00001/2/3/4) Regeneration - Displacement

Unique ID: BMR-CXP_MR-29

After the column loading is complete, the lead column shall be displaced by adding the *Displacement Volume* at the *Displacement Rate* through the column and then to one of the *UFP Permeate Receipt Vessels (UFP-VSL-00062A/B/C)*.
Basis: This model requirement is based on the description in Section 4.8.4 Cesium Removal Using ion Exchange Process System in 24590-WTP-MDD-PR-01-002, WTP MDD.

3.7.3.15 Cesium Ion Exchange Columns (CXP-IXC-00001/2/3/4) Regeneration - Pre-Elution Rinse

Unique ID: BMR-CXP_MR-28

After the displacement step is complete the pre-elution rinse step shall proceed by adding the Pre-Elution Rinse Volume of Water at the Pre-Elution Rinse Rate and routing this water through the column and then to one of the Acidic/Alkaline Effluent Vessels (PWD-VSL-00015 and PWD-VSL-00016).

Basis: This model requirement is based on the description in Section 4.8.4 Cesium Removal Using ion Exchange Process System in 24590-WTP-MDD-PR-01-002, WTP MDD.

3.7.3.16 Cesium Ion Exchange Columns (CXP-IXC-00001/2/3/4) Regeneration - Elution

Unique ID: BMR-CXP_MR-22

After the pre-elution rinse, the elution step shall proceed as follows:

1. Add the Elution Volume at the Elution Rate from the Cesium Evaporator Recovered Nitric Acid Vessel (CNP-VSL-00004).
2. Replace each mole of Na+, K+, 134Cs, 137Cs, Cs+, and 137mBa on the column with a mole of hydrogen from the HNO3.
3. Route the acid and contaminants to the Cesium Evaporator Separator Vessel (CNP-EVAP-00001).

Basis: This model requirement is based on the description in Section 4.8.4 Cesium Removal Using ion Exchange Process System in 24590-WTP-MDD-PR-01-002, WTP MDD.

3.7.3.17 Cesium Ion Exchange Columns (CXP-IXC-00001/2/3/4) Regeneration - Post Elution Rinse

Unique ID: BMR-CXP_MR-23

After the column elution step is complete, the post elution rinse shall proceed by adding the Post Elution Rinse Volume of Water at the Post Elution Rinse Rate and routing this water through the column and then to the Cesium Evaporator Separator Vessel (CNP-EVAP-00001).

Basis: This model requirement is based on the description in Section 4.8.4 Cesium Removal Using ion Exchange Process System in 24590-WTP-MDD-PR-01-002, WTP MDD.

3.7.3.18 Cesium Ion Exchange Columns (CXP-IXC-00001/2/3/4) Regeneration - Regeneration Step

Unique ID: BMR-CXP_MR-24

After the post-elution rinse is complete the regeneration step shall proceed as follows:

1. Add the Regeneration Volume at the Regeneration Rate to the column,
2. Replace the hydrogen ions on the column with Na ions (from the 0.5 M NaOH),
3. Route the solution to one of the Acidic/Alkaline Effluent Vessels (PWD-VSL-00015 and PWD-VSL-00016).

**Basis:** This model requirement is based on the description in Section 4.8.4 *Cesium Removal Using ion Exchange Process System* in 24590-WTP-MDD-PR-01-002, WTP MDD.

### 3.7.3.19 Cesium Ion Exchange Columns (CXP-IXC-00001/2/3/4) Regeneration - Column Conditioning Part 1

**Unique ID:** BMR-CXP_MR-25

After the regeneration step is complete, the column conditioning - Part 1 step shall proceed by adding the Column Conditioning Part 1 Volume of treated LAW from the polishing column to the newly regenerated column at the Column Conditioning Part 1 Rate then routing this solution to one of the Acidic/Alkaline Effluent Vessels (PWD-VSL-00015 and PWD-VSL-00016).

**Basis:** This model requirement is based on the description in Section 4.8.4 *Cesium Removal Using ion Exchange Process System* in 24590-WTP-MDD-PR-01-002, WTP MDD.

### 3.7.3.20 Cesium Ion Exchange Columns (CXP-IXC-00001/2/3/4) Regeneration - Column Conditioning Part 2

**Unique ID:** BMR-CXP_MR-26

After the column conditioning - Part 1 is complete, the column conditioning - Part 2 shall proceed by adding the Column Conditioning Part 2 Volume of pretreated LAW from the polishing column through the newly regenerated column at the Column Conditioning Part 2 Rate then routing this solution to the Cesium Ion Exchange Feed Vessel (CXP-VSL-00004).

**Basis:** This model requirement is based on the description in Section 4.8.4 *Cesium Removal Using ion Exchange Process System* in 24590-WTP-MDD-PR-01-002, WTP MDD.

### 3.7.3.21 Cesium Ion Exchange Columns (CXP-IXC-00001/2/3/4) Regeneration Cycle Completion

**Unique ID:** BMR-CXP_MR-27

After the column regeneration step is complete, the Regeneration Cycle Counter shall be incremented.

**Basis:** This model requirement is based on the description in Section 4.8.4 *Cesium Removal Using ion Exchange Process System* in 24590-WTP-MDD-PR-01-002, WTP MDD.

### 3.7.3.22 Cesium Ion Exchange Columns (CXP-IXC-00001/2/3/4) Resin Replacement Process

**Unique ID:** BMR-CXP_MR-21

If the number of resin regeneration cycles has exceeded the Resin Replacement Trigger then the resin replacement shall proceed per the RDP model requirements. After resin replacement the Regeneration Cycle Counter shall be reset.

**Basis:** This model requirement is based on the description in Section 4.8.4 *Cesium Removal Using ion Exchange Process System* in 24590-WTP-MDD-PR-01-002, WTP MDD.
3.7.3.23 Treated LAW Collection Vessels (CXP-VSL-00026A,B,C) Feed Receipt

Unique ID: BMR-CXP_MR-10

The Treated LAW Collection Vessels (CXP-VSL-00026A,B,C) shall receive feed from the Cesium Ion exchange Column (CXP-VSL-00001,2,3,4) that is in the "polishing" position (see CXP-VSL-00026A/B/C Logic Diagram).

Basis: This model requirement is based on the description in Section 4.8.4 Cesium Removal Using ion Exchange Process System in 24590-WTP-MDD-PR-01-002, WTP MDD.

3.7.3.24 Treated LAW Collection Vessels (CXP-VSL-00026A,B,C) Alternate Filling

Unique ID: BMR-CXP_MR-14

The Treated LAW Collection Vessels (CXP-VSL-00026A,B,C) shall alternate filling and emptying.

Basis: This model requirement is inferred from the description in Section 4.8.4 Cesium Removal Using ion Exchange Process System in 24590-WTP-MDD-PR-01-002, WTP MDD.

3.7.3.25 Treated LAW Collection Vessels (CXP-VSL-00026A,B,C) Complete Filling

Unique ID: BMR-CXP_MR-11

The Treated LAW Collection Vessels (CXP-VSL-00026A,B,C) shall each complete filling when its set volume is reached.

Basis: This model requirement is based on the description in Section 4.8.4 Cesium Removal Using ion Exchange Process System in 24590-WTP-MDD-PR-01-002, WTP MDD.

3.7.3.26 Treated LAW Collection Vessels (CXP-VSL-00026A,B,C) - Solubility Application

Unique ID: BMR-CXP_MR-12

After the Treated LAW Collection Vessels (CXP-VSL-00026A,B,C) have completed filling, solubility shall be applied at the vessel temperature (see CXP-VSL-00026A/B/C Logic Diagram).

Basis: This model requirement is based on the description in Section 4.8.4 Cesium Removal Using ion Exchange Process System and Section 4.7.16.3; Table 6 Solubility Application in 24590-WTP-MDD-PR-01-002.

3.7.3.27 Treated LAW Collection Vessels (CXP-VSL-00026A,B,C) - Sampling

Unique ID: BMR-CXP_MR-13

After solubility had been applied in the Treated LAW Collection Vessels (CXP-VSL-00026A,B,C), the Treated LAW Collection Vessels (CXP-VSL-00026A,B,C) Sample Time shall be applied (see CXP-VSL-00026A/B/C Logic Diagram).

Basis: This model requirement is based on the description in Section 4.8.4 Cesium Removal Using ion Exchange Process System in 24590-WTP-MDD-PR-01-002, WTP MDD.
3.7.3.28 Treated LAW Collection Vessels (CXP-VSL-00026A,B,C) Discharge

Unique ID: BMR-CXP_MR-15

After the sample time, the Treated LAW Collection Vessels (CXP-VSL-00026A,B,C) shall transfer one at a time to the Treated LAW Evaporator (TLP-SEP-00001) at the Treated LAW Collection Vessels (CXP-VSL-00026A,B,C) Pump Out Rate.

Basis: This model requirement is based on the description in Section 4.8.4 Cesium Removal Using ion Exchange Process System in 24590-WTP-MDD-PR-01-002, WTP MDD.

3.7.3.29 Cesium Ion Exchange Columns (CXP-IXC-00001/2/3/4) Regeneration Cycle Counter

Unique ID: BMR-CXP_MR-16

For each column, the number of times that it is regenerated (Cesium Ion Exchange Columns (CXP-IXC-00001/2/3/4) Regeneration Process) shall be counted.

Basis: This model requirement is based on the description in Section 4.8.4 Cesium Removal Using ion Exchange Process System in 24590-WTP-MDD-PR-01-002, WTP MDD.

3.7.4 Technical Requirements

3.7.4.1 Cesium Ion Exchange Feed Vessel (CXP-VSL-00004) Parameters

Unique ID: BMR-CXP_TR-11

The Cesium Ion Exchange Feed Vessel (CXP-VSL-00004) shall have the following parametric values.

<table>
<thead>
<tr>
<th>Vessel #</th>
<th>Maximum Volume (gal)</th>
<th>Upper Set Volume (gal)</th>
<th>Set Volume (gal)</th>
<th>Minimum Volume (gal)</th>
<th>Flow rate (gpm)</th>
<th>Temperature (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CXP-VSL-00004</td>
<td>8,907</td>
<td>7,807</td>
<td>7,807</td>
<td>1,840</td>
<td>30</td>
<td>45</td>
</tr>
</tbody>
</table>

Basis: The vessel parameters are based on Table E-1; Vessel Parameters, in 24590-WTP-MDD-PR-01-002, WTP MDD. The temperature is based on the value for the super tank solubility application in Table 6, Solubility Application in the 24590-WTP-MDD-PR-01-002, WTP MDD.

3.7.4.2 Cesium Ion Exchange Guard Filter (CXP-FILT-00001) Parameters

Unique ID: BMR-CXP_TR-14

The Cesium Ion Exchange Guard Filter (CXP-FILT-00001) shall have the following parametric values.
### 3.7.4.3 Cesium Ion Exchange Columns (CXP-IXC-00001/2/3/4) Parameters

**Unique ID:** BMR-CXP_TR-12

The Cesium Ion Exchange Columns (CXP-IXC-00001/2/3/4) shall have the following parametric values.

<table>
<thead>
<tr>
<th>Vessel #</th>
<th>Column Bed Volume (gal)</th>
<th>Temperature (C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CXP-IXC-00001</td>
<td>600</td>
<td>45</td>
</tr>
<tr>
<td>CXP-IXC-00002</td>
<td>600</td>
<td>45</td>
</tr>
<tr>
<td>CXP-IXC-00003</td>
<td>600</td>
<td>45</td>
</tr>
<tr>
<td>CXP-IXC-00004</td>
<td>600</td>
<td>45</td>
</tr>
</tbody>
</table>

**Basis:** The column resin bed volume are based on Section 2.5.2 Process Description, in 24590-WTP-RPT-PT-02-005, BARD Rev. 8. The temperature is based on the value for the super tank solubility application in Table 6, Solubility Application in the 24590-WTP-MDD-PR-01-002, WTP MDD.

### 3.7.4.4 Treated LAW Collection Vessels (CXP-VSL-00026A,B,C) Parameters

**Unique ID:** BMR-CXP_TR-13

The Treated LAW Collection Vessels (CXP-VSL-00026A,B,C) shall have the following parametric values.

<table>
<thead>
<tr>
<th>Vessel #</th>
<th>Maximum Volume (gal)</th>
<th>Upper Set Volume (gal)</th>
<th>Set Volume (gal)</th>
<th>Minimum Volume (gal)</th>
<th>Flow rate (gpm)</th>
<th>Temperature (C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CXP-VSL-00026A</td>
<td>33,335</td>
<td>29,768</td>
<td>28,768</td>
<td>2,268</td>
<td>30/34</td>
<td>45</td>
</tr>
<tr>
<td>CXP-VSL-00026B</td>
<td>33,335</td>
<td>29,768</td>
<td>28,768</td>
<td>2,268</td>
<td>30/34</td>
<td>45</td>
</tr>
<tr>
<td>CXP-VSL-00026C</td>
<td>33,335</td>
<td>29,768</td>
<td>28,768</td>
<td>2,268</td>
<td>30/34</td>
<td>45</td>
</tr>
</tbody>
</table>

**Basis:** The vessel parameters are based on the values in Table E-1; Vessel Parameters in the 24590-WTP-MDD-PR-01-002, WTP MDD, and the temperature is based on the value for the super tank solubility application in Table 6, Solubility Application in the 24590-WTP-MDD-PR-01-002, WTP MDD.

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**Basis:** The filter parameters are based on the description in Section 4.8.4 Cesium Removal Using ion Exchange Process System in 24590-WTP-MDD-PR-01-002, WTP MDD. The temperature is based on the value for the cesium ion exchange system in Table 6, Solubility Application in the 24590-WTP-MDD-PR-01-002, WTP MDD.
3.7.4.5 Cesium Ion Exchange Guard Filter (CXP-FILT-00001) Solid Removal Efficiency

Unique ID: BMR-CXP_TR-16

The Cesium Ion Exchange Guard Filter (CXP-FILT-00001) shall remove 100% of the incoming solids.

Basis: This model requirement is based on the description in Section 4.8.4 Cesium Removal Using Ion Exchange Process System in 24590-WTP-MDD-PR-01-002, WTP MDD.

3.7.4.6 Cesium Ion Exchange Guard Filter (CXP-FILT-00001) Back Flush Trigger

Unique ID: BMR-CXP_TR-17

The Cesium Ion Exchange Guard Filter (CXP-FILT-00001) trigger for a back flush shall occur after 34 total UFP cycles have occurred or 117 gallons of solids have accumulated (see Track UFP Feed Vessels (UFP-VSL-00002A/B) Cycles).

Basis: This model requirement is based on the description in Section 4.8.4 Cesium Removal Using Ion Exchange Process System in 24590-WTP-MDD-PR-01-002, WTP MDD.

3.7.4.7 Cesium Ion Exchange Guard Filter (CXP-FILT-00001) - Back flush Chemical Addition

Unique ID: BMR-CXP_TR-18

The Cesium Ion Exchange Guard Filter (CXP-FILT-00001) back flush chemical addition shall consist of 80 gallons of 0.1M NaOH.

Basis: This model requirement is based on the description in Section 4.8.4 Cesium Removal Using Ion Exchange Process System in 24590-WTP-MDD-PR-01-002, WTP MDD.

3.7.4.8 Cesium Ion Exchange Guard Filter (CXP-FILT-00001) Back Flush Time

Unique ID: BMR-CXP_TR-19

The Cesium Ion Exchange Guard Filter (CXP-FILT-00001) back flush time shall be 0.25 hours.

Basis: This model requirement is based on the description in Section 4.8.4 Cesium Removal Using Ion Exchange Process System in 24590-WTP-MDD-PR-01-002, WTP MDD.

3.7.4.9 Cesium Ion Exchange Columns (CXP-IXC-00001/2/3/4) Loading Volume Equation

Unique ID: BMR-CXP_TR-1

The loading volume for the lead column shall be calculated using Equation 12 in 24590-WTP-RPT-RT-07-005, Basis of Recommendation for Use of Spherical Resorcinol Formaldehyde Resin as the Primary Cesium Ion Exchange Resin and is shown below.

The following is Equation 12 from Appendix A of 24590-WTP-RPT-RT-07-005.

\[
K_{11} = 10^{-18.6}
\]

\[
K_{12} = 10^{-13.2}
\]
Where:

\[ [\text{Cs}^+] = \text{Soluble cesium concentration in the feed (mol/L)} \]

\[ [\text{K}^+] = \text{Soluble potassium concentration in the feed (mol/L)} \]

\[ [\text{Na}^+] = \text{Soluble sodium concentration in the feed (mol/L)} \]

\[ [\text{OH}^-] = \text{Soluble hydroxide concentration in the feed (mol/L)} \]

\[ K_{a1} = \text{Dissociation Constant } a1: \ 10^{-10.6} \text{ (mol/L)} \]
\[ K_{a2} = \text{Dissociation Constant a2: } 10^{-13.2} \text{ (mol/L)} \]
\[ K_w = \text{Dissociation Constant of water: } 10^{-14} \text{ (mol/L)}^2 \]
\[ Q_{Cs} = \text{Cesium Loading (mmol Cs/g dry H-form resin)} \]
\[ T = \text{Operating temperature in the CsIX (K)} \]

\[
L_{Cs,new} = Q_{Cs} \cdot \left( \frac{\text{mol}}{1000 \text{ mmol}} \right) \cdot AW_{Cs} \cdot \left( \frac{\text{kg}}{1000 \text{ g}} \right) \cdot \rho_{sRF} \cdot \left( \frac{3.785 \text{ mL}}{\text{gal}} \right) \cdot V_{Bed}
\]

Where:
\[ \rho_{sRF} = \text{Density of the resin (0.3 g dry H-form resin/mL wet Na-form resin)} \]
\[ AW_{Cs} = \text{Atomic weight of cesium (g/mol)} \]
\[ L_{Cs,new} = \text{Loading Volume (gallons) for a fresh column.} \]
\[ V_{Bed} = \text{Bed Volume of the CsIX column (600 gal/BV)} \]

**Basis:** The basis for this requirement is directly from Equation 12 in 24590-WTP-RPT-RT-07-005, *Basis of Recommendation for Use of Spherical Resorcinol Formaldehyde Resin as the Primary Cesium Ion Exchange Resin.*

**3.7.4.10 Cesium Ion Exchange Column (CXP-IXC-00001/2/3/4) Loading Rate**

**Unique ID:** BMR-CXP_TR-20

The Cesium Ion Exchange Column (CXP-IXC-00001/2/3/4) shall be loaded at 30 gpm (3 cv/hr).

**Basis:** The loading rate is based on the values listed in Table 16 *Ion Exchange Operating Parameters* (in Section 4.8.4 *Cesium Removal Using Ion Exchange Process System*) in 24590-WTP-MDD-PR-01-002, WTP MDD.

**3.7.4.11 Cesium Ion Exchange Columns (CXP-IXC-00001/2/3/4) Maximum Cesium Accumulation**

**Unique ID:** BMR-CXP_TR-2

The maximum amount of 137-Cs allowed to accumulate on the Cesium Ion Exchange Columns (CXP-IXC-00001/2/3/4) shall be 75,000 curries.
**Basis:** The maximum cesium limit is based on the discussion in Section 2.5.3.8 *Cs Removal Process Basis* in 24590-WTP-RPT-PT-02-005, BARD Rev. 8 and is an operating limit. The technical safety limit is 150,000 Ci of 137-Cs.

### 3.7.4.12 Cesium Ion Exchange Columns (CXP-IXC-00001/2/3/4) Mass Balance

**Unique ID:** BMR-CXP_TR-3

The mass balance of components absorbed onto the lead column is as follows.

<table>
<thead>
<tr>
<th>Ion</th>
<th>Start of Loading Cycle (kg-moles/column)</th>
<th>End of Loading Cycle (kg-moles/column)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Na+</td>
<td>4.63</td>
<td>4.63-(Sum of loading 134-Cs+ 137-Cs +137m-Ba +Cs+)</td>
</tr>
<tr>
<td>134-Cs</td>
<td>0</td>
<td>0.999766*134-Csfeed</td>
</tr>
<tr>
<td>137-Cs</td>
<td>0</td>
<td>0.999766*137-Csfeed</td>
</tr>
<tr>
<td>137m-Ba</td>
<td>0</td>
<td>1.526E-7 * 0.999766*137m-Csfeed</td>
</tr>
<tr>
<td>Cs+</td>
<td>0</td>
<td>0.999766*Cs+feed</td>
</tr>
<tr>
<td>K+</td>
<td>0</td>
<td>Potassium not modeled as collecting on the column.</td>
</tr>
</tbody>
</table>

**Basis:** The mass balance is based on the description in Section 4.8.4 *Cesium Removal Using ion Exchange Process System* in 24590-WTP-MDD-PR-01-002, WTP MDD, with the exception of potassium which is not modeled as collecting on the column in TOPSim at this time. The ratio of K+ to Na+ in the feed is generally very low and the amount of potassium absorbed onto the column is insignificant for the purpose of the TOPSim model (Refer to Figure 23 in 24590-WTP-RPT-RT-07-005, CsIX Resin in WTP )

### 3.7.4.13 Cesium Ion Exchange Columns (CXP-IXC-00001/2/3/4) Regeneration - Displacement Volume

**Unique ID:** BMR-CXP_TR-29

The column displacement volume is 1800 gallons (3 cv) of 0.1M NaOH.

**Basis:** The displacement volume is based on the value listed in Table 16 *Ion Exchange Operating Parameters* (in Section 4.8.4 *Cesium Removal Using ion Exchange Process System*) in 24590-WTP-MDD-PR-01-002, WTP MDD. The chemical reagent is based on Table 15 *Chemical Reagent for Resin Regeneration* also in the MDD.

### 3.7.4.14 Cesium Ion Exchange Columns (CXP-IXC-00001/2/3/4) Regeneration - Displacement Rate

**Unique ID:** BMR-CXP_TR-21

The column displacement rate shall be 30 gpm (3 cv/hr).

**Basis:** The column displacement rate is based on the value listed in Table 16 *Ion Exchange Operating Parameters* (in Section 4.8.4 *Cesium Removal Using ion Exchange Process System*) in 24590-WTP-MDD-PR-01-002, WTP MDD.
3.7.4.15 Cesium Ion Exchange Columns (CXP-IXC-00001/2/3/4) Regeneration - Pre-Elution Rinse Volume

**Unique ID:** BMR-CXP_TR-4

The pre-elution rinse volume shall be 1200 gallons (2 cv) of Water.

**Basis:** The pre-elution volume is based on the value listed in Table 16 Ion Exchange Operating Parameters (in Section 4.8.4 Cesium Removal Using ion Exchange Process System) in 24590-WTP-MDD-PR-01-002, WTP MDD. The chemical reagent is based on Table 15 Chemical Reagent for Resin Regeneration also in the MDD.

3.7.4.16 Cesium Ion Exchange Columns (CXP-IXC-00001/2/3/4) Regeneration - Pre-Elution Rinse Rate

**Unique ID:** BMR-CXP_TR-22

The pre-elution rinse rate shall be 30 gpm (3 cv/hr).

**Basis:** The pre-elution rate is based on the value listed in Table 16 Ion Exchange Operating Parameters (in Section 4.8.4 Cesium Removal Using ion Exchange Process System) in 24590-WTP-MDD-PR-01-002, WTP MDD.

3.7.4.17 Cesium Ion Exchange Columns (CXP-IXC-00001/2/3/4) Regeneration - Elution Volume

**Unique ID:** BMR-CXP_TR-5

The column elution volume shall be 9,000 gallons total (15 cv).

**Basis:** The elution volume is based on the value listed in Table 16 Ion Exchange Operating Parameters (in Section 4.8.4 Cesium Removal Using ion Exchange Process System) in 24590-WTP-MDD-PR-01-002, WTP MDD. The elution reagent is delivered from CXP-VSL-00004 and consist of 0.45 M HNO3 which is specified in the associated model requirement.

3.7.4.18 Cesium Ion Exchange Columns (CXP-IXC-00001/2/3/4) Regeneration - Elution Rate

**Unique ID:** BMR-CXP_TR-23

The column elution rate shall be 10 gpm (1 cv/hr).

**Basis:** The elution rate is based on the value listed in Table 16 Ion Exchange Operating Parameters (in Section 4.8.4 Cesium Removal Using ion Exchange Process System) in 24590-WTP-MDD-PR-01-002, WTP MDD.

3.7.4.19 Cesium Ion Exchange Columns (CXP-IXC-00001/2/3/4) Regeneration - Post Elution Rinse Volume

**Unique ID:** BMR-CXP_TR-6

The post elution rinse volume shall consist of 1500 gallons (2.5 cv) of Water.

**Basis:** The post elution rinse volume is based on the value listed in Table 16 Ion Exchange Operating Parameters (in Section 4.8.4 Cesium Removal Using ion Exchange Process System) in 24590-WTP-MDD-PR-01-002, WTP MDD.
3.7.4.20 Cesium Ion Exchange Columns (CXP-IXC-00001/2/3/4) Regeneration - Post Elution Rinse Rate

Unique ID: BMR-CXP_TR-24

The post elution rinse rate shall be 10 gpm (1 cv/hr).

Basis: The post elution rate is based on the values listed in Table 16 Ion Exchange Operating Parameters (in Section 4.8.4 Cesium Removal Using ion Exchange Process System) in 24590-WTP-MDD-PR-01-002, WTP MDD.

3.7.4.21 Cesium Ion Exchange Columns (CXP-IXC-00001/2/3/4) Regeneration - Regeneration Volume

Unique ID: BMR-CXP_TR-7

The regeneration volume shall be 2,575 gallons (4.292 cv) of 0.5M NaOH.

Basis: The regeneration volume is based on the value listed in Table 16 Ion Exchange Operating Parameters (in Section 4.8.4 Cesium Removal Using ion Exchange Process System) in 24590-WTP-MDD-PR-01-002, WTP MDD. The chemical reagent is based on Table 15 Chemical Reagent for Resin Regeneration also in the MDD.

3.7.4.22 Cesium Ion Exchange Columns (CXP-IXC-00001/2/3/4) Regeneration - Regeneration Rate

Unique ID: BMR-CXP_TR-25

The regeneration rate shall be 27.8 gpm (2.78 cv/hr).

Basis: The regeneration rate is based on the values listed in Table 16 Ion Exchange Operating Parameters (in Section 4.8.4 Cesium Removal Using ion Exchange Process System) in 24590-WTP-MDD-PR-01-002, WTP MDD.

3.7.4.23 Cesium Ion Exchange Columns (CXP-IXC-00001/2/3/4) Regeneration - Column Conditioning Part 1 Volume

Unique ID: BMR-CXP_TR-8

The column conditioning - Part 1 step volume shall be 1,050 gallons.

Basis: The column conditioning - Part 1 volume is based on the value listed in Table 16 Ion Exchange Operating Parameters (in Section 4.8.4 Cesium Removal Using ion Exchange Process System) in 24590-WTP-MDD-PR-01-002, WTP MDD.

3.7.4.24 Cesium Ion Exchange Columns (CXP-IXC-00001/2/3/4) Regeneration - Column Conditioning Part 1 Rate

Unique ID: BMR-CXP_TR-26

The column conditioning - Part 1 rate shall be 9.4 gpm (0.94 cv/hr).
Basis: The column conditioning - Part 1 rate is based on the value listed in Table 16 Ion Exchange Operating Parameters (in Section 4.8.4 Cesium Removal Using ion Exchange Process System) in 24590-WTP-MDD-PR-01-002, WTP MDD.

3.7.4.25 Cesium Ion Exchange Columns (CXP-IXC-00001/2/3/4) Regeneration - Column Conditioning Part 2 Volume

Unique ID: BMR-CXP_TR-9

The column conditioning - Part 2 step volume shall be 200 gallons.

Basis: The column conditioning - Part 2 volume is based on the value listed in Table 16 Ion Exchange Operating Parameters (in Section 4.8.4 Cesium Removal Using ion Exchange Process System) in 24590-WTP-MDD-PR-01-002, WTP MDD.

3.7.4.26 Cesium Ion Exchange Columns (CXP-IXC-00001/2/3/4) Regeneration - Column Conditioning Part 2 Rate

Unique ID: BMR-CXP_TR-27

The column conditioning - Part 2 rate shall be 15 gpm (1.5 cv/hr).

Basis: The column conditioning - Part 2 rate is based on the value listed in Table 16 Ion Exchange Operating Parameters (in Section 4.8.4 Cesium Removal Using ion Exchange Process System) in 24590-WTP-MDD-PR-01-002, WTP MDD.

3.7.4.27 Cesium Ion Exchange Columns (CXP-IXC-00001/2/3/4) Resin Replacement Trigger

Unique ID: BMR-CXP_TR-15

The resin replacement trigger is 10 resin regeneration cycles.

Basis: The resin replacement frequency is specified in Section 2.9.3.1 Resin Replacement Frequency (Assumption 2.9.2) in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

3.7.4.28 Cesium Ion Exchange Columns (CXP-IXC-00001/2/3/4) Spent Resin Transfer Solution Volume

Unique ID: BMR-CXP_TR-28

The Cesium Ion Exchange Columns (CXP-IXC-00001/2/3/4) spent transfer solution volume shall be 4,400 gallons.

Basis: The volume of spent resin transfer solution is based on the discussion in Section 2.11.2 RDP Process Description in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

3.7.4.29 Treated LAW Collection Vessels (CXP-VSL-00026A,B,C) Sample Time

Unique ID: BMR-CXP_TR-10

The Treated LAW Collection Vessels (CXP-VSL-00026A,B,C) sample time is 4.8 hours.

Basis: The Treated LAW Collection Vessels (CXP-VSL-00026A,B,C) sample time is based on model hold time designated in Table B-1; Facility Item Database, in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.
3.7.4.30 Treated LAW Collection Vessels (CXP-VSL-00026A,B,C) Pump Out Rate

Unique ID: BMR-CXP_TR-30

The *Treated LAW Collection Vessels (CXP-VSL-00026A,B,C)* pump out rate shall be 34 gpm.

Basis: The *Treated LAW Collection Vessels (CXP-VSL-00026A,B,C)* pump rate is based on the values in *Table B-1; Facility Item Database*, in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

3.7.5 CXP Figures and Diagrams

3.7.5.1 Simplified Ion-Exchange Diagram

Unique ID: BMR-CXP_FIG-1

![Simplified Ion-Exchange Diagram](image1)

3.7.5.2 CXP-FILT-00001 Logic Diagram

Unique ID: BMR-CXP_FIG-2

![CXP-FILT-00001 Logic Diagram](image2)
3.7.5.3 CXP Column Regeneration Diagram

Unique ID: BMR-CXP_FIG-3
3.7.5.4 CXP-VSL-00026A/B/C Logic Diagram

Unique ID: BMR-CXP FIG-4

3.8 WASTE TREATMENT AND IMMOBILIZATION PLANT CESIUM FRESH RESIN ADDITION PROCESS

The primary purposes of the CRP is to condition the fresh resin and add it to the ion exchange (IX) columns. The as-received, fresh resin is slurried via demineralized water into the Resin Addition Vessel (CRP-VSL-00001), where it mixes with water. The slurry is recirculated through a screen to remove fines from the as-received resin (not modeled). Once fines removal is complete, the demineralized water is decanted to one of the Alkaline Effluent Vessels (RLD-VSL-00017A/B). Sodium hydroxide is then added to convert the resin from the as-delivered H-form to the Na-form. The resin and solution undergoes a wait time to allow the hydrogen form resin to fully convert to the sodium form. The fluid in CRP-VSL-00001 is decanted to RLD-VSL-00017A/B after the wait time and then the alkalinity of the interstitial solution is adjusted by the addition of additional 2 M NaOH.

When a cesium ion exchange resin replacement is triggered, the slurry in CRP-VSL-00001 is transferred by gravity flow to an empty IX column. The fresh resin is captured on the IX column resin screen and the transfer solution is sent with treated LAW to CXP-VSL-00026A/B/C. The actual resin is not modeled and for simplification the prepared fresh resin solution in CRP-VSL-00001 is transferred to its final destination which is RDP-VSL-00002A; skipping the intermediate transfer through the column.

3.8.1 System Requirements

3.8.1.1 CRP Fresh Resin Addition

Unique ID: BMR-CRP_SR-1

The CRP shall prepare and add fresh resin to the CXP ion exchange columns.
Basis: This system requirement is based on the purpose statement in Section 1.0 Introduction in 24590-PTF-3YD-CRP-00001, CRP System Description.

3.8.2 Functional Requirements

3.8.2.1 CRP Fresh Resin Preparation

Unique ID: BMR-CRP_FR-4

The CRP shall have the capability to prepare the fresh resin for use in the CXP columns.

Basis: This functional requirement is based on the description in Sections 3.4 Convert Resin, 3.5 Decantation, and 3.6 Alkalinity Adjustment in 24590-PTF-3YD-CRP-00001, CRP System Description.

3.8.2.2 CRP Transfer to RLD

Unique ID: BMR-CRP_FR-5

The CRP shall have the capability to transfer liquids to the RLD.

Basis: This functional requirement is based on the description in Section 6 Description in 24590-PTF-3YD-CRP-00001, CRP System Description.

3.8.2.3 CRP Transfer Fresh Resin to CXP

Unique ID: BMR-CRP_FR-6

The CRP shall have the capability to transfer the prepared fresh resin slurry to the CXP.

Basis: This functional requirement is based on the description in Section 3.7 Transfer Resin in 24590-PTF-3YD-CRP-00001, CRP System Description.

3.8.3 Model Requirements

3.8.3.1 CRP Cesium Resin Addition Vessel

Unique ID: BMR-CRP_MR-1

The CRP shall include a Cesium Resin Addition Vessel identified as CRP-VSL-00001.

Basis: This model requirement is based on Section 2.9.2 CRP Process Description of the BARD (24590-WTP-RPT-PT-02-005, BARD Rev. 8) and Section 4.8.6 Cesium Fresh Resin Addition Process System in 24590-WTP-MDD-PR-01-002, WTP MDD.

3.8.3.2 CRP Fresh Resin Preparation Step #1 - First Water Addition

Unique ID: BMR-CRP_MR-2

The fresh resin shall be prepared by first transferring the fresh resin water addition #1 into the Cesium Resin Addition Vessel (CRP-VSL-00001). See Fresh Resin Preparation Sequence Diagram. Note- The actual physical resin is not modeled.

Basis: This model requirement is based on the steps in Section 4.8.6 Cesium Fresh Resin Addition Process System in 24590-WTP-MDD-PR-01-002, WTP MDD.
3.8.3.3 CRP Fresh Resin Step #2 - First Hold Time

Unique ID: BMR-CRP_MR-3

After fresh resin step #1 is complete, the CRP Fresh Resin Hold Time #1 shall be applied to the Cesium Resin Addition Vessel (CRP-VSL-00001). See Fresh Resin Preparation Sequence Diagram.

Basis: This model requirement is based on the steps in Section 4.8.6 Cesium Fresh Resin Addition Process System in 24590-WTP-MDD-PR-01-002, WTP MDD. Note That TOPSim does not physically model the resin.

3.8.3.4 CRP Fresh Resin Preparation Step #3 - Transfer to RLD

Unique ID: BMR-CRP_MR-4

After fresh resin step #2 is complete, the entire contents of the Cesium Resin Addition Vessel (CRP-VSL-00001) shall be transferred to one of the Alkaline Effluent Vessels (RLD-VSL-00017A/B). See Fresh Resin Preparation Sequence Diagram.

Basis: This model requirement is based on the steps in Section 4.8.6 Cesium Fresh Resin Addition Process System in 24590-WTP-MDD-PR-01-002, WTP MDD.

3.8.3.5 CRP Fresh Resin Preparation Step #4 - Second Water Addition

Unique ID: BMR-CRP_MR-6

After fresh resin preparation step #3 is complete, the water addition #2 shall be made into the Cesium Resin Addition Vessel (CRP-VSL-00001). See Fresh Resin Preparation Sequence Diagram.

Basis: This model requirement is based on the steps in Section 4.8.6 Cesium Fresh Resin Addition Process System in 24590-WTP-MDD-PR-01-002, WTP MDD; however according to the updated BARD (Section 2.9.2 CRP Process Description in the 24590-WTP-RPT-PT-02-005, BARD Rev. 8 ) this step does not occur. This step is eliminated by setting the water addition #2 value to 0 gallons to minimize rework.

3.8.3.6 CRP Fresh Resin Preparation Step #5 - First Caustic Addition

Unique ID: BMR-CRP_MR-5

After fresh resin preparation step #4 is complete, the caustic addition #1 shall be made into the Cesium Resin Addition Vessel (CRP-VSL-00001). See Fresh Resin Preparation Sequence Diagram.

Basis: This model requirement is based on the steps in Section 4.8.6 Cesium Fresh Resin Addition Process System in 24590-WTP-MDD-PR-01-002, WTP MDD.

3.8.3.7 CRP Fresh Resin Preparation Step #6 - Second Hold Time

Unique ID: BMR-CRP_MR-7

After fresh resin preparation step #5 is complete, the CRP Fresh Resin Hold Time #2 shall be applied in Cesium Resin Addition Vessel (CRP-VSL-00001). See Fresh Resin Preparation Sequence Diagram.
**Basis:** This model requirement is based on the steps in Section 4.8.6 *Cesium Fresh Resin Addition Process System* in 24590-WTP-MDD-PR-01-002, WTP MDD.

### 3.8.3.8 CRP Fresh Resin Preparation Step #7 - Transfer to RLD

**Unique ID:** BMR-CRP_MR-8

After fresh resin step #6 is complete, the CRP *Adjustment Volume* shall be transferred from the *Cesium Resin Addition Vessel (CRP-VSL-00001)* to one of the *Alkaline Effluent Vessels (RLD-VSL-00017A/B)*. See *Fresh Resin Preparation Sequence Diagram*.

**Basis:** This requirement is based on Section 2.9.2 CRP Process Description in the 24590-WTP-RPT-PT-02-005, BARD Rev. 8. This was confirmed in 24590-PTF-MVC-CRP-00004, Batch Specification for the Cesium Resin Addition Vessel (CRP-VSL-00001).

### 3.8.3.9 CRP Fresh Resin Preparation Step #8 - Second Caustic Addition

**Unique ID:** BMR-CRP_MR-9

After fresh resin preparation step #7 is complete, the *caustic addition #2* shall be made into the *Cesium Resin Addition Vessel (CRP-VSL-00001)*. See *Fresh Resin Preparation Sequence Diagram*.

**Basis:** This model requirement is based on the steps in Section 4.8.6 *Cesium Fresh Resin Addition Process System* in 24590-WTP-MDD-PR-01-002, WTP MDD.

### 3.8.3.10 CRP Fresh Resin Preparation Complete - Wait for Resin Replacement Process

**Unique ID:** BMR-CRP_MR-10

After fresh resin preparation step #9 is complete, the *Cesium Resin Addition Vessel (CRP-VSL-00001)* waits until it is called by the *RDP Resin Replacement Step #3 - Transfer Fresh Solution*.

**Basis:** This model requirement is based on the steps in Section 4.8.6 *Cesium Fresh Resin Addition Process System* in 24590-WTP-MDD-PR-01-002, WTP MDD.

### 3.8.3.11 CRP Trigger Repeat Fresh Resin Preparation

**Unique ID:** BMR-CRP_MR-11

After the completion of the *RDP Resin Replacement Step #3 - Transfer Fresh Solution*, the *Cesium Resin Addition Vessel (CRP-VSL-00001)* shall trigger the resin preparation cycle (starting with *CRP Fresh Resin Preparation Step #1 - First Water Addition*).

**Basis:** This model requirement is based on the steps in Section 4.8.6 *Cesium Fresh Resin Addition Process System* in 24590-WTP-MDD-PR-01-002, WTP MDD.
3.8.4 Technical Requirements

3.8.4.1 Cesium Resin Addition Vessel (CRP-VSL-00001) Parameters

**Unique ID:** BMR-CRP_TR-1

The *Cesium Resin Addition Vessel (CRP-VSL-00001)* shall have the following parametric values.

<table>
<thead>
<tr>
<th>Vessel #</th>
<th>Maximum Volume (gal)</th>
<th>Upper Set Volume (gal)</th>
<th>Set Volume (gal)</th>
<th>Minimum Volume (gal)</th>
<th>Flow rate (gpm)</th>
<th>Temperature (C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CRP-VSL-00001</td>
<td>2,500</td>
<td>2,146</td>
<td>1,140</td>
<td>0</td>
<td>60</td>
<td>45</td>
</tr>
</tbody>
</table>

**Basis:** This requirement is based on the values in *Table E-1 Vessel Parameters* found in 24590-WTP-MDD-PR-01-002, WTP MDD. The set volume is based on the CRP fresh resin water addition volume discussed in Section 4.8.6 *Cesium Fresh Resin Addition Process System* in 24590-WTP-MDD-PR-01-002, WTP MDD. The temperature is based on upper range of temperatures given in Section 2.9.3.3 Storage and Aging Effects in the 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

3.8.4.2 CRP Fresh Resin Water Addition #1

**Unique ID:** BMR-CRP_TR-2

The CRP Fresh Resin water addition #1 shall be 390 gallons of *Water*.

**Basis:** This model requirement is based on the steps in Section 2.9.2 CRP Process Description in the 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

3.8.4.3 CRP Fresh Resin Water Addition #2

**Unique ID:** BMR-CRP_TR-3

The CRP Fresh Resin water addition #2 shall be 0 gallons of *Water*.

**Basis:** According to the steps in Section 2.9.2 CRP Process Description in the 24590-WTP-RPT-PT-02-005, BARD Rev. 8 there is no second water addition. This was confirmed in 24590-PTF-MVC-CRP-00004, Batch Specification for the Cesium Resin Addition Vessel (CRP-VSL-00001). The step was maintained to minimize coding rework.

3.8.4.4 CRP Fresh Resin Caustic Addition #1

**Unique ID:** BMR-CRP_TR-4

The CRP fresh resin caustic addition #1 shall be 480 gallons of 2.0M *NaOH*.

**Basis:** This requirement is based on Section 2.9.2 CRP Process Description in the 24590-WTP-RPT-PT-02-005, BARD Rev. 8. This was confirmed in 24590-PTF-MVC-CRP-00004, Batch Specification for the Cesium Resin Addition Vessel (CRP-VSL-00001).
3.8.4.5 CRP Fresh Resin Caustic Addition #2

Unique ID: BMR-CRP_TR-5

The CRP fresh resin caustic addition #2 shall be 270 gallons of 2.0M NaOH.

Basis: This requirement is based on Section 2.9.2 CRP Process Description in the 24590-WTP-RPT-PT-02-005, BARD Rev. 8. This was confirmed in 24590-PTF-MVC-CRP-00004, Batch Specification for the Cesium Resin Addition Vessel (CRP-VSL-00001). Note there is an error in the BARD description that states this is 0.5 M NaOH but according to the referenced specification the target final NaOH concentration is 0.5 M but 2 M NaOH is added.

3.8.4.6 CRP Fresh Resin Hold Time #1

Unique ID: BMR-CRP_TR-6

The CRP fresh resin hold time is 2 hour.

Basis: This requirement is based on Section 2.9.2 CRP Process Description in the 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

3.8.4.7 CRP Fresh Resin Hold Time #2

Unique ID: BMR-CRP_TR-8

The CRP fresh resin hold time is 8 hour.

Basis: This requirement is based on Section 2.9.2 CRP Process Description in the 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

3.8.4.8 CRP Adjustment Volume

Unique ID: BMR-CRP_TR-7

The CRP adjustment volume shall be 211 gallons.

Basis: This requirement is based on Section 2.9.2 CRP Process Description in the 24590-WTP-RPT-PT-02-005, BARD Rev. 8.
3.8.5 CRP Figures and Diagrams

3.8.5.1 Fresh Resin Preparation Sequence Diagram

Unique ID: BMR-CRP_DIG-1
3.9 WASTE TREATMENT AND IMMOBILIZATION PLANT SPENT RESIN COLLECTION AND DEWATERING PROCESS

The purpose of the RDP is to provide the capability to temporarily store and sample spent resin removed from the ion exchange columns and to transfer the resin to a package suitable for solid waste disposal in compliance with 24590-WTP-ICD-MG-01-003, Interface Control Document for Radioactive Solid Waste. The RDP system consist of two Spent Resin Slurry Vessels; RDP-VSL-00002A and RDP-VSL-00002B.

Initially, the spent resin slurry vessel RDP-VSL-00002A will contain transport liquid that had been recycled from previous fresh resin addition or resin removal activities. Vessel RDP-VSL-00002B initially will be empty. After the elution cycle, if a resin change is necessary, the contents of vessel RDP-VSL-00002A are pumped through the spent column into vessel RDP-VSL-00002B. The spent slurry solution is recirculated to evenly suspend particles before sampling to demonstrate compliance for disposal. After the sample time, the spent resin is transferred in a slurry to a disposable resin dewatering container, where the resin is captured. Most of the transfer solution is transferred through the dewatering container and accumulated in RDP-VSL-00002A for reuse. Excess water is sent to FEP-VSL-00017A/B. As fresh resin is added to the emptied column through the Cs resin addition process, the displaced liquor from the column is gravity drained into vessel RDP-VSL-00002A.
3.9.1 System Requirements

3.9.1.1 RDP Receive Spent Resin

Unique ID: BMR-RDP_SR-1

The RDP shall receive and prepare spent resin for disposal.

Basis: This requirement is based on Section 2.9.2 CRP Process Description in the 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

3.9.2 Functional Requirements

3.9.2.1 RDP Resin Removal Liquids

Unique ID: BMR-RDP_FR-1

The RDP shall have the capability to transfer liquids to the CXP columns for spent resin removal.

Basis: This requirement is based on Section 2.9.2 CRP Process Description in the 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

3.9.2.2 RDP Receive Spent Resin

Unique ID: BMR-RDP_FR-2

The RDP shall have the capability to receive spent resin slurries from the CXP ion exchange columns.

Basis: This requirement is based on Section 2.9.2 CRP Process Description in the 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

3.9.2.3 RDP Sample Spent Resin

Unique ID: BMR-RDP_FR-4

The RDP shall have the capability to sample the spent resin.

Basis: This requirement is based on Section 2.9.2 CRP Process Description in the 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

3.9.2.4 RDP Dewatering

Unique ID: BMR-RDP_FR-5

The RDP shall have the capability to transfer water from the spent resin slurry (dewatering) to the FEP.

Basis: This requirement is based on Section 2.9.2 CRP Process Description in the 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

3.9.2.5 RDP Receive Displacement Liquids

Unique ID: BMR-RDP_FR-7

The RDP shall have the capability to receive from the CXP ion exchange columns during fresh resin additions.
Basis: This requirement is based on Section 2.9.2 CRP Process Description in the 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

3.9.3 Model Requirements

3.9.3.1 RDP Spent Slurry Vessels

Unique ID: BMR-RDP_MR-1

The spent slurry vessels are identified as RDP-VSL-00002A and RDP-VSL-00002B. Note RDP-VSL-00002C is not modeled.

Basis: This requirement is based on Section 2.9.2 CRP Process Description in the 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

3.9.3.2 Spent Resin Slurry Vessel (RDP-VSL-00002A) Initial Fill

Unique ID: BMR-RDP_MR-2

The Spent Resin Slurry Vessel (RDP-VSL-00002A) shall initially be filled with the RDP-VSL-00002A Initial Chemical Addition.

Basis: This requirement is based on Section 2.9.2 CRP Process Description in the 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

3.9.3.3 RDP Resin Replacement Step #1 - Transfer Spent Resin

Unique ID: BMR-RDP_MR-3

After the Resin Replacement Trigger has been met, the resin replacement steps shall begin by transferring the contents of the Spent Resin Slurry Vessel (RDP-VSL-00002A) to the Spent Resin Slurry Vessel (RDP-VSL-00002B); Transfer until the minimum volume is reached.

Basis: This requirement is based on Section 2.9.2 CRP Process Description in the 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

3.9.3.4 RDP Resin Replacement Step #2 - RDP-VSL-00002B Sample Time

Unique ID: BMR-RDP_MR-4

After the resin replacement step #1 is complete, the RDP-VSL-00002B sample time shall be applied to the Spent Resin Slurry Vessel (RDP-VSL-00002B).

Basis: This requirement is based on Section 2.9.2 CRP Process Description in the 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

3.9.3.5 RDP Resin Replacement Step #3 - Transfer Fresh Solution

Unique ID: BMR-RDP_MR-5

After the resin replacement #2 step is complete, the contents of the Cesium Resin Addition Vessel (CRP-VSL-00001) shall be transferred to Spent Resin Slurry Vessel (RDP-VSL-00002A).

Basis: This requirement is based on Section 2.9.2 CRP Process Description in the 24590-WTP-RPT-PT-02-005, BARD Rev. 8.
3.9.3.6 RDP Resin Replacement Step #4 - Column Flush Water

Unique ID: BMR-RDP_MR-6

After the resin replacement #3 step is complete, the fresh resin flush water shall be added to the Cesium Resin Addition Vessel (CRP-VSL-00001) and then transferred to the Spent Resin Slurry Vessel (RDP-VSL-00002A).

Basis: This requirement is based on Section 2.9.2 CRP Process Description in the 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

3.9.3.7 RDP Resin Replacement Step #5 - Transfer RDP-VSL-00002B to RDP-VSL-00002A

Unique ID: BMR-RDP_MR-9

After the resin replacement step #4 is complete, the content of the Spent Resin Slurry Vessel (RDP-VSL-00002B) shall be transferred to the Spent Resin Slurry Vessel (RDP-VSL-00002A). The transfer is complete when the Spent Resin Slurry Vessel (RDP-VSL-00002B) reaches its minimum volume.

Basis: This requirement is based on Section 2.9.2 CRP Process Description in the 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

3.9.3.8 RDP Resin Replacement Step #6 - RDP-VSL-00002A Hold Time

Unique ID: BMR-RDP_MR-8

After the resin replacement step #4 is complete, the Spent Resin Slurry Vessel (RDP-VSL-00002A) Hold Time shall be applied to the Spent Resin Slurry Vessel (RDP-VSL-00002A) Hold Time.

Basis: This requirement is based on Section 2.9.2 CRP Process Description in the 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

3.9.3.9 RDP Resin Replacement Step #7 - Transfer Flush Water

Unique ID: BMR-RDP_MR-7

After the resin replacement step #6 step is complete, the spent resin transfer flush water shall be added to Spent Resin Slurry Vessel (RDP-VSL-00002A).

Basis: This requirement is based on Section 2.9.2 CRP Process Description in the 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

3.9.3.10 RDP Resin Replacement Step #8 - Spent Resin Slurry Vessel (RDP-VSL-00002A) Transfer to FEP

Unique ID: BMR-RDP_MR-10

After the resin replacement step #7 is complete, the Spent Resin Slurry Vessel (RDP-VSL-00002A) shall transfer excess volume above its set point to one of the Waste Feed Evaporator Feed Vessels (FEP-VSL-00017A/B). The transfer shall continue until RDP-VSL-00002A reaches its set point (see RDP-VSL-00002A Parameters).
3.9.4 Technical Requirements

3.9.4.1 Spent Resin Slurry Vessel (RDP-VSL-00002A) Parameters

Unique ID: BMR-RDP_TR-1

The Spent Resin Slurry Vessel (RDP-VSL-00002A) shall have the following parametric values.

<table>
<thead>
<tr>
<th>Vessel #</th>
<th>Maximum Volume (gal)</th>
<th>Upper Set Volume (gal)</th>
<th>Set Volume (gal)</th>
<th>Minimum Volume (gal)</th>
<th>Flow rate (gpm)</th>
<th>Temperature (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>RDP-VSL-00002A</td>
<td>12,688</td>
<td>7,525</td>
<td>7,508</td>
<td>8</td>
<td>140</td>
<td>25</td>
</tr>
</tbody>
</table>

Basis: This requirement is based on Section 2.9.2 CRP Process Description in the 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

3.9.4.2 Spent Resin Slurry Vessel (RDP-VSL-00002B) Parameters

Unique ID: BMR-RDP_TR-2

The Spent Resin Slurry Vessel (RDP-VSL-00002B) shall have the following parametric values.

<table>
<thead>
<tr>
<th>Vessel #</th>
<th>Maximum Volume (gal)</th>
<th>Upper Set Volume (gal)</th>
<th>Set Volume (gal)</th>
<th>Minimum Volume (gal)</th>
<th>Flow rate (gpm)</th>
<th>Temperature (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>RDP-VSL-00002B</td>
<td>12,688</td>
<td>7,525</td>
<td>7,508</td>
<td>8</td>
<td>140</td>
<td>25</td>
</tr>
</tbody>
</table>

Basis: This requirement is based on Section 2.9.2 CRP Process Description in the 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

3.9.4.3 Spent Resin Slurry Vessel (RDP-VSL-00002A) Initial Chemical Addition

Unique ID: BMR-RDP_TR-3

The Spent Resin Slurry Vessel (RDP-VSL-00002A) initial chemical addition is 4,400 gallons of 0.25M NaOH.

Basis: This requirement is based on Section 2.9.2 CRP Process Description in the 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

3.9.4.4 Spent Resin Slurry Vessel (RDP-VSL-00002B) Sample Time

Unique ID: BMR-RDP_TR-4

The Spent Resin Slurry Vessel (RDP-VSL-00002B) sample time shall be 5.5 hours.

Basis: This requirement is based on Section 2.9.2 CRP Process Description in the 24590-WTP-RPT-PT-02-005, BARD Rev. 8.
3.9.4.5 Spent Resin Slurry Vessel (RDP-VSL-00002A) Hold Time

**Unique ID:** BMR-RDP_TR-7

The *Spent Resin Slurry Vessel (RDP-VSL-00002A)* hold time shall be 6 hours.

**Basis:** This requirement is based on Section 2.9.2 CRP Process Description in the 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

3.9.4.6 RDP Fresh Resin Flush Water

**Unique ID:** BMR-RDP_TR-5

The fresh resin flush shall be 100 gallons of *Water*.

**Basis:** This requirement is based on Section 2.9.2 CRP Process Description in the 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

3.9.4.7 Spent Resin Transfer Flush Water

**Unique ID:** BMR-RDP_TR-6

The RDP transfer flush shall consist of 800 gallons of *Water*.

**Basis:** This requirement is based on Section 2.9.2 CRP Process Description in the 24590-WTP-RPT-PT-02-005, BARD Rev. 8.
3.9.5 RDP Figures and Diagrams

3.9.5.1 Spent Resin Replacement Sequence Diagram

Unique ID: BMR-TXT-254

3.10 WASTE TREATMENT AND IMMOBILIZATION PLANT TREATED LOW-ACTIVITY WASTE EVAPORATION PROCESS

The primary purpose of the TLP is to concentrate the pretreated feed to the LAW and SLAW melters. The TLP also collects the offgas condensate from the LAW Vitrification Facility, neutralizes the stream, and evaporates the recycle stream with the treated LAW feed. The TLP system consists of two LAW SBS Condensate Receipt Vessels (TLP-VSL-00009A & B), a Treated LAW Evaporator (TLP-SEP-00001) for concentrating the treated LAW feed, a Treated LAW Evaporator Demister (TLP-DMST-00001) and an Evaporator Condensate Vessel (TLP-VSL-00002).

The LAW SBS waste is routed to the LAW SBS condensate vessel (TLP-VSL-00009A/B) and when the vessel is full, caustic is added to neutralize the contents to pH 12. The TLP-VSL-00009A and B vessels alternate between receiving and discharging. Treated LAW from CXP-VSL-00026A/B/C and the SBS recycle from TLP-VSL-00009A and B are fed forward to the evaporator where constituents are boiled off based on splits. Dynamic splits, identical to the 242-A Evaporator are used for the TLP evaporator which are based on the WVR.
The bottoms product from TLP-SEP-00001 is transferred to the treated LAW concentrate storage vessel (TCP-VSL-00001). The offgas from TLP-SEP-00001 is routed to the condenser/demister TLP-DMST-00001. The condenser receives offgas from the evaporators. Split factors are applied and the condensed liquid stream is collected in TLP-VSL-00002 and then sent to the RLD system via RLD-VSL-00006A and the noncondensable stream is routed to the WTP pretreatment stack. Air and water are constantly added to the condenser. All of the added water leaves with the condensate and all of the added air is routed to the stack. As a model simplification the intermediate vessel TLP-VSL-00002 is not modeled and the condensate stream is sent directly to RLD-VSL-00006A from TLP-DMST-00001.

3.10.1 System Requirements

3.10.1.1 TLP Provide Concentrated LAW Feed for Vitrification

**Unique ID:** BMR-TLP_SR-1

The *TLP* shall receive treated *LAW* feed and *LAW* Vitrification Facility offgas condensate, then concentrate it and transfer the concentrate and effluents to downstream processes.

**Basis:** This system requirement is based on the primary purpose statement in Section 1 of 24590-PTF-3YD-TLP-00001, *TLP System Description*.

3.10.2 Functional Requirements

3.10.2.1 TLP Feed Receipt of Treated LAW

**Unique ID:** BMR-TLP_FR-1

The *TLP* shall have the capability to receive treated *LAW* feed from the CXP.
Basis: This functional requirement is based on Section 3.1 Receive Treated LAW Feed in 24590-PTF-3YD-TLP-00001, TLP System Description.

3.10.2.2 TLP Feed Receipt from LOP
Unique ID: BMR-TLP_FR-2
The TLP shall have the capability to receive melter offgas condensate from the RLD system.

Basis: This functional requirement is based on Section 3.1 Receive Treated LAW Feed in 24590-PTF-3YD-TLP-00001, TLP System Description.

3.10.2.3 TLP Feed Blending
Unique ID: BMR-TLP_FR-9
The TLP shall have the capability to blend the feeds received.

Basis: This functional requirement is based on Section 3.3 Blend Treated LAW Feed in 24590-PTF-3YD-TLP-00001, TLP System Description.

3.10.2.4 TLP Concentrate Feed
Unique ID: BMR-TLP_FR-3
The TLP shall have the capability to concentrate the received feeds using evaporation.

Basis: This functional requirement is based on Section 3.4 Concentrate Process Fluids in 24590-PTF-3YD-TLP-00001, TLP System Description.

3.10.2.5 TLP Condense the Offgas
Unique ID: BMR-TLP_FR-4
The TLP shall have the capability to condense the vapor in the evaporator offgas.

Basis: This functional requirement is based on Section 3.6 Transfer Overheads in 24590-PTF-3YD-TLP-00001, TLP System Description.

3.10.2.6 TLP Evaporator Concentrate Transfer to TCP
Unique ID: BMR-TLP_FR-5
The TLP shall have the capability to transfer the evaporator concentrate to the TCP.

Basis: This functional requirement is based on Section 3.5 Transfer Concentrate Fluids in 24590-PTF-3YD-TLP-00001, TLP System Description.

3.10.2.7 TLP Offgas Routing
Unique ID: BMR-TLP_FR-6
The TLP shall have the capability to route the non-condensable stream from the evaporator offgas to the PVP and then to the Pretreatment Stack. Note - The PVP is not modeled.

Basis: This functional requirement is based on Section 3.6 Transfer Overheads in 24590-PTF-3YD-TLP-00001, TLP System Description.
3.10.2.8 TLP Process Condensate Routing

**Unique ID:** BMR-TLP_FR-7

The *TLP* shall have the capability to route the condensable stream from the evaporator offgas to the *RLD*.

**Basis:** This functional requirement is based on Section 3.5 *Transfer Concentrate Fluids* in 24590-PTF-3YD-TLP-00001, *TLP System Description*.

3.10.3 Model Requirements

3.10.3.1 TLP LAW SBS Condensate Receipt Vessels (TLP-VSL-00009A and TLP-VSL-00009B)

**Unique ID:** BMR-TLP_MR-1

The *TLP* shall include two LAW SBS Condensate Receipt vessels identified as TLP-VSL-00009A and TLP-VSL-00009B.

**Basis:** This model requirement is based on Section 2.12.2 *TLP Process Description* of the BARD (24590-WTP-RPT-PT-02-005, BARD Rev. 8) and Section 4.8.8 *Treated LAW Evaporation Process (TLP) System* in 24590-WTP-MDD-PR-01-002, *WTP MDD*.

3.10.3.2 Treated LAW Evaporator (TLP-SEP-00001)

**Unique ID:** BMR-TLP_MR-2

The *TLP* shall include an evaporator vessel identified as TLP-SEP-00001.

**Basis:** This model requirement is based on Section 2.12.2 *TLP Process Description* of the BARD (24590-WTP-RPT-PT-02-005, BARD Rev. 8) and Section 4.8.8 *Treated LAW Evaporation Process (TLP) System* in 24590-WTP-MDD-PR-01-002, *WTP MDD*.

3.10.3.3 Treated LAW Evaporator Demister (TLP-DMST-00001)

**Unique ID:** BMR-TLP_MR-3

The *TLP* shall include a demister/condenser unit identified as TLP-DMST-00001, which represents the functionality of a demister, and three condenser units (primary, inter and after).

**Basis:** This model requirement is based on Section 4.8.8 *Treated LAW Evaporation Process (TLP) System* in 24590-WTP-MDD-PR-01-002, *WTP MDD*.

3.10.3.4 LAW SBS Condensate Receipt Vessels (TLP-VSL-00009A/B) Feed Source

**Unique ID:** BMR-TLP_MR-5

The two *LAW SBS Condensate Receipt Vessels (TLP-VSL-00009A/B)* shall each receive feed from the *SBS Condensate Collection Vessel (RLD-VSL-00005)*.

**Basis:** This model requirement is based on the description in Section 4.8.11 *Radioactive Liquid Waste Disposal (RLS) System* in 24590-WTP-MDD-PR-01-002, *WTP MDD*.
3.10.3.5 LAW SBS Condensate Receipt Vessels (TLP-VSL-00009A/B) Receipt Trigger

Unique ID: BMR-TLP_MR-6

Each of the LAW SBS Condensate Receipt Vessels (TLP-VSL-00009A/B) shall be available to receive waste when the volume is less than the set volume.

Basis: This model requirement is based the description in Section 4.8.8 Treated LAW Evaporation Process (TLP) System of 24590-WTP-MDD-PR-01-002, WTP MDD.

3.10.3.6 LAW SBS Condensate Receipt Vessels (TLP-VSL-00009A/B) Alternate Filling

Unique ID: BMR-TLP_MR-7

The LAW SBS Condensate Receipt Vessels (TLP-VSL-00009A/B) shall fill in an alternating fashion (e.g. as one is filling the other is emptying).

Basis: This model requirement is based the description in Section 4.8.8 Treated LAW Evaporation Process (TLP) System of 24590-WTP-MDD-PR-01-002, WTP MDD.

3.10.3.7 LAW SBS Condensate Receipt Vessels (TLP-VSL-00009A/B) Complete Filling

Unique ID: BMR-TLP_MR-8

Each of the LAW SBS Condensate Receipt Vessels (TLP-VSL-00009A/B) shall complete filling when the volume is at the set volume.

Basis: This model requirement is based the description in Section 4.8.8 Treated LAW Evaporation Process (TLP) System of 24590-WTP-MDD-PR-01-002, WTP MDD.

3.10.3.8 LAW SBS Condensate Receipt Vessels (TLP-VSL-00009A/B) Apply Reactions

Unique ID: BMR-TLP_MR-9

Each time one of the LAW SBS Condensate Receipt Vessels (TLP-VSL-00009A/B) has been filled to the set volume the TLP-VSL-00009A/B Reactions shall be applied.

Basis: This model requirement is based the description in Section 4.8.8 Treated LAW Evaporation Process (TLP) System of 24590-WTP-MDD-PR-01-002, WTP MDD.

3.10.3.9 LAW SBS Condensate Receipt Vessels (TLP-VSL-00009A/B) pH Adjustment

Unique ID: BMR-TLP_MR-21

After the reactions have been applied in the LAW SBS Condensate Receipt Vessels (TLP-VSL-00009A/B), then the pH of the vessel shall be adjusted by adding enough TLP-VSL-00009A/B Caustic to meet the target pH without exceeding the upper set volume. After the caustic addition, the TLP-VSL-00009A/B Reactions shall be reapplied.

Basis: This model requirement is based the description in Section 4.8.8 Treated LAW Evaporation Process (TLP) System of 24590-WTP-MDD-PR-01-002, WTP MDD.
3.10.3.10 LAW SBS Condensate Receipt Vessels (TLP-VSL-00009A/B) Routing

Unique ID: BMR-TLP_MR-10

Once the pH has been adjusted, the contents of the LAW SBS Condensate Receipt Vessels (TLP-VSL-00009A or B) shall be transferred to the Treated LAW Evaporator (TLP-SEP-00001).

Basis: This model requirement is based the description in Section 4.8.8 Treated LAW Evaporation Process (TLP) System of 24590-WTP-MDD-PR-01-002, WTP MDD.

3.10.3.11 LAW SBS Condensate Receipt Vessels (TLP-VSL-00009A/B) Transfer Complete

Unique ID: BMR-TLP_MR-11

Each of the LAW SBS Condensate Receipt Vessels (TLP-VSL-00009A/B) shall complete transferring when it has reached its minimum volume.

Basis: This model requirement is based the description in Section 4.8.8 Treated LAW Evaporation Process (TLP) System of 24590-WTP-MDD-PR-01-002, WTP MDD.

3.10.3.12 Treated LAW Evaporator (TLP-SEP-00001) Routing

Unique ID: BMR-TLP_MR-15

The Treated LAW Evaporator (TLP-SEP-00001) shall send vapors to the Treated LAW Evaporator Demister (TLP-DMST-00001) and the liquid concentrate to the Treated LAW Concentrate Storage Vessel (TCP-VSL-00001).

Basis: This model requirement is based the description in Section 4.8.8 Treated LAW Evaporation Process (TLP) System of 24590-WTP-MDD-PR-01-002, WTP MDD.

3.10.3.13 Treated LAW Evaporator (TLP-SEP-00001) Feed Receipt

Unique ID: BMR-TLP_MR-22

The Treated LAW Evaporator (TLP-SEP-00001) shall receive feed from the LAW SBS Condensate Receipt Vessels (TLP-VSL-00009A/B) and the Treated LAW Collection Vessels (CXP-VSL-00026A,B,C).

Basis: This model requirement is based the description in Section 4.8.8 Treated LAW Evaporation Process (TLP) System of 24590-WTP-MDD-PR-01-002, WTP MDD.

3.10.3.14 Treated LAW Evaporator (TLP-SEP-00001) Feed Receipt Logic

Unique ID: BMR-TLP_MR-24

The Treated LAW Evaporator (TLP-SEP-00001) shall receive waste based on the following priority:

1. Dual-Pumping Mode when feed is available in both the Treated LAW Collection Vessels (CXP-VSL-00026A,B,C) and the LAW SBS Condensate Receipt Vessels (TLP-VSL-00009A/B). The feed receipt rates are the CXP-VSL-00026A,B,C Dual-Pumping Rate and the maximum pump rate of TLP-VSL-00009A/B respectively.

2. Feed-Only Mode when there is no recycles available in the LAW SBS Condensate Receipt Vessels (TLP-VSL-00009A/B) but there is feed available in the Treated LAW
Collection Vessels (CXP-VSL-00026A,B,C). Feed receipt rate shall be the CXP-VSL-00026A,B,C "Feed-Only" Pump Out Rate.

3. **Recycle-Only Mode** when there is no feed in the Treated LAW Collection Vessels (CXP-VSL-00026A,B,C) but there is recycles in the LAW SBS Condensate Receipt Vessels (TLP-VSL-00009A/B). Feed receipt rate is equal to the maximum pump rate of TLP-VSL-00009A/B. (see TLP-VSL-00009A and TLP-VSL-00009B Vessel Parameters)

**Basis:** This model requirement is based the description in Section 4.8.8 *Treated LAW Evaporation Process (TLP) System* of 24590-WTP-MDD-PR-01-002, WTP MDD.

### 3.10.3.15 Treated LAW Evaporator (TLP-SEP-00001) Water Boil Off

**Unique ID:** BMR-TLP_MR-13

The rate of water boiled off in the *Treated LAW Evaporator (TLP-SEP-00001)* shall not exceed the target *TLP maximum boil-off rate*.

**Basis:** This model requirement is based the description in Section 4.8.8 *Treated LAW Evaporation Process (TLP) System* of 24590-WTP-MDD-PR-01-002, WTP MDD.

### 3.10.3.16 Treated LAW Evaporator (TLP-SEP-00001) Discharge Rate

**Unique ID:** BMR-TLP_MR-23

The *Treated LAW Evaporator (TLP-SEP-00001)* shall discharge at a rate necessary to maintain a constant volume in the separator vessel and shall not exceed the *TLP-SEP-00001 Maximum Concentrate Flow Rate*.

**Basis:** This model requirement is based the description in Section 4.8.8 *Treated LAW Evaporation Process (TLP) System* of 24590-WTP-MDD-PR-01-002, WTP MDD.

### 3.10.3.17 Treated LAW Evaporator (TLP-SEP-00001) End Point

**Unique ID:** BMR-TLP_MR-12

The *Treated LAW Evaporator (TLP-SEP-00001)* shall concentrate the feed to the *TLP Evaporator Target Concentration Endpoint*.

**Basis:** This model requirement is based the description in Section 4.8.8 *Treated LAW Evaporation Process (TLP) System* of 24590-WTP-MDD-PR-01-002, WTP MDD.

### 3.10.3.18 Treated LAW Evaporator (TLP-SEP-00001) Offgas Component Splits

**Unique ID:** BMR-TLP_MR-14

The predicted components carried into the vapor stream from the *Treated LAW Evaporator (TLP-SEP-00001)* shall be calculated based on the method described in *RPP-RPT-52097, Evaporator Partition Coefficients* (see *TLP-SEP-00001 Dynamic Decontamination Factors*).

**Basis:** The splits for the TLP evaporator follow the recommendations in *RPP-RPT-52097, Evaporator Partition Coefficients* and are dynamic based on the WVR.
3.10.3.19  Treated LAW Evaporator Demister (TLP-DMST-00001) Routing

Unique ID: BMR-TLP_MR-16

The Treated LAW Evaporator Demister (TLP-DMST-00001) vapor shall be routed to the WTP-Stack and condensate shall be routed to the Process Condensate Vessel (RLD-VSL-00006A).

Basis: This model requirement is based the description in Section 4.8.8 Treated LAW Evaporation Process (TLP) System of 24590-WTP-MDD-PR-01-002, WTP MDD. Note the vapors actually are routed first through the PVP then to the stack; however the PVP is not modeled at this time.

3.10.3.20  Treated LAW Evaporator Demister (TLP-DMST-00001) Component Split

Unique ID: BMR-TLP_MR-17

The predicted component splits in the Treated LAW Evaporator Demister (TLP-DMST-00001) offgas and condensate shall be based on the TLP-DMST-00001 split factors.

Basis: This model requirement is based the description in Section 4.8.8 Treated LAW Evaporation Process (TLP) System of 24590-WTP-MDD-PR-01-002, WTP MDD.

3.10.3.21  Treated LAW Evaporator Demister (TLP-DMST-00001) Water Addition

Unique ID: BMR-TLP_MR-18

The Treated LAW Evaporator Demister (TLP-DMST-00001) shall include the TLP-DMST-00001 Water Addition when operating, which represents the amount of steam condensate added while using the vacuum eductor system to maintain a vacuum between the evaporator and condensers.

Basis: This model requirement is based the description in Section 4.8.8 Treated LAW Evaporation Process (TLP) System of 24590-WTP-MDD-PR-01-002, WTP MDD. Note - since the intermediate tank TLP-VSL-00002 is not modeled the water is added directly to the demister.

3.10.3.22  Treated LAW Evaporator Demister (TLP-DMST-00001) Air Addition

Unique ID: BMR-TLP_MR-19

The Treated LAW Evaporator Demister (TLP-DMST-00001) shall include the TLP-DMST-00001 Air Addition when operating which represents the control air used to maintain a relatively constant air flow to the vacuum eductor.

Basis: This model requirement is based on the values in Table B-10 Chemical Reagents for TLP/TCP in 24590-WTP-MDD-PR-01-002, WTP MDD.

3.10.3.23  Treated LAW Evaporator Demister (TLP-DMST-00001) Offgas Conditions

Unique ID: BMR-TLP_MR-20

Offgas from Treated LAW Evaporator Demister (TLP-DMST-00001) shall be discharged at the saturation conditions of the condenser outlet conditions, which is calculated by using the Mole Fraction of Water at Saturation equation at the TLP-DMST-00001 Outlet Conditions.

Basis: This model requirement is based the description in Section 2.12.3.15 Condenser Outlet Temperatures of 24590-WTP-RPT-PT-02-005, BARD Rev. 8.
3.10.4 Technical Requirements

3.10.4.1 TLP-VSL-00009A and TLP-VSL-00009B Vessel Parameters

Unique ID: BMR-TLP_TR-1

The LAW SBS Condensate Receipt Vessels (TLP-VSL-00009A/B) shall each have the following parametric values.

<table>
<thead>
<tr>
<th>Vessel #</th>
<th>Maximum Volume (gal)</th>
<th>Upper Set Volume</th>
<th>Set Volume (gal)</th>
<th>Minimum Volume (gal)</th>
<th>Maximum Flow rate (gpm)</th>
<th>Temperature (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>TLP-VSL-00009A/B</td>
<td>114,064</td>
<td>87,450</td>
<td>82,450</td>
<td>7,450</td>
<td>30</td>
<td>25</td>
</tr>
</tbody>
</table>

Basis: The vessel parameters are based on the values in Table E-1: Vessel Parameters in the 24590-WTP-MDD-PR-01-002, WTP MDD and the temperature is based on engineering judgment. The maximum pump rate is based on the boil-off rate of the evaporator.

3.10.4.2 Treated LAW Evaporator (TLP-SEP-00001) Parameters

Unique ID: BMR-TLP_TR-2

For simplification, the Treated LAW Evaporator (TLP-SEP-00001) shall be modeled as splitter which does not have the physical attributes of the actual vessel associated with it.

Basis: This is a modeling simplification. To model the evaporator for flowsheet purposes the actual physical volume is not required.

3.10.4.3 Treated LAW Evaporator Demister (TLP-DMST-00001) Vessel Parameters

Unique ID: BMR-TLP_TR-3

The Treated LAW Evaporator Demister (TLP-DMST-00001) shall have the following parametric values.

<table>
<thead>
<tr>
<th>Vessel #</th>
<th>Maximum Volume (gal)</th>
<th>Upper Set Volume</th>
<th>Set Volume (gal)</th>
<th>Minimum Volume (gal)</th>
<th>Flow rate (gpm)</th>
<th>Temperature (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>TLP-DMST-00001</td>
<td>1,300</td>
<td>1,300</td>
<td>350</td>
<td>50</td>
<td>66</td>
<td>30 (outlet)</td>
</tr>
</tbody>
</table>

Basis: The parameters for the TLP demister are based on the values in Table E-1 in 24590-WTP-MDD-PR-01-002, WTP MDD. The temperature is based on the value specified in Section 2.12.3.15 Condenser Outlet Temperatures in the BARD (24590-WTP-RPT-PT-02-005, BARD Rev. 8).

3.10.4.4 LAW SBS Condensate Receipt Vessels (TLP-VSL-00009A/B) Caustic

Unique ID: BMR-TLP_TR-11

5.0M NaOH shall be added to the LAW SBS Condensate Receipt Vessels (TLP-VSL-00009A/B) for pH adjustment.

Basis: This requirement is based the description in Section 4.8.8 Treated LAW Evaporation Process (TLP) System of 24590-WTP-MDD-PR-01-002, WTP MDD.
3.10.4.5 LAW SBS Condensate Receipt Vessels (TLP-VSL-00009A/B) Target pH

**Unique ID:** BMR-TLP_TR-12

The target pH endpoint for the *LAW SBS Condensate Receipt Vessels (TLP-VSL-00009A/B)* shall be 12.0.

**Basis:** This requirement is based the description in Section 4.8.8 *Treated LAW Evaporation Process (TLP) System* of 24590-WTP-MDD-PR-01-002, WTP MDD.

3.10.4.6 LAW SBS Condensate Receipt Vessels (TLP-VSL-00009A/B) Reactions

**Unique ID:** BMR-TLP_TR-13

The *LAW SBS Condensate Receipt Vessels (TLP-VSL-00009A/B)* reactions are as follows:

- **RXN-NH4-NEUTRALIZATION** Conversion = 1.0
- **HG-LIQUID-to-SOLID** Conversion = 1.0
- **NEUT-REACTION** Conversion = 1.0

**Basis:** This requirement is based the description in Section 4.8.8 *Treated LAW Evaporation Process (TLP) System* of 24590-WTP-MDD-PR-01-002, WTP MDD.

3.10.4.7 Treated LAW Evaporator (TLP-SEP-00001) Dynamic Decontamination Factors

**Unique ID:** BMR-TLP_TR-4

The partition factors from the "EVAP-SEP" tab of *SVF-1778, HTWOS Equipment Splits Rev. 8* shall be applied to the *Treated LAW Evaporator (TLP-SEP-00001)* based on the Equation 6 in *RPP-RPT-52097, Recommendation for Updating Evaporator Partition Coefficients*.

**Basis:** This requirement is based on *SVF-1778, HTWOS Equipment Splits Rev. 8* and Equation 6 in *RPP-RPT-52097, Evaporator Partition Coefficients*.

3.10.4.8 Treated LAW Evaporator (TLP-SEP-00001) Maximum Concentrate Flow Rate

**Unique ID:** BMR-TLP_TR-14

The *Treated LAW Evaporator (TLP-SEP-00001)* concentrate flow rate shall not exceed 34 gpm.

**Basis:** This requirement is based the description in Section 4.8.8 *Treated LAW Evaporation Process (TLP) System* of 24590-WTP-MDD-PR-01-002, WTP MDD.

3.10.4.9 Treated LAW Evaporator (TLP-SEP-00001) Target Concentration Endpoint

**Unique ID:** BMR-TLP_TR-5

The *Treated LAW Evaporator (TLP-SEP-00001)* target concentration endpoint is a SpG of 1.33 or 3.4 wt% solids, whichever threshold is reached first.

**Basis:** This requirement is based the description in Section 4.8.8 *Treated LAW Evaporation Process (TLP) System* of 24590-WTP-MDD-PR-01-002, WTP MDD.
3.10.4.10 Treated LAW Evaporator (TLP-SEP-00001) Maximum Boil-Off Rate

Unique ID: BMR-TLP_TR-6

The maximum boil-off rate for the Treated LAW Evaporator (TLP-SEP-00001) is 28 gpm. This is the maximum design rate of 30 gpm minus the 2 gpm used for the evaporator recycle spray.

Basis: This requirement is based on the description in Section 4.8.8 Treated LAW Evaporation Process (TLP) System of 24590-WTP-MDD-PR-01-002, WTP MDD.

3.10.4.11 Treated LAW Evaporator Demister (TLP-DMST-00001) Water Addition

Unique ID: BMR-TLP_TR-7

The Treated LAW Evaporator Demister (TLP-DMST-00001) water addition shall be 0.96 gpm of water.

Basis: This requirement is based on the description in Section 4.8.8 Treated LAW Evaporation Process (TLP) System of 24590-WTP-MDD-PR-01-002, WTP MDD (also in Table B-10).

3.10.4.12 Treated LAW Evaporator Demister (TLP-DMST-00001) Air Addition

Unique ID: BMR-TLP_TR-8

The Treated LAW Evaporator Demister (TLP-DMST-00001) air addition shall be at a flow rate of 5 ft³/min (@ 70 °F and 14.7 psi).

Basis: This requirement is based on the values in Table B-10 Chemical Reagents for TLP/TCP in 24590-WTP-MDD-PR-01-002, WTP MDD.

3.10.4.13 Treated LAW Evaporator Demister (TLP-DMST-00001) Outlet Conditions

Unique ID: BMR-TLP_TR-9

The condenser outlet conditions of the Treated LAW Evaporator Demister (TLP-DMST-00001) shall be 30 °C and 810 Torr (1.06579 atm., 1079.91 millibars).

Basis: This requirement is based on the description in Section 2.12.3.15 Condenser Outlet Temperatures of 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

3.10.4.14 Treated LAW Evaporator Demister (TLP-DMST-00001) Split Factors

Unique ID: BMR-TLP_TR-10

The split factors from the tab "TLP-DMST-00001" in SVF-1778, HTWOS Equipment Splits Rev. 8 shall be applied to the Treated LAW Evaporator Demister (TLP-DMST-00001).

Basis: This requirement is based on SVF-1778, HTWOS Equipment Splits Rev. 8.
3.10.5 TLP Figures and Diagrams

3.10.5.1 TLP-VSL-00009A/B Operation

**Unique ID:** BMR-TLP FIG-1

![Diagram of TLP-VSL-00009A/B Operation]
3.10.5.2 LP-SEP-00001 Operation

**Unique ID:** BMR-TLPFIG-2

![Diagram](image)

3.11 WASTE TREATMENT AND IMMOBILIZATION PLANT TREATED LOW-ACTIVITY WASTE CONCENTRATE STORAGE PROCESS

The purpose of the TCP is to provide buffer storage capacity between the PT and LAW Vitrification Facilities (including second LAW). The TCP system consists of a single Treated LAW Concentrate Storage Vessel (TCP-VSL-00001) which receives the bottoms from TLP-SEP-00001 and sends them to the LAW Facilities, Concentrate Receipt Vessels (LCP-VSL-00001_2). The TCP-VSL-00001 vessel can receive feed while it is transferring out to another vessel. The TCP-VSL-00001 vessel also routes excess LAW to the SLAW facility.

3.11.1 System Requirements

3.11.1.1 TCP Buffer Storage

**Unique ID:** BMR-TCP_SR-1

The TCP shall provide buffer storage capacity between the PT and LAW Vitrification Facilities (including second LAW).
**Basis:** The system requirement is based on Section 2.12.1 *TLP/TCP Function and Requirements* in 24590-WTP-RPT-PT-02-005, *BARD Rev. 8*.

### 3.11.2 Functional Requirements

**3.11.2.1 TCP Concentrate Receipt**

**Unique ID:** BMR-TCP_FR-1

The *TCP* shall have the capability to receive treated *LAW* concentrate from the *TLP*.

**Basis:** This functional requirement is based on Section 3.1 *Receive Treated Streams* in 24590-PTF-3YD-TCP-00001, *TCP System Description*.

**3.11.2.2 TCP Lag Storage**

**Unique ID:** BMR-TCP_FR-2

The *TCP* shall have the capability to provide *lag storage* of treated *LAW*.

**Basis:** This functional requirement is based on Section 3.2 *Store Treated Streams* in 24590-PTF-3YD-TCP-00001, *TCP System Description*.

**3.11.2.3 TCP Transfer to LCP**

**Unique ID:** BMR-TCP_FR-3

The *TCP* shall have the capability to transfer the treated *LAW* concentrate to the *LCP*.

**Basis:** This functional requirement is based on Section 3.4 *Transfer Treated *LAW* Concentrate* in 24590-PTF-3YD-TCP-00001, *TCP System Description*.

**3.11.2.4 TCP Transfer to Second LAW**

**Unique ID:** BMR-TCP_FR-6

The *TCP* shall have the capability to transfer the treated *LAW* concentrate to the *second LAW* facility.

**Basis:** This functional requirement is based on Assumption A1.3.2.3 of the ORP-11242, *System Plan Rev. 8*.

### 3.11.3 Model Requirements

**3.11.3.1 LAW Concentrate Storage Vessel (TCP-VSL-00001) Identification**

**Unique ID:** BMR-TCP_MR-1

The *TCP* system shall contain a treated LAW Concentrate Storage Vessel identified as TCP-VSL-00001.

**Basis:** This model requirement is based on *Section 2.12.2 TLP/TCP Process Description* of the BARD (24590-WTP-RPT-PT-02-005, *BARD Rev. 8*) and Section 4.8.9 *Treated LAW Concentrate Storage Process (TLP) System* in 24590-WTP-MDD-PR-01-002, *WTP MDD*. 
3.11.3.2 Treated LAW Concentrate Storage Vessel (TCP-VSL-00001) Simultaneous Transfer and Receive

Unique ID: BMR-TCP_MR-5

The Treated LAW Concentrate Storage Vessel (TCP-VSL-00001) shall be capable of simultaneously transferring and receiving.

**Basis:** This model requirement is based Section 4.8.9 Treated LAW Concentrate Storage Process (TLP) System in 24590-WTP-MDD-PR-01-002, WTP MDD.

3.11.3.3 Treated LAW Concentrate Storage Vessel (TCP-VSL-00001) Maximum Fill Volume

Unique ID: BMR-TCP_MR-3

The Treated LAW Concentrate Storage Vessel (TCP-VSL-00001) shall not exceed the upper set volume.

**Basis:** This model requirement is based Section 4.8.9 Treated LAW Concentrate Storage Process (TLP) System in 24590-WTP-MDD-PR-01-002, WTP MDD.

3.11.3.4 Treated LAW Concentrate Storage Vessel (TCP-VSL-00001) Solubility Application

Unique ID: BMR-TCP_MR-7

The Solubility Application shall be applied to the Treated LAW Concentrate Storage Vessel (TCP-VSL-00001) at the vessel temperature prior to discharge.

**Basis:** This model requirement is based on Table 6 Solubility Application in 24590-WTP-MDD-PR-01-002, WTP MDD.

3.11.3.5 Treated LAW Concentrate Storage Vessel (TCP-VSL-00001) Discharge

Unique ID: BMR-TCP_MR-4

After solubility has been applied, the Treated LAW Concentrate Storage Vessel (TCP-VSL-00001) shall discharge to the LAW Concentrate Receipt Vessel (LCP-VSL-00001_2) or to the SLAW-BUFFER-TANK at its maximum pump rate when the downstream vessel is available to fill. Note - discharge to the SLAW-BUFFER-TANK shall occur after the second LAW start-up.

**Basis:** This model requirement is based on 24590-WTP-MDD-PR-01-002, WTP MDD Rev. 13 for WTP LAW routing and Assumption A1.3.2.3 of the ORP-11242, System Plan Rev. 8 for routing to second LAW.

3.11.3.6 Treated LAW Concentrate Storage Vessel (TCP-VSL-00001) Discharge Priority

Unique ID: BMR-TCP_MR-6

Once the second LAW start date has occurred then the Treated LAW Concentrate Storage Vessel (TCP-VSL-00001) shall give priority to the LAW Concentrate Receipt Vessel (LCP-VSL-00001_2) over the SLAW-BUFFER-TANK.
Basis: This model requirement is based on Assumption A1.3.2.3 of the ORP-11242, System Plan Rev. 8.

3.11.4 Technical Requirements

3.11.4.1 Treated LAW Concentrate Storage Vessel (TCP-VSL-00001) Parameters

Unique ID: BMR-TCP_TR-1

The *Treated LAW Concentrate Storage Vessel (TCP-VSL-00001)* shall have the following parametric values.

<table>
<thead>
<tr>
<th>Vessel #</th>
<th>Maximum Volume (gal)</th>
<th>Upper-Set Volume (gal)</th>
<th>Set Volume (gal)</th>
<th>Minimum Volume (gal)</th>
<th>Maximum Flow rate (gpm)</th>
<th>Temperature (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>TCP-VSL-00001</td>
<td>130,234</td>
<td>103,430</td>
<td>75,000</td>
<td>7,430</td>
<td>88</td>
<td>31</td>
</tr>
</tbody>
</table>

Basis: The parameters for the TLP demister are based on the values in Table E-1 in 24590-WTP-MDD-PR-01-002, WTP MDD. The temperature is based on the value specified in Table 6 Solubility Applications in 24590-WTP-MDD-PR-01-002, WTP MDD.

3.11.5 TCP Figures and Diagrams

3.11.5.1 TCP-VSL-00001 Operating Diagram

Unique ID: BMR-TCP_FIG-1

3.12 WASTE TREATMENT AND IMMOBILIZATION PLANT PLANT WASH AND DISPOSAL SYSTEM

The primary function of the plant wash and disposal system (PWD) is to collect process recycle streams and wash solutions for storage, neutralization, and transfer to the FEP systems. The
PWD system is composed of five vessels; PWD-VSL-00015, PWD-VSL-00016, PWD-VSL-00033, PWD-VSL-00043, and PWD-VSL-00044. The major sources of plant wash, include HLW offgas condensate, canister decontamination waste, ultrafilter wash solution, ultrafilter cleaning solution, ion exchange displacement effluents, cesium nitric acid recovery process evaporator condensate, pretreatment offgas condensate and purge solutions, vessel wash solutions, and transfer line flushes.

The acidic/alkaline effluent vessels (PWD-VSL-00015 and PWD-VSL-00016) operate in an alternate mode and receive recycles from UFP and CXP. Once one of the acidic/alkaline effluent vessels are filled the pH is adjusted by adding sodium hydroxide and it then becomes available to transfer to one of the Waste Feed Evaporator Feed Vessels (FEP-VSL-00017A/B). The HLW Effluent transfer vessel (PWD-VSL-00043) receives HLW offgas recycle and HLW decontamination chemicals from RLD-VSL-00007/8, and inhibited water for pre- and post-transfer line flushes from the tank farm. When the HLW Effluent transfer vessel if full, its contents are transferred to the Plant Wash vessel (PWD-VSL-00044).

The overflow vessel, PWD-VSL-00033 receives line flushes and drains from pretreatment and ultrafiltration flushes. Since TOPSim does not model internal line flushes, this vessel is not used in the current baseline model.

The plant wash vessel (PWD-VSL-00044) receives material from PWD-VSL-00043, PWD-VSL-00033. When the vessel is full, NaOH is added if required to adjust the pH and then it becomes available to transfer to one of the Waste Feed Evaporator Feed Vessels (FEP-VSL-00017A/B).
3.12.1 System Requirements

3.12.1.1 PWD System Requirement

Unique ID: BMR-PWD_SR-1

The PWD shall collect process recycle streams and wash solutions from throughout WTP for storage, neutralization, and transfer to the PT evaporation systems.

Basis: The system requirement is based on Section 2.15.1 Functions and Requirements in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

3.12.2 Functional Requirements

3.12.2.1 PWD Receipts from UFP

Unique ID: BMR-PWD_FR-1

The PWD shall have the capability to receive wash solutions and dilute effluents from UFP.

Basis: This functional requirement is based on Section 3.1 Receive Washes and Recycle Streams and Figure 2-1 Simplified Diagram of the PWD in 24590-PTF-3YD-PWD-00001, PWD and RLD System Description.

3.12.2.2 PWD Receipt from CXP

Unique ID: BMR-PWD_FR-2

The PWD shall have the capability to receive dilute regeneration waste from the CXP.

Basis: This functional requirement is based on Section 3.1 Receive Washes and Recycle Streams and Figure 2-1 Simplified Diagram of the PWD in 24590-PTF-3YD-PWD-00001, PWD and RLD System Description.

3.12.2.3 PWD Receipt from CNP

Unique ID: BMR-PWD_FR-3

The PWD shall have the capability to receive evaporator process condensate from the CNP.

Basis: This functional requirement is based on Section 3.1 Receive Washes and Recycle Streams and Figure 2-1 Simplified Diagram of the PWD in 24590-PTF-3YD-PWD-00001, PWD and RLD System Description.

3.12.2.4 PWD Receive from RLD

Unique ID: BMR-PWD_FR-11

The PWD shall have the capability to receive neutralized HOP process condensate from RLD.

Basis: This functional requirement is based on Section 3.1 Receive Washes and Recycle Streams and Figure 2-1 Simplified Diagram of the PWD in 24590-PTF-3YD-PWD-00001, PWD and RLD System Description.
3.12.2.5 PWD Receipts PT Flashes

**Unique ID:** BMR-PWD_FR-4

The *PWD* shall have the capability to receive flushes from throughout *PT*.

**Basis:** This functional requirement is based on *Section 2.15.1 Functions and Requirements* in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

3.12.2.6 PWD Receive Tank Farm Flushes

**Unique ID:** BMR-PWD_FR-5

The *PWD* shall have the capability to receive flush water from Tank Farms.

**Basis:** This functional requirement is based on *Section 2.1.3.2 Line Flushes* in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

3.12.2.7 PWD Store the Liquid

**Unique ID:** BMR-PWD_FR-7

The *PWD* shall have the capability to store the received liquid washes, recycles, and effluents.

**Basis:** This functional requirement is based on *Section 3.2 Store Washes* in 24590-PTF-3YD-PWD-00001, PWD and RLD System Description.

3.12.2.8 PWD Adjust pH

**Unique ID:** BMR-PWD_FR-8

The *PWD* shall have the capability to adjust the pH to meet downstream requirements.

**Basis:** This functional requirement is based on *Section 3.3 Mix Washes* in 24590-PTF-3YD-PWD-00001, PWD and RLD System Description.

3.12.2.9 PWD Transfer to FEP

**Unique ID:** BMR-PWD_FR-10

The *PWD* shall have the capability to transfer to *FEP*.

**Basis:** This functional requirement is based on *Section 3.4 Transfer Collected Effluents* in 24590-PTF-3YD-PWD-00001, PWD and RLD System Description.

3.12.3 Model Requirements

3.12.3.1 Acidic/Alkaline Effluent Vessels (PWD-VSL-00015 and PWD-VSL-00016)

**Unique ID:** BMR-PWD_MR-1

The *PWD* shall include two acidic/alkaline effluent vessels that are identified as PWD-VSL-00015 and PWD-VSL-00016.

**Basis:** This model requirement is based on *Section 2.15.2 PWD Process Description* in the BARD (24590-WTP-RPT-PT-02-005, BARD Rev. 8) and *Section 4.8.21 Plant Wash and Disposal (PWD) System* in 24590-WTP-MDD-PR-01-002, WTP MDD.
3.12.3.2 Ultimate Overflow Vessel (PWD-VSL-00033)

**Unique ID:** BMR-PWD_MR-2

The *PWD* shall include an ultimate overflow vessel, identified as PWD-VSL-00033.

**Basis:** This model requirement is based on *Section 2.15.2 PWD Process Description* in the BARD (24590-WTP-RPT-PT-02-005, BARD Rev. 8) and *Section 4.8.21 Plant Wash and Disposal (PWD)* System in 24590-WTP-MDD-PR-01-002, WTP MDD. This vessel currently does not receive or transfer any waste in the model.

3.12.3.3 HLW Effluent Transfer Vessel (PWD-VSL-00043)

**Unique ID:** BMR-PWD_MR-3

The *PWD* shall include a HLW effluent transfer vessel, identified as PWD-VSL-00043.

**Basis:** This model requirement is based on *Section 2.15.2 PWD Process Description* in the BARD (24590-WTP-RPT-PT-02-005, BARD Rev. 8) and *Section 4.8.21 Plant Wash and Disposal (PWD)* System in 24590-WTP-MDD-PR-01-002, WTP MDD.

3.12.3.4 Plant Wash Vessel (PWD-VSL-00044)

**Unique ID:** BMR-PWD_MR-4

The *PWD* shall include a plant wash vessel identified as PWD-VSL-00044.

**Basis:** This model requirement is based on *Section 2.15.2 PWD Process Description* in the BARD (24590-WTP-RPT-PT-02-005, BARD Rev. 8) and *Section 4.8.21 Plant Wash and Disposal (PWD)* System in 24590-WTP-MDD-PR-01-002, WTP MDD.

3.12.3.5 Acidic/Alkaline Effluent Vessels (PWD-VSL-00015 and PWD-VSL-00016)

**Receipt Sources**

**Unique ID:** BMR-PWD_MR-5

The *Acidic/Alkaline Effluent Vessels (PWD-VSL-00015 and PWD-VSL-00016)* shall each receive feed from the following sources:

- The *UFP Feed Vessels (UFP-VSL-00002A/B)*
- The *Cesium Ion Exchange Columns (CXP-IXC-00001/2/3/4)*
- The *Cesium Evaporator Nitric Acid Rectifier (CNP-DISTC-00001)*
- The *Cesium Ion Exchange Guard Filter (CXP-FILT-00001)* - PWD-VSL-00016 Only.

**Basis:** This model requirement is based on *Section 4.8.21 Plant Wash and Disposal (PWD)* System in 24590-WTP-MDD-PR-01-002, WTP MDD. The *Cesium Ion Exchange Guard Filter (CXP-FILT-00001)* discussion is found in Section 4.8.4 Cesium Removal using Ion Exchange Process (CXP) System within the WTP MDD.

3.12.3.6 Acidic/Alkaline Effluent Vessels (PWD-VSL-00015 and PWD-VSL-00016)

**Waste Receipt Trigger**

**Unique ID:** BMR-PWD_MR-6

Each of the *Acidic/Alkaline Effluent Vessels (PWD-VSL-00015 and PWD-VSL-00016)* shall be available to receive waste when the volume is at or below than the lower set volume.
Basis: This model requirement is based on Section 4.8.21 Plant Wash and Disposal (PWD) System in 24590-WTP-MDD-PR-01-002, WTP MDD.

3.12.3.7 Acidic/Alkaline Effluent Vessels (PWD-VSL-00015 and PWD-VSL-00016) Operational Constraints

Unique ID: BMR-PWD_MR-7

The following operational constraints shall apply to the Acidic/Alkaline Effluent Vessels (PWD-VSL-00015 and PWD-VSL-00016):

1. Each vessel can only receive from one source at a time,
2. Both vessels may receive material at the same time but must be from different sources, and
3. If both vessels are available to fill, then the vessel which is fullest shall be selected.

Basis: This model requirement is based on Section 4.8.21 Plant Wash and Disposal (PWD) System in 24590-WTP-MDD-PR-01-002, WTP MDD.

3.12.3.8 Acidic/Alkaline Effluent Vessels (PWD-VSL-00015 and PWD-VSL-00016) Complete Filling

Unique ID: BMR-PWD_MR-8

Each of the Acidic/Alkaline Effluent Vessels (PWD-VSL-00015 and PWD-VSL-00016) shall complete filling when the volume is at the lower set volume.

Basis: This model requirement is based on Section 4.8.21 Plant Wash and Disposal (PWD) System in 24590-WTP-MDD-PR-01-002, WTP MDD. The volume between the set volume and upper set volume is reserved for sodium hydroxide addition required to adjust the pH level.

3.12.3.9 Acidic/Alkaline Effluent Vessels (PWD-VSL-00015 and PWD-VSL-00016) pH Adjustment

Unique ID: BMR-PWD_MR-12

After one of the Acidic/Alkaline Effluent Vessels (PWD-VSL-00015 and PWD-VSL-00016) has been filled to the lower set volume, then the pH of the vessel shall be adjusted by adding enough PWD-VSL-00015/16 Caustic to meet the PWD-VSL-00015/16 Target pH if needed and the PWD-VSL-00015 and PWD-VSL-00016 pH Adjustment Reactions shall be applied.

Basis: This model requirement is based on Section 4.8.21 Plant Wash and Disposal (PWD) System in 24590-WTP-MDD-PR-01-002, WTP MDD.

3.12.3.10 Acidic/Alkaline Effluent Vessels (PWD-VSL-00015 and PWD-VSL-00016) Solubility Application

Unique ID: BMR-PWD_MR-9

After the pH adjustment is complete and prior to discharge, the Solubility Application shall be applied in the Acidic/Alkaline Effluent Vessels (PWD-VSL-00015 and PWD-VSL-00016) at the vessel temperature (see Acidic/Alkaline Effluent Vessels (PWD-VSL-00015 and PWD-VSL-00016) Parameters)
**Basis:** This model requirement is based on Section 4.7.16.3; Table 6 Solubility Application in 24590-WTP-MDD-PR-01-002, WTP MDD.

3.12.3.11 Acidic/Alkaline Effluent Vessels (PWD-VSL-00015 and PWD-VSL-00016) Routing

**Unique ID:** BMR-PWD_MR-10

Once solubility has been applied, the Acidic/Alkaline Effluent Vessels (PWD-VSL-00015 and PWD-VSL-00016) shall transfer to one of the Waste Feed Evaporator Feed Vessels (FEP-VSL-00017A/B).

**Basis:** This model requirement is based on Section 4.8.21 Plant Wash and Disposal (PWD) System in 24590-WTP-MDD-PR-01-002, WTP MDD.

3.12.3.12 Acidic/Alkaline Effluent Vessels (PWD-VSL-00015 and PWD-VSL-00016) Transfer Complete

**Unique ID:** BMR-PWD_MR-11

Emptying of the Acidic/Alkaline Effluent Vessels (PWD-VSL-00015 and PWD-VSL-00016) shall be complete when the vessel has reached its minimum volume.

**Basis:** This model requirement is based on interpretation of Section 4.8.21 Plant Wash and Disposal (PWD) System in 24590-WTP-MDD-PR-01-002, WTP MDD.

3.12.3.13 HLW Effluent Transfer Vessel (PWD-VSL-00043) Receipt Sources

**Unique ID:** BMR-PWD_MR-13

The HLW Effluent Transfer Vessel (PWD-VSL-00043) shall receive from the following sources:

1. The second part of the LAW post-transfer line flush from tank farms (PWD - LAW Batch Post Transfer Flush - Part 2 Volume),
2. The second part of the HLW post-transfer line flush from tank farms (PWD - HLW Batch Post Transfer Flush - Part 2 Volume),
3. Part of the HLP Feed Blending Vessel (HLP-VSL-00028) Internal Line Flush (Not Modeled)
4. Neutralized HLW recycle from the Acidic Waste Vessel (RLD-VSL-00007) and the Acidic Waste Vessel (RLD-VSL-00008).

**Basis:** This model requirement is based on discussion in Section 4.8.21 Plant Wash and Disposal (PWD) System and Section 4.7.13 Line Flushes in 24590-WTP-MDD-PR-01-002, WTP MDD.

3.12.3.14 HLW Effluent Transfer Vessel (PWD-VSL-00043) Single Source at a Time

**Unique ID:** BMR-PWD_MR-31

The HLW Effluent Transfer Vessel (PWD-VSL-00043) shall receive from one source at a time.

**Basis:** This model requirement is based on the interpretation of the discussion in Section 4.8.21 Plant Wash and Disposal (PWD) System in 24590-WTP-MDD-PR-01-002, WTP MDD.
3.12.3.15  HLW Effluent Transfer Vessel (PWD-VSL-00043) Complete Filling

Unique ID: BMR-PWD_MR-15

The *HLW Effluent Transfer Vessel (PWD-VSL-00043)* shall complete filling when the volume is at the upper set volume.

**Basis:** This model requirement is based on the interpretation of the discussion in Section 4.8.21 Plant Wash and Disposal (PWD) System in 24590-WTP-MDD-PR-01-002, WTP MDD.

3.12.3.16  HLW Effluent Transfer Vessel (PWD-VSL-00043) Routing

Unique ID: BMR-PWD_MR-16

After filling is complete, the *HLW Effluent Transfer Vessel (PWD-VSL-00043)* shall transfer to the *Plant Wash Vessel (PWD-VSL-00044)*.

**Basis:** This model requirement is based on the discussion in Section 4.8.21 Plant Wash and Disposal (PWD) System in 24590-WTP-MDD-PR-01-002, WTP MDD.

3.12.3.17  HLW Effluent Transfer Vessel (PWD-VSL-00043) Transfer Complete

Unique ID: BMR-PWD_MR-17

The *HLW Effluent Transfer Vessel (PWD-VSL-00043)* shall complete transferring when it has reached its minimum volume.

**Basis:** This model requirement is based on the interpretation of the discussion in Section 4.8.21 Plant Wash and Disposal (PWD) System in 24590-WTP-MDD-PR-01-002, WTP MDD.

3.12.3.18  Plant Wash Vessel (PWD-VSL-00044) Receipt Source

Unique ID: BMR-PWD_MR-18

The *Plant Wash Vessel (PWD-VSL-00044)* shall receive from the *HLW Effluent Transfer Vessel (PWD-VSL-00043)* and the *Ultimate Overflow Vessel (PWD-VSL-00033)*.

**Basis:** This model requirement is based on discussion in Section 4.8.21 Plant Wash and Disposal (PWD) System in 24590-WTP-MDD-PR-01-002, WTP MDD.

3.12.3.19  Plant Wash Vessel (PWD-VSL-00044) Single Source at a Time

Unique ID: BMR-PWD_MR-33

The *Plant Wash Vessel (PWD-VSL-00044)* shall receive from one source at a time.

**Basis:** This model requirement is based on discussion in Section 4.8.21 Plant Wash and Disposal (PWD) System in 24590-WTP-MDD-PR-01-002, WTP MDD.

3.12.3.20  Plant Wash Vessel (PWD-VSL-00044) Complete Filling

Unique ID: BMR-PWD_MR-20

The *Plant Wash Vessel (PWD-VSL-00044)* shall complete filling with waste when the volume is at the set volume.

**Basis:** This model requirement is based on discussion in Section 4.8.21 Plant Wash and Disposal (PWD) System in 24590-WTP-MDD-PR-01-002, WTP MDD.
3.12.3.21 Plant Wash Vessel (PWD-VSL-00044) pH Adjustment

**Unique ID:** BMR-PWD_MR-25

After the Plant Wash Vessel (PWD-VSL-00044) has completed filling, enough PWD-VSL-00044 caustic shall be added to meet the PWD-VSL-00044 target pH (if needed).

**Basis:** This model requirement is based on discussion in Section 4.8.21 Plant Wash and Disposal (PWD) System in 24590-WTP-MDD-PR-01-002, WTP MDD.

3.12.3.22 Plant Wash Vessel (PWD-VSL-00044) Apply Reactions

**Unique ID:** BMR-PWD_MR-24

After the pH adjustment caustic has been added, the PWD-VSL-00044 Reactions shall be applied.

**Basis:** This model requirement is based on discussion in Section 4.8.21 Plant Wash and Disposal (PWD) System in 24590-WTP-MDD-PR-01-002, WTP MDD.

3.12.3.23 Plant Wash Vessel (PWD-VSL-00044) Solubility Application

**Unique ID:** BMR-PWD_MR-21

The Solubility Application shall be applied in the Plant Wash Vessel (PWD-VSL-00044) at the vessel temperature after the pH has been adjusted and prior to discharge (see Plant Wash Vessel (PWD-VSL-00044) Parameters)

**Basis:** This model requirement is based on Section 4.7.16.3; Table 6 Solubility Application in 24590-WTP-MDD-PR-01-002, WTP MDD.

3.12.3.24 Plant Wash Vessel (PWD-VSL-00044) Routing

**Unique ID:** BMR-PWD_MR-22

Once solubility has been applied, the Plant Wash Vessel (PWD-VSL-00044) shall transfer to the one of the Waste Feed Evaporator Feed Vessels (FEP-VSL-00017A/B).

**Basis:** This model requirement is based on discussion in Section 4.8.21 Plant Wash and Disposal (PWD) System in 24590-WTP-MDD-PR-01-002, WTP MDD.

3.12.3.25 Plant Wash Vessel (PWD-VSL-00044) Transfer Complete

**Unique ID:** BMR-PWD_MR-23

The Plant Wash Vessel (PWD-VSL-00044) shall complete transferring when it has reached its minimum volume.

**Basis:** This model requirement is based on discussion in Section 4.8.21 Plant Wash and Disposal (PWD) System in 24590-WTP-MDD-PR-01-002, WTP MDD.
3.12.4 Technical Requirements

3.12.4.1 Acidic/Alkaline Effluent Vessels (PWD-VSL-00015 and PWD-VSL-00016) Parameters

Unique ID: BMR-PWD_TR-1

The Acidic/Alkaline Effluent Vessels (PWD-VSL-00015 and PWD-VSL-00016) shall each have the following parametric values.

<table>
<thead>
<tr>
<th>Vessel #</th>
<th>Maximum Volume (gal)</th>
<th>Upper Set Volume (gal)</th>
<th>Lower Set Volume *(gal)</th>
<th>Minimum Volume (gal)</th>
<th>Maximum Flow rate (gpm)</th>
<th>Temperature (C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PWD-VSL-00015</td>
<td>105,864</td>
<td>87,148</td>
<td>82,148</td>
<td>12,148</td>
<td>108</td>
<td>25</td>
</tr>
<tr>
<td>PWD-VSL-00016</td>
<td>105,864</td>
<td>87,148</td>
<td>82,148</td>
<td>12,148</td>
<td>108</td>
<td>25</td>
</tr>
</tbody>
</table>

*5,000 gallons is reserved for pH adjustment.

Basis: The PWD vessel parameters are based on Table E-1 Vessel Parameters in 24590-WTP-MDD-PR-01-002, WTP MDD. The temperature is based on the value for the cesium ion exchange system in Table 6, Solubility Application in the 24590-WTP-MDD-PR-01-002, WTP MDD. The 5,000 gallons between the lower and upper set volume is reserved for pH adjustment chemical addition.

3.12.4.2 HLW Effluent Transfer Vessel (PWD-VSL-00043) Parameters

Unique ID: BMR-PWD_TR-2

The HLW Effluent Transfer Vessel (PWD-VSL-00043) shall have the following parametric values.

<table>
<thead>
<tr>
<th>Vessel #</th>
<th>Maximum Volume (gal)</th>
<th>Upper Set Volume (gal)</th>
<th>Lower Set Volume (gal) *</th>
<th>Minimum Volume (gal)</th>
<th>Maximum Flow rate (gpm)</th>
<th>Temperature (C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PWD-VSL-00043</td>
<td>26,504</td>
<td>20,301</td>
<td>10,301</td>
<td>5,301</td>
<td>79</td>
<td>25</td>
</tr>
</tbody>
</table>

Basis: The PWD vessel parameters are based on Table E-1 Vessel Parameters in 24590-WTP-MDD-PR-01-002, WTP MDD. The temperature is based on the estimated waste temperature for related vessels in Table 6, Solubility Application in the 24590-WTP-MDD-PR-01-002, WTP MDD.

3.12.4.3 Plant Wash Vessel (PWD-VSL-00044) Parameters

Unique ID: BMR-PWD_TR-3

The Plant Wash Vessel (PWD-VSL-00044) shall have the following parametric values.

<table>
<thead>
<tr>
<th>Vessel #</th>
<th>Maximum Volume (gal)</th>
<th>Upper Set Volume (gal)</th>
<th>*Lower Set Volume (gal)</th>
<th>Minimum Volume (gal)</th>
<th>Maximum Flow rate (gpm)</th>
<th>Temperature (C)</th>
</tr>
</thead>
</table>
* 5,000 gallon headspace is reserved for pH adjustment.

Basis: The PWD vessel parameters are based on Table E-1 Vessel Parameters in 24590-WTP-MDD-PR-01-002, WTP MDD. The temperature is based on the value for the cesium ion exchange system in Table 6, Solubility Application in the 24590-WTP-MDD-PR-01-002, WTP MDD. The 5,000 gallons between the lower and upper set volume is reserved for pH adjustment chemical addition.

3.12.4.4 Ultimate Overflow Vessel (PWD-VSL-00033) Parameters

Unique ID: BMR-PWD_TR-4

The Ultimate Overflow Vessel (PWD-VSL-00033) shall have the following parametric values.

<table>
<thead>
<tr>
<th>Vessel #</th>
<th>Maximum Volume (gal)</th>
<th>Upper Set Volume (gal)</th>
<th>Lower Set Volume (gal)</th>
<th>Minimum Volume (gal)</th>
<th>Maximum Flow rate (gpm)</th>
<th>Temperature (C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PWD-VSL-00033</td>
<td>31,476</td>
<td>20,386</td>
<td>10,386</td>
<td>5,386</td>
<td>83</td>
<td>25</td>
</tr>
</tbody>
</table>

Basis: The PWD vessel parameters are based on Table E-1 Vessel Parameters in 24590-WTP-MDD-PR-01-002, WTP MDD. The temperature is based on the estimated waste temperature for related vessels in Table 6, Solubility Application in the 24590-WTP-MDD-PR-01-002, WTP MDD. While this vessel is in the model it does not actively receive or send any waste or flushes.

3.12.4.5 Acidic/Alkaline Effluent Vessels (PWD-VSL-00015 and PWD-VSL-00016) Target pH

Unique ID: BMR-PWD_TR-5

The target pH endpoint for the Acidic/Alkaline Effluent Vessels (PWD-VSL-00015 and PWD-VSL-00016) shall be 12.0.

Basis: This model requirement is based on the discussion in Section 4.8.21 Plant Wash and Disposal (PWD) System in 24590-WTP-MDD-PR-01-002, WTP MDD.

3.12.4.6 Acidic/Alkaline Effluent Vessels (PWD-VSL-00015 and PWD-VSL-00016) Caustic

Unique ID: BMR-PWD_TR-6

19M NaOH shall be added to the Acidic/Alkaline Effluent Vessels (PWD-VSL-00015 and PWD-VSL-00016) for pH adjustment.

Basis: This model requirement is based on the discussion in Section 4.8.21 Plant Wash and Disposal (PWD) System in 24590-WTP-MDD-PR-01-002, WTP MDD.
3.12.4.7 Acidic/Alkaline Effluent Vessels (PWD-VSL-00015 and PWD-VSL-00016) pH Adjustment Reactions

Unique ID: BMR-PWD_TR-12

The Acidic/Alkaline Effluent Vessels (PWD-VSL-00015 and PWD-VSL-00016) pH Adjustment reactions shall be:

1. RXN-NH4-NEUTRALIZATION Conversion = 1.0
2. NEUT-REACTION Conversion = 1.0.

Basis: This model requirement is based on the discussion in Section 4.8.21 Plant Wash and Disposal (PWD) System in 24590-WTP-MDD-PR-01-002, WTP MDD.

3.12.4.8 PWD - LAW Batch Post Transfer Flush - Part 2 Volume

Unique ID: BMR-PWD_TR-7

The LAW batch post transfer flush - Part 2 shall consist of 3,000 gallons of Inhibited Water.

Basis: This model requirement is based the description in Section 4.7.13 Line Flushes in 24590-WTP-MDD-PR-01-002, WTP MDD.

3.12.4.9 PWD - HLW Batch Post Transfer Flush - Part 2 Volume

Unique ID: BMR-PWD_TR-8

The HLW batch post transfer flush - Part 2 shall consist of:

- 3,000 gallons of Inhibited Water if the waste transfer is from a DST or
- 1,200 gallons of Inhibited Water if the waste transfer is from TWCS.

Basis: The flush volume from a DST is based on the description in Section 4.7.13 Line Flushes in 24590-WTP-MDD-PR-01-002, WTP MDD. The TWCSF volume is based on the following;

- TWCSF location consistent with Site 5 from RPP-54668, 15 acres of greenfield located between East Area tank farms and the WTP HLW Vitrification Facility
- 1,800 foot distance from center of proposed TWCSF location to PT pipe tunnel (per RPP H-14-014365) multiplied by 1.15 to account for thermal expansion joints (per Wes Bryan)
- 417 foot internal piping length from PT wall to HLP-VSL-00022
- 3 inch nominal pipe diameter
- 3X line volume flush per ICD-19 maximum
- This equates to approximately 2700 gallons rounded to 3,000 gallons
- The division of the pre-warming flush was taken to be the same ratio as the DST flush so 3000/7500 = 0.4 * 3000 = 1,200 gallons.

3.12.4.10 Plant Wash Vessel (PWD-VSL-00044) Reactions

Unique ID: BMR-PWD_TR-11

The Plant Wash Vessel (PWD-VSL-00044) reactions are as follows.
- **RXN-NH4-NEUTRALIZATION** Conversion = 1.0
- **HG-LIQUID-to-SOLID** Conversion = 1.0
- **NEUT-REACTION** Conversion = 1.0

**Basis:** This model requirement is based on the discussion in Section 4.8.21 Plant Wash and Disposal (PWD) System in 24590-WTP-MDD-PR-01-002, WTP MDD.

### 3.12.4.11 Plant Wash Vessel (PWD-VSL-00044) Caustic

**Unique ID:** BMR-PWD_TR-9

19M NaOH shall be added to the Plant Wash Vessel (PWD-VSL-00044) for pH adjustment.

**Basis:** This model requirement is based on the discussion in Section 4.8.21 Plant Wash and Disposal (PWD) System in 24590-WTP-MDD-PR-01-002, WTP MDD.

### 3.12.4.12 Plant Wash Vessel (PWD-VSL-00044) Target pH

**Unique ID:** BMR-PWD_TR-10

The target pH endpoint for the Plant Wash Vessel (PWD-VSL-00044) shall be 12.0.

**Basis:** This model requirement is based on the discussion in Section 4.8.21 Plant Wash and Disposal (PWD) System in 24590-WTP-MDD-PR-01-002, WTP MDD.

### 3.12.5 PWD Figures and Diagrams

#### 3.12.5.1 PWD-VSL-00044 Operation

**Unique ID:** BMR-PWD_DIG-1
3.12.5.2 PWD-VSL-00015 and PWD-VSL-00016 Operations

Unique ID: BMR-PWD_DIG-2
3.12.5.3 PWD-VSL-00043 and PWD-VSL-00033 Operation

Unique ID: BMR-PWD_DIG-3

3.13 WASTE TREATMENT AND IMMOBILIZATION PLANT RADIOACTIVE LIQUID WASTE DISPOSAL SYSTEM

The primary purpose of the Radioactive Liquid Disposal (RLD) system is to collect and store process condensate for use as process wash and dilution streams and collect liquid effluent from the WTP for disposal to the LERF/ETF. The RLD system consists of eight vessels, listed below which are located in the PT, LAW Vitrification and HLW vitrification facilities.

- Alkaline Effluent Vessels - RLD-VSL-00017A/B
- Process Condensate Vessels – RLD-VSL-00006A/B
- C3/C5 Drains/Sump Collection Vessel - RLD-VSL-00004
- SBS Condensate Collection Vessel – RLD-VSL-00005
- Acidic Waste Vessel – RLD-VSL-00007
- Acidic Waste Vessel – RLD-VSL-00008

The alkaline effluent vessels (RLD-VSL-00017A and B) receive fresh resin preparation solution from Cesium Resin Addition Vessel (CRP-VSL-00001) and effluent from the LAW caustic scrubber (LVP-SCB-00001). When RLD-VSL-00017A or B are full, it stops receiving feed, and then empties to RLD-VSL-00006B.
The Process Condensate Vessel, RLD-TK-00006A receives Evaporator Condensate from FEP-DMST-00005 and TLP-DMST-00001. A portion of the process condensate is recycled to various Pretreatment systems for washing, dilution, and line flush operations. Excessive process condensate is sent to the ETF/LERF through RLD-VSL-00006B.

The Process Condensate Vessel, RLD-VSL-00006B receives from RLD-VSL-00017A/B and RLD-VSL-00006A. When RLD-TK-00006B is full, the vessel will empty its contents to the ETF/LERF.

The vessel RLD-VSL-00004 receives liquid continuously from the LAW WESP columns. When the vessel is full, it empties its contents into RLD-VSL-00005. RLD-VSL-00005 receives material from RLD-VSL-00004 and LAW-SBS. When the vessel is full, it empties to either LAW SBS Condensate receipt Vessel (TLP-VSL-00009A or TLP-VSL-00009B) depending on their availability.

The acidic Waste Vessel, RLD-VSL-00007 receives material from the HLW SBS Condensate Vessels (HOP-SCB-00001, HOP-SCB-00002) and the canister decontamination chemicals. Once full the vessels is neutralized to bring the pH up to 8.0. A sample is taken before the vessel contents can be discharged to PWD-VSL-00043 if available. However, if PWD-VSL-00043 is not available an indirect transfer from RLD-VSL-00007 to RLD-VSL-00008 then to PWD-VSL-00043 can also be used. The vessel RLD-VSL-00008 receives from RLD-VSL-00007 if needed and transfers to PWD-VSL-00043.

3.13.1 System Requirements

3.13.1.1 RLD Collect Process Condensate

Unique ID: BMR-RLD_SR-1

The RLD shall collect and store evaporator process condensate streams from the WTP PT facility and liquids from the WTP HLW and LAW Vitrification Facilities Offgas Systems.

Basis: The system requirement is based on the discussion in Section 2.17.1 Function and Requirements in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

3.13.1.2 RLD Reuse Process Condensate

Unique ID: BMR-RLD_SR-2

The RLD shall provide the evaporator process condensate to PT systems for use as process wash, dilution streams and flushes.

Basis: The system requirement is based on the discussion in Section 2.17.1 Function and Requirements in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

3.13.1.3 RLD Transfer to Off-Site Disposal

Unique ID: BMR-RLD_SR-3

The RLD shall transfer liquid effluent to LERF.

Basis: The system requirement is based on the discussion in Section 2.17.1 Function and Requirements in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.
3.13.1.4 RLD Transfer Melter Offgas Condensate and Canister Decontamination Waste

Unique ID: BMR-RLD_SR-4

The RLD shall transfer the melter offgas condensate and canister decontamination waste to downstream processes.

Basis: The system requirement is based on the discussion in Sections 4.5.1 RLD/NLD HLW Liquid Waste Disposal Process Function and Requirements and 3.4.1 RLD/NLD LAW Liquid Waste Disposal Process Function and Requirements in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

3.13.2 Functional Requirements

3.13.2.1 RLD Receive from FEP

Unique ID: BMR-RLD_FR-1

The RLD shall have the capability to receive evaporator process condensate from the FEP.

Basis: This functional requirement is based on the discussion in Section 2.17.2.4 Process Condensate Tank RLD-TK-00006A/B in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

3.13.2.2 RLD Receive from TLP

Unique ID: BMR-RLD_FR-2

The RLD shall have the capability to receive evaporator process condensate from the TLP.

Basis: This functional requirement is based on the discussion in Section 2.17.2.4 Process Condensate Tank RLD-TK-00006A/B in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

3.13.2.3 RLD Receive from CRP

Unique ID: BMR-RLD_FR-11

The RLD shall have the capability to receive fresh resin preparation liquids from the CRP.

Basis: This functional requirement is based on Figure 2.17-1 Pretreatment Liquid Effluent Disposal System in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

3.13.2.4 RLD Receive from LVP

Unique ID: BMR-RLD_FR-14

The RLD shall have the capability to receive effluent from the LVP.

Basis: This functional requirement is based on the discussion in 3.4.1 RLD/NLD LAW Liquid Waste Disposal Process Function and Requirements in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

3.13.2.5 RLD Receive from LOP

Unique ID: BMR-RLD_FR-12

The RLD shall have the capability to receive process condensate from the LOP.
**Basis:** This functional requirement is based on the discussion in 3.4.1 *RLD/NLD LAW Liquid Waste Disposal Process Function and Requirements* in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

### 3.13.2.6 RLD Receive Acidic Process Condensate from HOP

**Unique ID:** BMR-RLD_FR-17

The *RLD* shall have the capability to receive *acidic process condensate* from the *HOP*.

**Basis:** This functional requirement is based on the discussion in Section 4.5.1 *RLD/NLD HLW Liquid Waste Disposal Process Function* in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

### 3.13.2.7 RLD Receive from the HDH System

**Unique ID:** BMR-RLD_FR-21

The *RLD* shall have the capability to receive *canister decontamination waste* from the *HDH System*.

**Basis:** This functional requirement is based on the discussion in Section 4.5.1, *RLD/NLD HLW Liquid Waste Disposal Process Function*, in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

### 3.13.2.8 RLD Store Evaporator Process Condensate

**Unique ID:** BMR-RLD_FR-3

The *RLD* shall have the capability to store the received evaporator *process condensate*.

**Basis:** This functional requirement is based on the discussion in Section 2.17.2.4 *Process Condensate Tank RLD-TK-00006A/B* in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

### 3.13.2.9 RLD Neutralize Acidic Process Condensate

**Unique ID:** BMR-RLD_FR-19

The *RLD* shall have the capability to neutralize acidic *HOP process condensate*.

**Basis:** This functional requirement is based on the discussion in Section 4.5.2 *RLD/NLD HLW Liquid Waste Disposal Process Description* in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

### 3.13.2.10 RLD Sampling

**Unique ID:** BMR-RLD_FR-16

The *RLD* shall have the capability to sample *liquid effluents* that will be transferred to *LERF*.

**Basis:** This functional requirement is based on the discussion in Section 2.17.2.3 *Alkaline Effluent Vessels RLD-VSL-000017A/B* in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

### 3.13.2.11 RLD Transfer Between Vessels

**Unique ID:** BMR-RLD_FR-20

The *RLD* system shall be capable of transferring between vessels per the design.

**Basis:** This functional requirement is based on the discussion in Sections 2.17 *RLD and NLD Systems*, 4.5 *RLD/NLD HLW Liquid Waste Disposal Process* and 3.4 *RLD/NLD LAW Liquid Waste Disposal Process* in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.
3.13.2.12 RLD Transfer to FRP

Unique ID: BMR-RLD_FR-10

The RLD shall have the capability to transfer the evaporator process condensate to the FRP.

Basis: This requirement is based on Appendix H Transfer, Sampling, and Time Triggered Line Flushes of 24590-WTP-MDD-PR-01-002, WTP MDD Rev. 13 which identifies the line flushes, RLD-VSL-00006A is the preferred source for line flushes and process water is the secondary source.

3.13.2.13 RLD Transfer to HLP

Unique ID: BMR-RLD_FR-4

The RLD shall have the capability to transfer the evaporator process condensate to the HLP.

Basis: This requirement is based on Appendix H Transfer, Sampling, and Time Triggered Line Flushes of 24590-WTP-MDD-PR-01-002, WTP MDD Rev. 13 which identifies the line flushes, RLD-VSL-00006A is the preferred source for line flushes and process water is the secondary source.

3.13.2.14 RLD Transfer to PWD

Unique ID: BMR-RLD_FR-5

The RLD shall have the capability to transfer the evaporator process condensate to the PWD.

Basis: This requirement is based on Appendix H Transfer, Sampling, and Time Triggered Line Flushes of 24590-WTP-MDD-PR-01-002, WTP MDD Rev. 13 which identifies the line flushes, RLD-VSL-00006A is the preferred source for line flushes and process water is the secondary source.

3.13.2.15 RLD Transfer to UFP

Unique ID: BMR-RLD_FR-8

The RLD shall have the capability to transfer the evaporator process condensate to the UFP.

Basis: This requirement is based on Appendix H Transfer, Sampling, and Time Triggered Line Flushes of 24590-WTP-MDD-PR-01-002, WTP MDD Rev. 13 which identifies the line flushes, RLD-VSL-00006A is the preferred source for line flushes and process water is the secondary source. In addition the UFP uses the condensate in RLD-VSL-00006A as the primary source of solids washing (Section 2.17.3.2 Process Condensate Tanks RLD-VSL-00006A/B in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

3.13.2.16 RLD Transfer to LERF

Unique ID: BMR-RLD_FR-15

The RLD shall have the capability to transfer liquid effluents to LERF.

Basis: This functional requirement is based on the discussion in Section 2.17.1 Function and Requirements in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.
3.13.2.17 RLD Transfer to TLP

**Unique ID:** BMR-RLD_FR-13

The RLD shall have the capability to transfer the received LOP process condensate and liquid effluent that does not meet LERF acceptance criteria to the TLP.

**Basis:** The functional requirement is based on the discussion in Sections 2.17.2.3 Alkaline Effluent Vessels RLD-VSL-00017A/B and 2.17.3.3 Process Condensate Tank RLD-VSL-00006B in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

3.13.2.18 RLD Transfer to EMF

**Unique ID:** BMR-RLD_FR-22

The RLD shall have the capability to transfer the received LOP process condensate and liquid effluent to the EMF.

**Basis:** The functional requirement is based on the discussion in Section 3.8.1 DFLAW: EMF, DEP, WTP, LAW and Tank Farm AP Facilities and Process Function and Requirements in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

3.13.2.19 RLD Transfer HLW Process Condensate to PWD

**Unique ID:** BMR-RLD_FR-18

The RLD shall have the capability to transfer neutralized HOP process condensate to the PWD.

**Basis:** This functional requirement is based on the discussion in Section 4.5.12 RLD/NLD HLW Liquid Waste Disposal Process Description in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

3.13.3 Model Requirements

3.13.3.1 Alkaline Effluent Vessels (RLD-VSL-00017A and RLD-VSL-00017B)

**Unique ID:** BMR-RLD_MR-1

The RLD shall include two Alkaline Effluent Vessels identified as RLD-VSL-00017A and RLD-VSL-00017B.

**Basis:** This model requirement is based on Section 2.17.2 RLD and NLD Process Description of the BARD (24590-WTP-RPT-PT-02-005, BARD Rev. 8) and Section 4.8.11 Radioactive Liquid Waste Disposal (RLD) System in 24590-WTP-MDD-PR-01-002, WTP MDD.

3.13.3.2 Process Condensate Tanks (RLD-VSL-00006A/B)

**Unique ID:** BMR-RLD_MR-2

The RLD shall include two process condensate vessels identified as RLD-VSL-00006A and RLD-VSL-00006B.

**Basis:** This model requirement is based on Section 2.17.2 RLD and NLD Process Description of the BARD (24590-WTP-RPT-PT-02-005, BARD Rev. 8) and Section 4.8.11 Radioactive Liquid Waste Disposal (RLD) System in 24590-WTP-MDD-PR-01-002, WTP MDD.
3.13.3.3 C3/C5 Drain/Sump Collection Vessel (RLD-VSL-00004)

Unique ID: BMR-RLD_MR-42

The RLD system shall include a C3/C5 Drain/Sump Collection Vessel identified as RLD-VSL-00004 which receives LAW WESP condensate.

Basis: This model requirement is based on Section 3.4.2 RLD/NLD: LAW Liquid Waste Disposal Process Description of the BARD (24590-WTP-RPT-PT-02-005, BARD Rev. 8) and Section 4.8.11 Radioactive Liquid Waste Disposal (RLD) System in 24590-WTP-MDD-PR-01-002, WTP MDD.

3.13.3.4 SBS Condensate Collection Vessel (RLD-VSL-00005)

Unique ID: BMR-RLD_MR-43

The RLD shall include a SBS Condensate Collection vessel identified as RLD-VSL-00005 which receives LAW SBS condensate.

Basis: This model requirement is based on Section 3.4.2 RLD/NLD: LAW Liquid Waste Disposal Process Description of the BARD (24590-WTP-RPT-PT-02-005, BARD Rev. 8) and Section 4.8.11 Radioactive Liquid Waste Disposal (RLD) System in 24590-WTP-MDD-PR-01-002, WTP MDD.

3.13.3.5 Acidic Waste Vessels RLD-VSL-00007 and RLD-VSL-00008

Unique ID: BMR-RLD_MR-44

The RLD shall include two acidic waste vessel identified as RLD-VSL-00007 and RLD-VSL-00008 which receive HLW SBS condensate.

Basis: This model requirement is based on Section 4.5.2 RLD/NLD: HLW Liquid Waste Disposal Process Description of the BARD (24590-WTP-RPT-PT-02-005, BARD Rev. 8) and Section 4.8.11 Radioactive Liquid Waste Disposal (RLD) System in 24590-WTP-MDD-PR-01-002, WTP MDD.

3.13.3.6 Alkaline Effluent Vessels (RLD-VSL-00017A/B) Receipt Sources

Unique ID: BMR-RLD_MR-3

The Alkaline Effluent Vessels (RLD-VSL-00017A/B) shall each receive feed from the Cesium Resin Addition Vessel (CRP-VSL-00001) and from the LVP-SCB-00001 - Caustic Scrubber Column (note the transfer is actually from the LVP-TK-00001 - Caustic Scrubber Collection Vessel; however for simplification this tank is modeled as combined with the scrubber)

Basis: This model requirement is based on the description in Section 4.8.11 Radioactive Liquid Waste Disposal (RLD) System of 24590-WTP-MDD-PR-01-002, WTP MDD Rev. 13. The transfer is actually from the LVP-TK-00001 - Caustic Scrubber Collection Vessel; however for simplification this tank is modeled as combined with the scrubber.

3.13.3.7 Alkaline Effluent Vessels (RLD-VSL-00017A/B) Alternate Filling

Unique ID: BMR-RLD_MR-5

The Alkaline Effluent Vessels (RLD-VSL-00017A/B) shall alternate filling and emptying.
**Basis**: This model requirement is based the description in Section 4.8.11 *Radioactive Liquid Waste Disposal (RLD) System of 24590-WTP-MDD-PR-01-002, WTP MDD Rev. 13.*

3.13.3.8 **Alkaline Effluent Vessels (RLD-VSL-00017A/B) Single Source at a Time**  
**Unique ID**: BMR-RLD_MR-45  
The Alkaline Effluent Vessels (RLD-VSL-00017A/B) shall only receive from one source at a time.

**Basis**: This model requirement is based the description in Section 4.8.11 *Radioactive Liquid Waste Disposal (RLD) System of 24590-WTP-MDD-PR-01-002, WTP MDD Rev. 13.*

3.13.3.9 **Alkaline Effluent Vessels (RLD-VSL-00017A/B) Complete Filling**  
**Unique ID**: BMR-RLD_MR-6  
Each of the Alkaline Effluent Vessels (RLD-VSL-00017A/B) shall complete filling when the volume is at the set volume.

**Basis**: This model requirement is based the description in Section 4.8.11 *Radioactive Liquid Waste Disposal (RLD) System of 24590-WTP-MDD-PR-01-002, WTP MDD Rev. 13.*

3.13.3.10 **Alkaline Effluent Vessels (RLD-VSL-00017A/B) - Sampling**  
**Unique ID**: BMR-RLD_MR-18  
After the Alkaline Effluent Vessels (RLD-VSL-00017A/B) has completed filling, the RLD-VSL-00017A/B Sample Time shall be applied.

**Basis**: This model requirement is based the description in Section 4.8.11 *Radioactive Liquid Waste Disposal (RLD) System of 24590-WTP-MDD-PR-01-002, WTP MDD Rev. 13.*

3.13.3.11 **Alkaline Effluent Vessels (RLD-VSL-00017A/B) Routing**  
**Unique ID**: BMR-RLD_MR-7  
Once the sample time has been applied, the Alkaline Effluent Vessels (RLD-VSL-00017A/B) shall transfer to the Process Condensate Vessel (RLD-VSL-00006B).

**Basis**: This model requirement is based the description in Section 4.8.11 *Radioactive Liquid Waste Disposal (RLD) System of 24590-WTP-MDD-PR-01-002, WTP MDD Rev. 13.*

3.13.3.12 **Alkaline Effluent Vessels (RLD-VSL-00017A/B) Transfer Complete**  
**Unique ID**: BMR-RLD_MR-8  
The Alkaline Effluent Vessels (RLD-VSL-00017A/B) shall complete transferring when it has reached its minimum volume.

**Basis**: This model requirement is based the description in Section 4.8.11 *Radioactive Liquid Waste Disposal (RLD) System of 24590-WTP-MDD-PR-01-002, WTP MDD Rev. 13.*
3.13.3.13 Process Condensate Vessel (RLD-VSL-00006A) Receipt Sources

Unique ID: BMR-RLD_MR-9

The Process Condensate Vessel (RLD-VSL-00006A) shall receive process condensate from the FEP Waste Feed Evaporator Demister (FEP-DMST-00001A) and the Treated LAW Evaporator Demister (TLP-DMST-00001).

Basis: This model requirement is based the description in Section 4.8.11 Radioactive Liquid Waste Disposal (RLD) System of 24590-WTP-MDD-PR-01-002, WTP MDD Rev. 13.

3.13.3.14 Process Condensate Vessel (RLD-VSL-00006A) Simultaneous Receipts

Unique ID: BMR-RLD_MR-46

The Process Condensate Vessel (RLD-VSL-00006A) shall be capable of receiving simultaneously from both sources.

Basis: This model requirement is based the description in Section 4.8.11 Radioactive Liquid Waste Disposal (RLD) System of 24590-WTP-MDD-PR-01-002, WTP MDD Rev. 13.

3.13.3.15 Process Condensate Vessel (RLD-VSL-00006A) Recycle Condensate Reserve

Unique ID: BMR-RLD_MR-19

The Process Condensate Vessel (RLD-VSL-00006A) shall reserve the volume between the set point and the minimum volume for process condensate supply to the PT systems.

Basis: This model requirement is based the description in Section 4.8.11 Radioactive Liquid Waste Disposal (RLD) System of 24590-WTP-MDD-PR-01-002, WTP MDD Rev. 13.

3.13.3.16 Process Condensate Vessel (RLD-VSL-00006A) Recycle Condensate Discharge

Unique ID: BMR-RLD_MR-20

The Process Condensate Vessel (RLD-VSL-00006A) shall supply process condensate to the following vessels (as currently modeled) at the RLD-VSL-00006A Condensate Recycle Rate.

- UFP Feed Vessels (UFP-VSL-00002A/B)
- UFP Permeate Receipt Vessels (UFP-VSL-00062A/B/C)
- UFP Feed Preparation Vessels (UFP-VSL-00001A/B)
- Ultimate Overflow Vessel (PWD-VSL-00033) - Not Modeled
- HLW Effluent Transfer Vessel (PWD-VSL-00043) - Not Modeled

Basis: This model requirement is based the descriptions of the receiving vessels within 24590-WTP-MDD-PR-01-002, WTP MDD Rev. 13.

3.13.3.17 Process Condensate Vessel (RLD-VSL-00006A) Stop Receiving

Unique ID: BMR-RLD_MR-11

The Process Condensate Vessel (RLD-VSL-00006A) shall stop receiving when the volume is at the upper set volume.

Basis: This model requirement is based the description in Section 4.8.11 Radioactive Liquid Waste Disposal (RLD) System of 24590-WTP-MDD-PR-01-002, WTP MDD Rev. 13.
3.13.3.18 Process Condensate Vessel (RLD-VSL-00006A) Discharge to RLD-VSL-00006B

Unique ID: BMR-RLD_MR-12

When the volume of the Process Condensate Vessel (RLD-VSL-00006A) is at or above the upper set point it shall transfer to the Process Condensate Vessel (RLD-VSL-00006B) until it reaches its set point at the RLD-VSL-00006A to RLD-VSL-00006B Rate.

Basis: This model requirement is based the description in Section 4.8.11 Radioactive Liquid Waste Disposal (RLD) System of 24590-WTP-MDD-PR-01-002, WTP MDD Rev. 13.

3.13.3.19 Process Condensate Vessel (RLD-VSL-00006A) Concurrent Transfer

Unique ID: BMR-RLD_MR-47

The Process Condensate Vessel (RLD-VSL-00006A) shall be capable of concurrently transferring to the Process Condensate Vessel (RLD-VSL-00006B) and supplying process condensate to the downstream PT systems.

Basis: This model requirement is based the description in Section 4.8.11 Radioactive Liquid Waste Disposal (RLD) System of 24590-WTP-MDD-PR-01-002, WTP MDD Rev. 13.

3.13.3.20 Process Condensate Vessel (RLD-VSL-00006B) Receipt Source

Unique ID: BMR-RLD_MR-13

The Process Condensate Vessel (RLD-VSL-00006B) shall receive from the Process Condensate Vessel (RLD-VSL-00006A) and the Alkaline Effluent Vessels (RLD-VSL-00017A/B).

Basis: This model requirement is based the description in Section 4.8.11 Radioactive Liquid Waste Disposal (RLD) System of 24590-WTP-MDD-PR-01-002, WTP MDD Rev. 13.

3.13.3.21 Process Condensate Vessel (RLD-VSL-00006B) Single Source at a Time

Unique ID: BMR-RLD_MR-48

The Process Condensate Vessel (RLD-VSL-00006B) shall receive from one source at a time.

Basis: This model requirement is inferred from the description in Section 4.8.11 Radioactive Liquid Waste Disposal (RLD) System of 24590-WTP-MDD-PR-01-002, WTP MDD Rev. 13.

3.13.3.22 Process Condensate Vessel (RLD-VSL-00006B) Complete Filling

Unique ID: BMR-RLD_MR-15

The Process Condensate Vessel (RLD-VSL-00006B) shall complete filling when the volume is between the set volume and upper set volume.

Basis: This model requirement is based the description in Section 4.8.11 Radioactive Liquid Waste Disposal (RLD) System of 24590-WTP-MDD-PR-01-002, WTP MDD Rev. 13. The basis document states that RLD-VSL-00006B shall be filled to the set volume before discharging; however due to the inherit scheduling conflicts within the TOPSim model a target fill range between the set volume and upper set volume is acceptable.
3.13.3.23 Process Condensate Vessel (RLD-VSL-00006B) Routing

Unique ID: BMR-RLD_MR-16

Once the Process Condensate Vessel (RLD-VSL-00006B) has been filled then, it shall transfer to one of the LERF basins at its maximum pump rate.

Basis: This model requirement is based the description in Section 4.8.11 Radioactive Liquid Waste Disposal (RLD) System of 24590-WTP-MDD-PR-01-002, WTP MDD Rev. 13.

3.13.3.24 Process Condensate Vessel (RLD-VSL-00006B) Transfer Complete

Unique ID: BMR-RLD_MR-17

The Process Condensate Vessel (RLD-VSL-00006B) shall complete transferring when it has reached its minimum volume.

Basis: This model requirement is based the description in Section 4.8.11 Radioactive Liquid Waste Disposal (RLD) System of 24590-WTP-MDD-PR-01-002, WTP MDD Rev. 13.

3.13.3.25 C3/C5 Drains/Sump Collection Vessel (RLD-VSL-00004) Receipt Source

Unique ID: BMR-RLD_MR-22

The C3/C5 Drains/Sump Collection Vessel (RLD-VSL-00004) shall receive liquids from the LAW Wet Electrostatic Precipitator (LOP-WESP-00001_2).

Basis: This model requirement is based the description in Section 4.8.11 Radioactive Liquid Waste Disposal (RLD) System of 24590-WTP-MDD-PR-01-002, WTP MDD Rev. 13.

3.13.3.26 C3/C5 Drains/Sump Collection Vessel (RLD-VSL-00004) Complete Filling

Unique ID: BMR-RLD_MR-23

The C3/C5 Drains/Sump Collection Vessel (RLD-VSL-00004) shall complete filling when the volume is between the set volume and upper set volume.

Basis: This model requirement is based the description in Section 4.8.11 Radioactive Liquid Waste Disposal (RLD) System of 24590-WTP-MDD-PR-01-002, WTP MDD Rev. 13. The basis document states that RLD-VSL-00004 shall be filled to the set volume before discharging; however due to the inherit scheduling conflicts within the TOPSim model a target fill range between the set volume and upper set volume is acceptable.

3.13.3.27 C3/C5 Drains/Sump Collection Vessel (RLD-VSL-00004) Discharge to RLD-VSL-00005

Unique ID: BMR-RLD_MR-24

When the volume of the C3/C5 Drains/Sump Collection Vessel (RLD-VSL-00004) is at its set volume, then it shall transfer at its maximum pump rate to the SBS Condensate Collection Vessel (RLD-VSL-00005).

Basis: This model requirement is based the description in Section 4.8.11 Radioactive Liquid Waste Disposal (RLD) System of 24590-WTP-MDD-PR-01-002, WTP MDD Rev. 13.
3.13.3.28 C3/C5 Drains/Sump Collection Vessel (RLD-VSL-00004) Complete Transfer

Unique ID: BMR-RLD_MR-49

The C3/C5 Drains/Sump Collection Vessel (RLD-VSL-00004) shall complete transferring when it reaches its minimum volume.

Basis: This model requirement is based on the description in Section 4.8.11 Radioactive Liquid Waste Disposal (RLD) System of 24590-WTP-MDD-PR-01-002, WTP MDD Rev. 13.

3.13.3.29 SBS Condensate Collection Vessel (RLD-VSL-00005) Receipt Source

Unique ID: BMR-RLD_MR-25

The SBS Condensate Collection Vessel (RLD-VSL-00005) shall receive from the LAW Melter Submerged Bed Scrubber (LOP-SCB-00001_2) and the C3/C5 Drains/Sump Collection Vessel (RLD-VSL-00004).

Basis: This model requirement is based on the description in Section 4.8.11 Radioactive Liquid Waste Disposal (RLD) System of 24590-WTP-MDD-PR-01-002, WTP MDD Rev. 13.

3.13.3.30 SBS Condensate Collection Vessel (RLD-VSL-00005) Simultaneous Receipt

Unique ID: BMR-RLD_MR-53

The SBS Condensate Collection Vessel (RLD-VSL-00005) shall be capable of receiving from both sources simultaneously.

Basis: This model requirement is based on the description in Section 4.8.11 Radioactive Liquid Waste Disposal (RLD) System of 24590-WTP-MDD-PR-01-002, WTP MDD Rev. 13.

3.13.3.31 SBS Condensate Collection Vessel (RLD-VSL-00005) Complete Filling

Unique ID: BMR-RLD_MR-27

The SBS Condensate Collection Vessel (RLD-VSL-00005) shall complete filling when the volume is between the set volume and upper set volume.

Basis: This model requirement is based on the description in Section 4.8.11 Radioactive Liquid Waste Disposal (RLD) System of 24590-WTP-MDD-PR-01-002, WTP MDD Rev. 13. The basis document states that RLD-VSL-00005 shall be filled to the set volume before discharging; however due to the inherent scheduling conflicts within the TOPSim model, a target fill range between the set volume and upper set volume is acceptable.

3.13.3.32 SBS Condensate Collection Vessel (RLD-VSL-00005) Routing - DFLAW Operation

Unique ID: BMR-RLD_MR-28

During DFLAW operation, after the SBS Condensate Collection Vessel (RLD-VSL-00005) has been filled, the condensate shall be routed to the EMF-VSL-00002A/B - EMF SBS Condensate Receipt Vessel.

Basis: This model requirement is based on the description in Section 3.4.3.1.3 SBS Condensate Collection Vessel in 24590-WTP-RPT-PT-02-005, BARD Rev. 8. Note the TOPSim EMF vessel
numbers differ from the WTP vessel numbers. Currently there is no returns to tank farms planned from the melter offgas effluent.

3.13.3.33  **SBS Condensate Collection Vessel (RLD-VSL-00005) Routing - PT Operation**

**Unique ID:** BMR-RLD_MR-54

During PT Operation (Post DFLAW); after the *SBS Condensate Collection Vessel (RLD-VSL-00005)* has been filled then, it shall discharge to the *LAW SBS Condensate Receipt Vessels (TLP-VSL-00009A/B)*.

**Basis:** This model requirement is based the description in Section 3.4.3.1.3 *SBS Condensate Collection Vessel* in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

3.13.3.34  **SBS Condensate Collection Vessel (RLD-VSL-00005) Transfer Complete**

**Unique ID:** BMR-RLD_MR-29

The *SBS Condensate Collection Vessel (RLD-VSL-00005)* shall transfer at the maximum pump-rate until the vessel has reached its minimum volume.

**Basis:** This model requirement is based the description in Section 4.8.11 *Radioactive Liquid Waste Disposal (RLD) System* of 24590-WTP-MDD-PR-01-002, WTP MDD Rev. 13.

3.13.3.35  **Acidic Waste Vessel (RLD-VSL-00007) Receive From HOP**

**Unique ID:** BMR-RLD_MR-30

The *Acidic Waste Vessel (RLD-VSL-00007)* shall receive from the *HLW SBS Condensate Vessels (HOP-SCB-00001-2)*.

**Basis:** This model requirement is based the description in Section 4.8.11 *Radioactive Liquid Waste Disposal (RLD) System* of 24590-WTP-MDD-PR-01-002, WTP MDD Rev. 13.

3.13.3.36  **Acidic Waste Vessel (RLD-VSL-00007) Receive Canister Decontamination Chem Adds**

**Unique ID:** BMR-RLD_MR-51

The *Acidic Waste Vessel (RLD-VSL-00007)* shall receive the *HLW Effluent Transfer Vessel Canister Decontamination Chem Adds*.

**Basis:** This model requirement is based the description in Section 4.8.11 *Radioactive Liquid Waste Disposal (RLD) System* of 24590-WTP-MDD-PR-01-002, WTP MDD Rev. 13.

3.13.3.37  **Acidic Waste Vessel (RLD-VSL-00007) Simultaneous Receipt**

**Unique ID:** BMR-RLD_MR-52

The *Acidic Waste Vessel (RLD-VSL-00007)* may receive from multiple sources simultaneously.

**Basis:** This requirement is based on TOPSim modeling methodology of the melter activity. The receipt of the RLD waste from the melter and the canister decontamination occur at the same time because the activity for the melter operations all start at the same time. In reality the receipts into RLD-VSL-00007 would not occur simultaneously; however for the purpose of the
TOPSim model, this approach is acceptable and represents an average time for the melter activity.

3.13.3.38 Acidic Waste Vessel (RLD-VSL-00007) Complete Filling

Unique ID: BMR-RLD_MR-32

The Acidic Waste Vessel (RLD-VSL-00007) shall complete filling when the volume has reached the set volume; if the downstream vessel is unavailable the vessel may accumulate but shall not exceed the upper set volume of the vessel.

Basis: This model requirement is based the description in Section 4.8.11 Radioactive Liquid Waste Disposal (RLD) System of 24590-WTP-MDD-PR-01-002, WTP MDD Rev. 13. This vessel is associated with the melter activity and may exceed the set volume at times in order to prevent the melter from backing up.

3.13.3.39 Acidic Waste Vessel (RLD-VSL-00007) pH Adjustment

Unique ID: BMR-RLD_MR-41

After the Acidic Waste Vessel (RLD-VSL-00007) has been filled, the pH of the vessel shall be adjusted if needed by adding enough RLD-VSL-00007 Caustic to meet the minimum RLD-VSL-00007 Target pH and then the RLD-VSL-00007 pH Adjustment Reactions shall be applied. The vessel may be filled to the upper-set volume if needed.

Basis: This model requirement is based the description in Section 4.8.11 Radioactive Liquid Waste Disposal (RLD) System of 24590-WTP-MDD-PR-01-002, WTP MDD Rev. 13.

3.13.3.40 Acidic Waste Vessel (RLD-VSL-00007) Sampling

Unique ID: BMR-RLD_MR-40

The RLD-VSL-00007 Sample Time shall be applied after the Acidic Waste Vessel (RLD-VSL-00007) has completed its pH adjustment.

Basis: This model requirement is based the description in Section 4.8.11 Radioactive Liquid Waste Disposal (RLD) System of 24590-WTP-MDD-PR-01-002, WTP MDD Rev. 13.

3.13.3.41 Acidic Waste Vessel (RLD-VSL-00007) Discharge

Unique ID: BMR-RLD_MR-33

After the sample time has elapsed, the Acidic Waste Vessel (RLD-VSL-00007) shall transfer to the HLW Effluent Transfer Vessel (PWD-VSL-00043) if available at its maximum pump rate. If the HLW Effluent Transfer Vessel (PWD-VSL-00043) is not available then the contents of the Acidic Waste Vessel (RLD-VSL-00007) shall be transferred to the Acidic Waste Vessel (RLD-VSL-00008) at its maximum pump rate.

Basis: This model requirement is based the description in Section 4.8.11 Radioactive Liquid Waste Disposal (RLD) System of 24590-WTP-MDD-PR-01-002, WTP MDD Rev. 13.
3.13.3.42 Acidic Waste Vessel (RLD-VSL-00007) Transfer Complete

Unique ID: BMR-RLD_MR-34

The Acidic Waste Vessel (RLD-VSL-00007) shall complete transferring when it has reached its minimum volume.

Basis: This model requirement is based the description in Section 4.8.11 Radioactive Liquid Waste Disposal (RLD) System of 24590-WTP-MDD-PR-01-002, WTP MDD Rev. 13.

3.13.3.43 Acidic Waste Vessel (RLD-VSL-00008) Receipt Source

Unique ID: BMR-RLD_MR-35

The Acidic Waste Vessel (RLD-VSL-00008) shall receive from the Acidic Waste Vessel (RLD-VSL-00007).

Basis: This model requirement is based the description in Section 4.8.11 Radioactive Liquid Waste Disposal (RLD) System of 24590-WTP-MDD-PR-01-002, WTP MDD Rev. 13.

3.13.3.44 Acidic Waste Vessel (RLD-VSL-00008) Complete Filling

Unique ID: BMR-RLD_MR-37

The Acidic Waste Vessel (RLD-VSL-00008) shall complete filling when the volume has reached the set volume.

Basis: This model requirement is based the description in Section 4.8.11 Radioactive Liquid Waste Disposal (RLD) System of 24590-WTP-MDD-PR-01-002, WTP MDD Rev. 13.

3.13.3.45 Acidic Waste Vessel (RLD-VSL-00008) Routing

Unique ID: BMR-RLD_MR-38

Once the Acidic Waste Vessel (RLD-VSL-00008) has been filled, it shall transfer the HLW Effluent Transfer Vessel (PWD-VSL-00043) at its maximum pump rate.

Basis: This model requirement is based the description in Section 4.8.11 Radioactive Liquid Waste Disposal (RLD) System of 24590-WTP-MDD-PR-01-002, WTP MDD Rev. 13.

3.13.3.46 Acidic Waste Vessel (RLD-VSL-00008) Transfer Complete

Unique ID: BMR-RLD_MR-39

The Acidic Waste Vessel (RLD-VSL-00008) shall complete transferring when it has reached its minimum volume.

Basis: This model requirement is based the description in Section 4.8.11 Radioactive Liquid Waste Disposal (RLD) System of 24590-WTP-MDD-PR-01-002, WTP MDD Rev. 13.

3.13.3.47 HLW Effluent Transfer Vessel Canister Decontamination Chem Adds

Unique ID: BMR-RLD_MR-50

The HLW Canister Decontamination Chem Adds shall be added to the Acidic Waste Vessel (RLD-VSL-00007) for every two HLW canisters produced to simulate the canister decontamination. The chemical additions shall be made at the Canister Decontamination Chemical Addition Rate.
3.13.4 Technical Requirements

3.13.4.1 Alkaline Effluent Vessels (RLD-VSL-00017A/B) Parameters

Unique ID: BMR-RLD_TR-2

The Alkaline Effluent Vessels (RLD-VSL-00017A/B) shall have the following parametric values.

<table>
<thead>
<tr>
<th>Vessel #</th>
<th>Maximum Volume (gal)</th>
<th>Upper Set Volume (gal)</th>
<th>Set Volume (gal)</th>
<th>Minimum Volume (gal)</th>
<th>Maximum Pump Rate (gpm)</th>
<th>Temperature (C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>RLD-VSL-00017A</td>
<td>28,075</td>
<td>21,870</td>
<td>21,870</td>
<td>1,870</td>
<td>130</td>
<td>25</td>
</tr>
<tr>
<td>RLD-VSL-00017B</td>
<td>28,075</td>
<td>21,870</td>
<td>21,870</td>
<td>1,870</td>
<td>130</td>
<td>25</td>
</tr>
</tbody>
</table>

Basis: The vessel parameters are based on Table E-1 Vessel Parameters in 24590-WTP-MDD-PR-01-002, WTP MDD (also consistent with Table B-1, Facility Item Datasheet in 24590-WTP-RPT-PT-02-005, BARD Rev. 8). The temperature is based on engineering judgment.

3.13.4.2 Process Condensate Vessel (RLD-VSL-00006A) Parameters

Unique ID: BMR-RLD_TR-3

The Process Condensate Vessel (RLD-VSL-00006A) shall have the following parametric values (Note for this vessel due to the multiple set points the maximum volume is not the overflow volume as is the case for other WTP vessels).

<table>
<thead>
<tr>
<th>Vessel #</th>
<th>Maximum Volume (gal)</th>
<th>Upper Set Volume (gal)</th>
<th>Set Volume (gal)</th>
<th>Minimum Volume (gal)</th>
<th>Maximum pump rate (gpm)</th>
<th>Temperature (C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>RLD-VSL-00006A</td>
<td>313,500</td>
<td>292,500</td>
<td>110,000</td>
<td>27,500</td>
<td>1,000</td>
<td>25</td>
</tr>
</tbody>
</table>

Basis: The vessel parameters are based on Table E-1 Vessel Parameters in 24590-WTP-MDD-PR-01-002, WTP MDD (also consistent with Table B-1, Facility Item Datasheet in 24590-WTP-RPT-PT-02-005, BARD Rev. 8). The temperature is based on engineering judgement. Actual pump rate is specified in other requirements and is based on destination.

3.13.4.3 Process Condensate Vessel (RLD-VSL-00006B) Parameters

Unique ID: BMR-RLD_TR-4

The Process Condensate Vessel (RLD-VSL-00006B) shall have the following parametric values.
<table>
<thead>
<tr>
<th>Vessel #</th>
<th>Maximum Volume (gal)</th>
<th>Upper Set Volume (gal)</th>
<th>Set Volume (gal)</th>
<th>Minimum Volume (gal)</th>
<th>Maximum Pump Rate (gpm)</th>
<th>Temperature (C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>RLD-VSL-00006B</td>
<td>313,500</td>
<td>292,500</td>
<td>200,000</td>
<td>27,500</td>
<td>170</td>
<td>25</td>
</tr>
</tbody>
</table>

**Basis:** The vessel parameters are based on Table E-1 Vessel Parameters in 24590-WTP-MDD-PR-01-002, WTP MDD (also consistent with Table B-1, Facility Item Datasheet in 24590-WTP-RPT-PT-02-005, BARD Rev. 8). The temperature is based on engineering judgment.

### 3.13.4.4 C3/C5 Drains/Sump Collection Vessel (RLD-VSL-00004) Parameters

**Unique ID:** BMR-RLD_TR-9

The C3/C5 Drains/Sump Collection Vessel (RLD-VSL-00004) shall have the following parametric values.

<table>
<thead>
<tr>
<th>Vessel #</th>
<th>Maximum Volume (gal)</th>
<th>Upper Set Volume (gal)</th>
<th>Set Volume (gal)</th>
<th>Minimum Volume (gal)</th>
<th>Maximum Pump Rate (gpm)</th>
<th>Temperature (C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>RLD-VSL-00004</td>
<td>6,456</td>
<td>5,887</td>
<td>3,387</td>
<td>1,387</td>
<td>75</td>
<td>25</td>
</tr>
</tbody>
</table>

**Basis:** The vessel parameters are based on Table E-1 Vessel Parameters in 24590-WTP-MDD-PR-01-002, WTP MDD (also consistent with Table B-1, Facility Item Datasheet in 24590-WTP-RPT-PT-02-005, BARD Rev. 8). The temperature is based on engineering judgment.

### 3.13.4.5 SBS Condensate Collection Vessel (RLD-VSL-00005) Parameters

**Unique ID:** BMR-RLD_TR-8

The SBS Condensate Collection Vessel (RLD-VSL-00005) shall have the following parametric values.

<table>
<thead>
<tr>
<th>Vessel #</th>
<th>Maximum Volume (gal)</th>
<th>Upper Set Volume (gal)</th>
<th>Set Volume (gal)</th>
<th>Minimum Volume (gal)</th>
<th>Maximum Pump Rate (gpm)</th>
<th>Temperature (C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>RLD-VSL-00005</td>
<td>23,264</td>
<td>20,300</td>
<td>17,300</td>
<td>4,300</td>
<td>175</td>
<td>25</td>
</tr>
</tbody>
</table>

**Basis:** The vessel parameters are based on Table E-1 Vessel Parameters in 24590-WTP-MDD-PR-01-002, WTP MDD (also consistent with Table B-1, Facility Item Datasheet in 24590-WTP-RPT-PT-02-005, BARD Rev. 8). The temperature is based on engineering judgment.

### 3.13.4.6 Acidic Waste Vessel (RLD-VSL-00007) Parameters

**Unique ID:** BMR-RLD_TR-10

The Acidic Waste Vessel (RLD-VSL-00007) shall have the following parametric values.
Basis: This requirement is based the values in *Table B-1 Facility Item Datasheet* in 24590-WTP-RPT-PT-02-005, BARD Rev. 8. The temperature is based on the value downstream PWD vessels in Table 6, *Solubility Application* in the 24590-WTP-MDD-PR-01-002, WTP MDD. The set volume is based on allowing 3,000 gallons (engineering judgement) for caustic addition used in neutralization prior to transferring to PWD.

### 3.13.4.7 Acidic Waste Vessel (RLD-VSL-00008) Parameters

**Unique ID:** BMR-RLD_TR-11

The *Acidic Waste Vessel (RLD-VSL-00008)* shall have the following parametric values.

<table>
<thead>
<tr>
<th>Vessel #</th>
<th>Overflow Volume (gal)</th>
<th>Upper Set Volume (gal)</th>
<th>Set Volume (gal)</th>
<th>Minimum Volume (gal)</th>
<th>Maximum pump rate (gpm)</th>
<th>Temperature (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>RLD-VSL-00008</td>
<td>15,321</td>
<td>12,739</td>
<td>12,739</td>
<td>2,049</td>
<td>190</td>
<td>25</td>
</tr>
</tbody>
</table>

**Basis:** This model requirement is based the values in *Table B-1 Facility Item Datasheet* in 24590-WTP-RPT-PT-02-005, BARD Rev. 8. The temperature is based on the downstream PWD vessels in Table 6, *Solubility Application* in the 24590-WTP-MDD-PR-01-002, WTP MDD.

### 3.13.4.8 Alkaline Effluent Vessels (RLD-VSL-00017A/B) Sample Time

**Unique ID:** BMR-RLD_TR-5

The *Alkaline Effluent Vessels (RLD-VSL-00017A/B)* sample time is 8.4 hours.

**Basis:** This model requirement is based the description in Section 4.8.11 *Radioactive Liquid Waste Disposal (RLD) System* (and *Table E-1 Vessel Parameters*) of 24590-WTP-MDD-PR-01-002, WTP MDD Rev. 13.

### 3.13.4.9 RLD-VSL-00006A Recycle Condensate Rate

**Unique ID:** BMR-RLD_TR-6

The *Process Condensate Vessel (RLD-VSL-00006A)* discharge rate for PT process condensate is 250 gpm.

**Basis:** This model requirement is based the description in Section 4.8.11 *Radioactive Liquid Waste Disposal (RLD) System* of 24590-WTP-MDD-PR-01-002, WTP MDD Rev. 13.
3.13.4.10  RLD-VSL-00006A to RLD-VSL-00006B Rate

Unique ID: BMR-RLD_TR-7

The *Process Condensate Vessel (RLD-VSL-00006A)* discharge rate to the *Process Condensate Vessel (RLD-VSL-00006B)* is 100 gpm.

**Basis:** This model requirement is based the description in Section 4.8.11 *Radioactive Liquid Waste Disposal (RLD) System* of 24590-WTP-MDD-PR-01-002, WTP MDD Rev. 13.

3.13.4.11  Acidic Waste Vessel (RLD-VSL-00007) Caustic

Unique ID: BMR-RLD_TR-14

5.0M NaOH shall be added to the *Acidic Waste Vessel (RLD-VSL-00007)* for pH adjustment.

**Basis:** This model requirement is based the description in Section 4.8.11 *Radioactive Liquid Waste Disposal (RLD) System* of 24590-WTP-MDD-PR-01-002, WTP MDD Rev. 13.

3.13.4.12  Acidic Waste Vessel (RLD-VSL-00007) Target Minimum pH

Unique ID: BMR-RLD_TR-12

The target minimum pH endpoint for the *Acidic Waste Vessel (RLD-VSL-00007)* shall be 8.0.

**Basis:** This model requirement is based the description in Section 4.8.11 *Radioactive Liquid Waste Disposal (RLD) System* of 24590-WTP-MDD-PR-01-002, WTP MDD Rev. 13.

3.13.4.13  Acidic Waste Vessel (RLD-VSL-00007) pH Adjustment Reactions

Unique ID: BMR-RLD_TR-15

The *Acidic Waste Vessel (RLD-VSL-00007)* pH Adjustment reactions are:

- RXN-NH4-NEUTRALIZATION Conversion = 1.0
- HG-LIQUID-to-SOLID Conversion = 1.0
- NEUT-REACTION Conversion = 1.0.

**Basis:** This model requirement is based the description in Section 4.8.11 *Radioactive Liquid Waste Disposal (RLD) System* of 24590-WTP-MDD-PR-01-002, WTP MDD Rev. 13.

3.13.4.14  Acidic Waste Vessel (RLD-VSL-00007) Sample Time

Unique ID: BMR-RLD_TR-13

The *Acidic Waste Vessel (RLD-VSL-00007)* sample time is 7.8 hours.

**Basis:** This model requirement is based the description in Section 4.8.11 *Radioactive Liquid Waste Disposal (RLD) System* (and Table E-1 Vessel Parameters) of 24590-WTP-MDD-PR-01-002, WTP MDD Rev. 13.

3.13.4.15  HLW Effluent Transfer Vessel Canister Decontamination Chem Adds

Unique ID: BMR-RLD_TR-1

The following chemical additions are added for every two *HLW* canisters produced.

- 1,397.6 gallons of *Water*,
- 40 gallons of *0.5M cerium nitrate (Ce(NO3)3)*,
- 790 gallons of 1.0M HNO₃,
- 1 gallon of Hydrogen Peroxide (H₂O₂),
- 166 gallons of 5.0M NaOH

**Basis:** This requirement is based on the steps listed in Section 4.8.20 Canister Decontamination Handling (HDH) System of 24590-WTP-MDD-PR-01-002, WTP MDD Rev. 13. The chemical additions in WTP actually collect in the vessel HDH-VSL-00003 which is not modeled; therefore the rate of chemical additions is not specified in TOPSim.

### 3.13.5 RLD Figures and Diagrams

#### 3.13.5.1 RLD Routing Diagram

**Unique ID:** BMR-RLD_DIG-1

![RLD Routing Diagram](image)

#### 3.13.5.2 RLD-VSL-00017A/B Operation

**Unique ID:** BMR-RLD_DIG-2

![RLD-VSL-00017A/B Operation](image)
3.13.5.3 RLD-VSL-00006B Operation

Unique ID: BMR-RLD_DIG-3

3.13.5.4 RLD-VSL-00006A Operation

Unique ID: BMR-RLD_DIG-4
3.13.5.5 RLD-VSL-00004 and RLD-VSL-00005

Unique ID: BMR-RLD_DIG-5
3.13.5.6 RLD-VSL-00007 and RLD-VSL-00008 Operation

Unique ID: BMR-RLD_DIG-6

3.14 WASTE TREATMENT AND IMMOBILIZATION PLANT LOW-ACTIVITY WASTE VITRIFICATION FACILITY

The LAW Vitrification Facility converts the low-activity waste from the Tank Farms into molten glass. LAW Vitrification (LAW) in the HSM consists of the WTP LAW melter feed process and the LAW melter process. The basis for operation of the LAW melter feed process is to ensure adequate feed is provided at all times for all LAW melters in operation. The LAW melter operation is modeled as a single melter (including all associated equipment and vessels) having the total capacity of all the LAW melters and associated equipment and vessels that will be installed in the WTP.

In the LAW melter feed process, LAW feed is delivered directly from the Tank Farms during DFLAW, and from the PT facility after DFLAW. The LAW feed first enters the LAW Concentrate Receipt Vessels, LCP-VSL-00001_2 where it is sampled (the sampling of the LAW feed batch is not part of the HSM at this time) to determine the composition of glass formers required to achieve the minimum waste loading of Na2O as specified by the WTP Contract.

The LAW Melter Feed Preparation Vessels, LFP-VSL-00001_3, receives the LAW concentrate from the concentrate receipt vessel and mixes the waste with glass formers and sucrose delivered from the Glass Former Feed Hoppers, GFR-VSL-000022_23. This mixture is transferred to the LAW Melter Feed Vessels, LFP-VSL-00002_4.

The LAW Melter Feed Vessels provide continuous feed of LAW slurry to the LAW Melters (LMP-MLTR-00001_2 to meet the glass production rate. User-defined reference data sets the melter’s throughput rate in MTG/d. The rate at which the melter operates varies throughout the
mission and is also specified by the user-defined reference data. The ramp rate is identified by the HSM requirements. The HSM compares the rate of glass production to the user-defined reference data every eight simulation hours. If the calculated value and set value do not match, the HSM adjusts the melter feed rate to maintain the desired production rate.

When feed enters the melter, the HSM applies a split to the liquid and gas components. The liquid split values apply to the liquid components that come into the melter. After the splits are applied, the reactions, as defined by the HSM requirements, are completed in the order given. The decomposition reactions are completed before the oxide reactions. Air is added to the melter to supply the O2 needed for the reactions.

Molten glass discharges from the melter when the glass level is above the upper set volume and is collected in the LAW Canister Accumulation Vessel, LAW-CANISTERS. The number of canisters are tracked based on the mass accumulated in the LAW Canister Accumulation Vessel and dividing by the assumed glass density and canister volume. Storage and handling of the canisters is not modeled, but replacement of the melter is modeled.

3.14.1 System Requirements

3.14.1.1 LAW Concentrate Reciept Process (LCP)
Unique ID: BMR-LAW_SR-2
The LCP shall receive pretreated LAW.
Basis: N/A

3.14.1.2 LAW Melter Feed Preparation (LFP)
Unique ID: BMR-LAW_SR-3
The LFP shall prepare the LAW to feed into LMP.
Basis: N/A

3.14.1.3 LAW Melter Process (LMP)
Unique ID: BMR-LAW_SR-1
The LMP shall convert LAW into ILAW glass and route it to storage.
Basis: N/A

3.14.2 Functional Requirements

3.14.2.1 LAW Melter Capacity
Unique ID: BMR-LAW_FR-7
The LMP shall have the capability to process the capacity as specified by the WTP Contract.
Basis: This functional requirement is contained in Section C.7(b)(2) in DE-AC27-01RV14136, WTP/DOE Statement of Work.
3.14.2.2 LAW Melter Feed Receipt

Unique ID: BMR-LAW_FR-2

The LCP system shall have the capability to receive *pretreated LAW* from TCP and the DST System.

Basis: This functional requirement comes from Section 3.1.3.1. LAW Concentrate Receipt Vessel in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

3.14.2.3 LAW Melter Feed Receipt (DFLAW)

Unique ID: BMR-LAW_FR-4

During DFLAW operations the LCP shall have the capability to receive *pretreated LAW* directly from the DST System, stated in BMR-FR-572.

Basis: This functional requirement is in Section 3.1.1 Functions and Requirements (LAW Melter Feed Process) in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

3.14.2.4 LAW Melter Flush Receipt (DFLAW)

Unique ID: BMR-LAW_FR-16

During DFLAW operations the LCP system shall have the capability to receive *process condensate* and line flushes from EMF according to BMR-FR-502 - Condensate Waste Routing.

Basis: This functional requirement is in Section 3.1.1 Functions and Requirements (LAW Melter Feed Process) in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

3.14.2.5 LAW Melter Feed Sampling

Unique ID: BMR-LAW_FR-11

The LCP shall have the capability to sample the *pretreated LAW*.

Basis: This functional requirement is in Section 3.1.3.1 LAW Concentrate Feed Vessel in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

3.14.2.6 LFP Feed Receipt

Unique ID: BMR-LAW_FR-13

The LFP shall have the capability to receive *pretreated LAW* from LCP.

Basis: This functional requirement is in Section 3.1.3.3 LAW Melter Feed Preparation Vessel in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

3.14.2.7 LAW Melter Feed Preparation

Unique ID: BMR-LAW_FR-8

The LFP shall have the capability to receive *glass formers* from GFR.

Basis: This functional requirement is in Section 3.1.3.3 LAW Melter Feed Preparation Vessel in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.
3.14.2.8 LFP to LMP

Unique ID: BMR-LAW_FR-14

The LMP shall have the capability to receive the slurry and glass formers from LFP.

**Basis:** This functional requirement is from Section 3.4.1.1 LMP Feed (General Requirements) in 24590-LAW-3ZD-LMP-00001, LMP System Design Description.

3.14.2.9 LAW Melter Process

Unique ID: BMR-LAW_FR-1

The LMP shall have the capability to convert the slurry and glass formers into molten ILAW glass product.

**Basis:** This functional requirement is from Section 4.1 Configuration Information (System Description) in 24590-LAW-3ZD-LMP-00001, LMP System Design Description.

3.14.2.10 LAW Glass Packaging

Unique ID: BMR-LAW_FR-9

The LMP shall have the capability to pour molten glass into ILAW containers.

**Basis:** This functional requirement is in Section 4.8.15 LAW Melter Process (LMP) System in 24590-WTP-MDD-PR-01-002, WTP MDD.

3.14.2.11 LAW Melter Offgas Stream

Unique ID: BMR-LAW_FR-5

The LMP shall have the capability to capture and route melter offgas to the LOP.

**Basis:** This functional requirement comes from Section 3.5.2.1 Confinement of Offgas in 24590-LAW-3ZD-LMP-00001, LMP System Design Description.

3.14.2.12 LAW Melter Replacement

Unique ID: BMR-LAW_FR-6

The LMP shall have the capability to replace a melter, when it has become defective or reached the end of its useful life.

**Basis:** This functional requirement comes from Section 3.15.4.21 Design for Replacement after End of Life or Failure in 24590-LAW-3ZD-LMP-00001, LMP System Design Description.

3.14.3 Model Requirements

3.14.3.1 LAW Concentrate Receipt Vessel (LCP-VSL-00001_2) Identification

Unique ID: BMR-LAW_MR-2

The LAW Concentrate Receipt Vessels shall consist of one vessel identified as LCP-VSL-00001_2, which represents the combined throughput capacity of the two LAW Concentrate Receipt Vessels (LCP-VSL-00001 and LCP-VSL-00002).

**Basis:** This model requirement is in Section 3.1.3.1 LAW Concentrate Receipt Vessel in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.
3.14.3.2 LAW Glass Former Feed Hopper (GFR-VSL-00022_23) Identification

Unique ID: BMR-LAW_MR-11

LAW Glass Former Feed Hopper shall consist of one vessel identified as GFR-TK-00022_23, which represents the combined capacity of the two LAW Glass Former Feed Hoppers (GFR-VSL-00022 and GFR-VSL-00023).

Basis: This model requirement is in Section 3.1.3.2 Glass Former Mixers in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

3.14.3.3 LAW Melter Feed Preparation Vessel (LFP-VSL-00001_3) Identification

Unique ID: BMR-LAW_MR-3

LAW Melter Feed Preparation Vessel shall consist of one vessel identified as LFP-VSL-00001_3, which represents the combined throughput capacity of the two LAW Melter Feed Preparation Vessels (LFP-VSL-00001 and LFP-VSL-00003).

Basis: This model requirement is in Section 3.1.3.3 LAW Melter Feed Preparation Vessel in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

3.14.3.4 LAW Melter Feed Vessel (LFP-VSL-00002_4) Identification

Unique ID: BMR-LAW_MR-4

The LAW Melter Feed Vessels shall consist of one vessel identified as LFP-VSL-00002_4, which represents the combined throughput capacity of two LAW Melter Feed Vessels (LFP-VSL-00002 and LFP-VSL-00004).

Basis: This model requirement is in Section 3.1.3.4 LAW Melter Feed Vessel in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

3.14.3.5 LAW Melter (LMP-MLTR-00001_2) Identification

Unique ID: BMR-LAW_MR-1

The LAW Melter shall consist of one melter identified as LMP-MLTR-00001_2, which represents the combined throughput capacity of two LAW Melters (LMP-MLTR-00001 and LMP-MLTR-00002).

Basis: This model requirement is in Section 3.2.2 System Description (LAW Melter Process) in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

3.14.3.6 LAW Glass Packaging Identification

Unique ID: BMR-LAW_MR-10

The mass of ILAW glass shall be accumulated in the LAW-Canister Accumulation Vessel identified in TOPSim as LAW-CANISTERS.

Basis: This model requirement is in Section 4.8.15 LAW Melter Process (LMP) System in 24590-WTP-MDD-PR-01-002, WTP MDD.
3.14.3.7 LAW Concentrate Feed Receipt from the DST System during DFLAW

**Unique ID:** BMR-LAW_MR-19

*LCP-VSL-00001_2* shall receive *pretreated LAW* from the Interim LAW Storage Tank during DFLAW.

**Basis:** This model requirement is in Section 3.1.3.1 LAW Concentrate Receipt Vessel in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

3.14.3.8 LAW Condensate Feed Receipt from EMF during DFLAW

**Unique ID:** BMR-LAW_MR-20

*LCP-VSL-00001_2* shall receive *process condensate* and line flushes from *EMF-VSL-00001A/B/C* during DFLAW.

**Basis:** This model requirement is in Section 3.1.3.1 LAW Concentrate Receipt Vessel in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

3.14.3.9 LAW Inter-facility Transfer Line Flush (DFLAW)

**Unique ID:** BMR-LAW_MR-8

The inter-facility transfer line, between *TLS-VSL-00001/2/3* and *LCP-VSL-00001_2*, shall flush the *DFLAW Inter-facility Transfer Line Flush Volume of inhibited water* after *TLS-VSL-00001/2/3* and *EMF-VSL-00001A/B/C* transfers the LCP Batch Volume of *pretreated LAW*.

**Basis:** This model requirement is in Section 3.1.3.1 LAW Concentrate Receipt Vessel in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

3.14.3.10 LAW Feed Changeover Time

**Unique ID:** BMR-LAW_MR-23

*LCP-VSL-00001_2* shall stop receiving from *TLS-VSL-00001/2/3* prior to *WTP PT* start-up to allow changeover from *DFLAW* to *WTP feed*.

**Basis:** This model requirement is based on engineering judgement.

3.14.3.11 LAW Concentrate Feed Receipt from TCP

**Unique ID:** BMR-LAW_MR-18

*LCP-VSL-00001_2* shall receive concentrated *pretreated LAW* from *TCP-VSL-00001* after *WTP PT* startup.

**Basis:** This model requirement is in Section 4.8.13 LAW Concentrate Receipt Process (LCP System) in 24590-WTP-MDD-PR-01-002, WTP MDD.

3.14.3.12 LAW Concentrate Receipt Vessel (LCP-VSL-00001_2) Receipt Trigger

**Unique ID:** BMR-LAW_MR-29

The LAW Concentrate Receipt Vessel (LCP-VSL-00001_2) shall be available to receive a new pretreated LAW feed batch when its remaining feed above the minimum volume plus the formulated glass formers amount in *GFR-TK-00022_23* do not make a full vessel batch volume of formulated feed for the LAW Melter Feed Preparation Vessel (LFP-VSL-00001_3).
At that point the LAW Concentrate Receipt Vessel (LCP-VSL-00001_2) shall switch to filling mode.

**Basis:** This model requirement is in Section 3.1.3.1 LAW Concentrate Receipt Vessel in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

The basis for operation of the LAW melter feed system is to ensure adequate feed is provided at all times for all LAW melters in operation at any one time. The feed system contains standardized equipment sized to hold the same batch capacity under similar process conditions. Therefore the LCP batch volume is such that its addition and the addition of glass formers from GFR-TK-000022_23 provides a full batch volume for LFP-VSL-00001_3.

### 3.14.3.13 LAW Concentrate Receipt Vessel (LCP-VSL-00001_2) Operation

**Unique ID:** BMR-LAW_MR-16

The following operational constraints shall apply to the LAW Concentrate Receipt Vessel (LCP-VSL-00001_2):

1. *LCP-VSL-00001_2* shall not simultaneously fill and discharge

2. *LCP-VSL-00001_2* shall not discharge when the volume of *LCP-VSL-00001_2* is at or below the lower set volume.

3. *LCP-VSL-00001_2* shall not discharge when the remaining pretreated LAW in *LCP-VSL-00001_2* above the minimum volume plus the glass formers amount required for formulation is not sufficient to fill a full vessel batch volume of formulated feed in *LFP-VSL-00001_3*, e.g. partial transfers are prohibited.

**Basis:** This model requirement is in Section 3.1.3.1 LAW Concentrate Receipt Vessel in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

### 3.14.3.14 LAW Concentrate Receipt Vessel (LCP-VSL-00001_2) Complete Filling

**Unique ID:** BMR-LAW_MR-32

The LAW Concentrate Receipt Vessel (LCP-VSL-00001_2) shall complete filling when the volume is at the upper set volume.

**Basis:** This model requirement is in Section 3.1.3.1 LAW Concentrate Receipt Vessel in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

### 3.14.3.15 LAW Melter Feed Sampling

**Unique ID:** BMR-LAW_MR-7

The amount of glass formers shall be calculated from the glass models, using the composition of the pretreated LAW to be transferred to *LCP-VSL-00001_2*.

**Basis:** This model requirement comes from Section 3.1.3.2 Glass Former Mixers in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.
3.14.3.16 LAW Glass Formulation Calculations
Unique ID: BMR-LAW_MR-28

Based on the LCP-VSL-00001_2 composition, the amount of glass formers to be added (as contained in Glass Former Mineral Addition model requirement) shall be calculated using the LAW Selected Glass Model, subject to applicable property and composition constraints. Note that the glass models are part of the software and the actual mathematical model was tested separately.

Basis: This model requirement is in Section 3.1.3.5.2 Waste Loading and Glass Formulation in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

3.14.3.17 LAW Glass Former Feed Hopper (GFR-TK-00022_23) Feed Receipt
Unique ID: BMR-LAW_MR-9

After the glass former composition has been calculated from the LAW Selected Glass Model, the glass formers shall be added to GFR-TK-00022_23.

Basis: This model requirement is in Section 3.1.3.2.2 Operating Logic - Glass Former Mixers in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

3.14.3.18 LAW Sugar Receipt
Unique ID: BMR-LAW_MR-31

After the glass formers have been added to GFR-VSL-000022_23, sugar shall be added to GFR-VSL-000022_23. See NOTE in Basis.

Basis: This model requirement is found in Section 4.8.13 LAW Concentrate Receipt Process (LCP) System in 24590-WTP-MDD-PR-01-002, WTP MDD.

NOTE: For modeling purposes however, the sugar is added at the same time along with the glass formers into the melter feed preparation vessel.

3.14.3.19 LAW Concentrate Receipt Vessel (LCP-VSL-00001_2) Batch Size Determination
Unique ID: BMR-LAW_MR-33

After the LCP-VSL-00001_2 sampling is complete and the formulated glass formers amount is defined, the LFP Batch Size shall be determined. The batch size is defined according to the combined volumes of: a) LCP-VSL-00001_2 filled to upper set point, and b) formulated glass formers amount that generates a discrete melt feed chemical composition of known waste loading. This Batch Size determines the number of transfers that can be made to LFP-VSL-00001_3 to fill LFP-VSL-00001_3 to its upper set volume.

Basis: This model requirement is found in Section 3.1.3.3 of 24590-WTP-RPT-PT-02-005, BARD Rev. 8.
3.14.3.20  LAW Concentrate Receipt Vessel (LCP-VSL-00001_2) Discharge

Unique ID: BMR-LAW_MR-34

After the LFP Batch Size has been determined, the LCP-VSL-00001_2 shall discharge to LAW Melter Feed Preparation Vessel LFP-VSL-00001_3.

Basis: This model requirement is found in Section 3.1.3.3 of 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

3.14.3.21  LAW Concentrate Receipt Vessel (LCP-VSL-00001_2) Transfer Complete

Unique ID: BMR-LAW_MR-25

LCP-VSL-00001_2 shall stop transferring to LFP-VSL-00001_3, when the volume of LCP-VSL-00001_2 is below the Set Volume.

Basis: This model requirement is in Section 3.1.3.3 LAW Melter Feed Preparation Vessel in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

3.14.3.22  LAW Melter Feed Preparation Preparation Vessel (LFP-VSL-00001_3) Receipt Source

Unique ID: BMR-LAW_MR-21

LFP-VSL-00001_3 shall receive from the following sources:

1. LAW feed from LAW Concentrate Receipt Vessel (LCP-VSL-00001_2),
2. Blended glass formers from LAW Glass Former Feed Hopper (GFR-TK-00022_23).

Basis: This model requirement is in Section 3.1.3.3 LAW Melter Feed Preparation Vessel in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

3.14.3.23  LAW Melter Feed Preparation Vessel (LFP-VSL-00001_3) Operation

Unique ID: BMR-LAW_MR-35

The following operational constraints shall apply to the LAW Melter Feed Preparation Vessel (LFP-VSL-00001_3):

1. LFP-VSL-00001_3 shall not simultaneously fill and discharge,
2. LFP-VSL-00001_3 shall not discharge when the volume of LFP-VSL-00001_3 is at or below the minimum volume,
3. LFP-VSL-00001_3 shall receive LAW feed from LCP-VSL-00001_2, after the glass former composition has been calculated and the LFP Batch Size is determined, and then subsequently LFP-VSL-00001_3 shall receive from GFR-TK-00022_23,
4. Each transfer of combined volumes from LCP-VSL-00001_2 and GFR-TK-00022_23 shall fill LFP-VSL-00001_3 to its upper set volume, i.e. partial transfers are prohibited.

Basis: This model requirement is in Section 3.1.3.3 LAW Melter Feed Preparation Vessel in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.
3.14.3.24 LAW Melter Feed Preparation Vessel (LFP-VSL-00001_3) Complete Filling
Unique ID: BMR-LAW_MR-36
The LAW Melter Feed Preparation Vessel (LFP-VSL-00001_3) shall complete filling when the volume is at the upper set volume.
Basis: This model requirement is in Section 3.1.3.3 LAW Melter Feed Preparation Vessel in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

3.14.3.25 LAW Melter Feed Preparation Vessel (LFP-VSL-00001_3) Transfer Complete
Unique ID: BMR-LAW_MR-26
LFP-VSL-00001_3 shall stop transferring to LFP-VSL-00002_4, when the volume of LFP-VSL-00001_3 is at the Lower Set Volume
Basis: This model requirement is in Section 3.1.3.3.2 Operating Logic - LAW Melter Feed Preparation Vessel in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

3.14.3.26 LAW Melter Feed Preparation Vessel (LFP-VSL-00001_3) Routing
Unique ID: BMR-LAW_MR-37
After filling is complete, the LAW Melter Feed Preparation Vessel (LFP-VSL-00001_3) shall transfer to the LAW Melter Feed Vessel (LFP-VSL-00002_4).
Basis: This model requirement is in Section 3.1.3.3.2 Operating Logic - LAW Melter Feed Preparation Vessel in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

3.14.3.27 LAW Melter Feed Vessel (LFP-VSL-00002_4) Receipt Source
Unique ID: BMR-LAW_MR-38
The LAW Melter Feed Vessel (LFP-VSL-00002_4) shall receive feed from the LAW Melter Feed Preparation Vessel (LFP-VSL-00001_3).
Basis: This model requirement is in Section 4.8.14 LAW Feed Preparation Process (LFP) System in 24590-WTP-MDD-PR-01-002, WTP MDD.

3.14.3.28 LAW Melter Feed Vessel (LFP-VSL-00002_4) Receipt Trigger
Unique ID: BMR-LAW_MR-24
LFP-VSL-00002_4 shall be able to fill when the current volume is below the Set Volume.
Basis: This model requirement is in Section 4.8.14 LAW Feed Preparation Process (LFP) System in 24590-WTP-MDD-PR-01-002, WTP MDD.

3.14.3.29 LAW Melter Feed Vessel (LFP-VSL-00002_4) Simultaneous Transfers
Unique ID: BMR-LAW_MR-17
LFP-VSL-00002_4 shall discharge continuously to LMP-MLTR-00001_2 while receiving from LFP-VSL-00001_3.
**Basis:** This model requirement is in Section 4.8.14 LAW Feed Preparation Process (LFP) System in 24590-WTP-MDD-PR-01-002, WTP MDD.

### 3.14.3.30 LAW Melter Feed Vessel (LFP-VSL-00002_4) Discharge Rate

**Unique ID:** BMR-LAW_MR-42

LFP-VSL-00002_4 shall discharge continuously to LAW Melter (LMP-MLTR-00001_2) at LAW Melter Variable Rate.

**Basis:** This model requirement is found in Section 4.8.14 LAW Feed Preparation Process (LFP) System in 24590-WTP-MDD-PR-01-002, WTP MDD Rev. 13.

### 3.14.3.31 LAW Melter Feed Vessel (LFP-VSL000002_4) Complete Filling

**Unique ID:** BMR-LAW_MR-48

The LFP-VSL-00002_4 - LAW Melter Feed Vessel shall fill to between the set volume and the upper set volume.

**Basis:** This model requirement is in Section 4.8.14 LAW Feed Preparation Process (LFP) System in 24590-WTP-MDD-PR-01-002, WTP MDD.

### 3.14.3.32 LAW Melter Feed Vessel (LFP-VSL-00002_4) Transfer Complete

**Unique ID:** BMR-LAW_MR-43

The LAW Melter Feed Vessel (LFP-VSL-00002_4) shall complete transferring when it has reached its minimum volume.

**Basis:** This model requirement is found in Section 4.8.14 LAW Feed Preparation Process (LFP) System in 24590-WTP-MDD-PR-01-002, WTP MDD Rev. 13.

### 3.14.3.33 LAW Melter (LMP-MLTR-00001_2) Receipt

**Unique ID:** BMR-LAW_MR-22

LMP-MLTR-00001_2 shall receive from LFP-VSL-00002_4 when the volume of LFP-VSL-00002_4 is above the Lower Set Volume.

**Basis:** This model requirement is found in Section 4.8.14 LAW Feed Preparation Process (LFP) System in 24590-WTP-MDD-PR-01-002, WTP MDD.

### 3.14.3.34 LAW Melter (LMP-MLTR-00001_2) Simultaneous Transfer and Receive

**Unique ID:** BMR-LAW_MR-39

The LAW Melter (LMP-MLTR-00001_2) shall be capable of simultaneously transferring and receiving.

**Basis:** Simultaneous transfer and receipts are in place to prevent the LAW melter from becoming idle. The only time that a LAW Melter Feed Preparation Vessel will stop pumping to the melter is when there is no feed available from the LAW Melter Feed Prep Vessel and that vessel is at its minimum volume. This Requirement can be found in Section 4.8.14 of 24590-WTP-MDD-PR-01-002, WTP MDD Rev. 13.
3.14.3.35 LAW Melter Vessel (LMP-MLTR-00001_2) Production Rate

Unique ID: BMR-LAW_MR-41

The LAW Melter (LMP-MLTR-00001_2) shall operate at the calculated LAW Melter Variable Rate for each glass batch as a function of glass forming oxides, solids concentration, water concentration, melt power, and LAW Melter Ramp Rate.

Basis: This model requirement is found in Section 4.8.15 LAW Melter Process (LMP) System in 24590-WTP-MDD-PR-01-002, WTP MDD Rev. 13.

3.14.3.36 LAW Melter (LMP-MLTR-00001_2) Vapor-Melt Split

Unique ID: BMR-LAW_MR-13

The amount of contaminants carried into the melter offgas from LMP-MLTR-00001_2 shall be calculated from split factors, after LFP-VSL-00002_4 has transferred to LMP-MLTR-00001_2.

Basis: This model requirement is in Section 4.8.15 LAW Melter Process (LMP) System in 24590-WTP-MDD-PR-01-002, WTP MDD.

3.14.3.37 LAW Melter (LMP-MLTR-00001_2) Air Addition

Unique ID: BMR-LAW_MR-5

The Air Addition shall enter LMP-MLTR-00001_2 at the LAW Melter Air Flowrates. The air stream is made up of air inleakage, bubbler air, purge air, control air and cooling air. The air provides the source of oxygen for the melter reactions.

Basis: This model requirement is in Section 4.8.15 LAW Melter Process (LMP) System in 24590-WTP-MDD-PR-01-002, WTP MDD.

3.14.3.38 LAW Melter (LMP-MLTR-00001_2) Reactions

Unique ID: BMR-LAW_MR-14

The LAW Glass Melt Reactions shall be applied to the contents of LMP-MLTR-00001_2 after the melter splits have occurred.

Basis: This model requirement is in Section 4.8.15 LAW Melter Process (LMP) System in 24590-WTP-MDD-PR-01-002, WTP MDD.

3.14.3.39 LAW Melter (LMP-MLTR-00001_2) Offgas Discharge

Unique ID: BMR-LAW_MR-27

LMP-MLTR-00001_2 shall route the melter offgas to the LAW Submerged Bed Scrubber (LOP-SCB-00001_2), after the split factors and reactions have been applied.

Basis: This model requirement is in Section 4.8.15 LAW Melter Process (LMP) System in 24590-WTP-MDD-PR-01-002, WTP MDD.

3.14.3.40 LAW Melter (LMP-MLTR-00001_2) Idle Mode

Unique ID: BMR-LAW_MR-45

The LAW Melter (LMP-MLTR-00001_2) is in idle mode when the following conditions occur:
• LMP-MLTR-00001_2 has reached its minimum volume, and
• No additional combined LAW feed and glass formers are available, (i.e. that LFP-VSL-00002_4 is at its minimum volume), and
• LMP-MLTR-00001_2 has stopped discharging molten glass into LAW-Canister Accumulation Vessel.

**Basis:** This model requirement is found in Section 4.8.14 LAW Feed Preparation Process (LFP) System in 24590-WTP-MDD-PR-01-002, WTP MDD Rev. 13 where it states that "the only time that an LAW MFV will stop pumping to the melter is when there is no feed available from the LAW MFPV and the LAW MFV is at its minimum volume."

### 3.14.3.41 LAW Melter (LMP-MLTR-0001_2) Molten Glass Discharge

**Unique ID:** BMR-LAW_MR-12

After the reactions have been applied, the *LMP-MLTR-00001_2* shall discharge molten glass continuously, above the Upper Set Volume to the LAW-Canister accumulation vessel.

**Basis:** This model requirement is in Section 4.8.15 LAW Melter Process (LMP) System in 24590-WTP-MDD-PR-01-002, WTP MDD.

### 3.14.3.42 LAW Canister Accumulation Vessel (LAW-CANISTERS) Receipt

**Unique ID:** BMR-LAW_MR-46

The LAW-CANISTERS shall receive molten glass for Immobilized LAW (ILAW) glass packaging.

**Basis:** This model requirement is found in Section 4.8.15 LAW Melter Process (LMP) System in 24590-WTP-MDD-PR-01-002, WTP MDD Rev. 13.

### 3.14.3.43 LAW Canister Accumulation Vessel (LAW-CANISTERS) Accounting

**Unique ID:** BMR-LAW_MR-47

The LAW-CANISTERS shall track produced ILAW glass packaging numbers based on the mass accumulated in LAW-Canister Accumulation Vessel and dividing by assumed glass density and container volume.

**Basis:** This model requirement is found in Section 4.8.15 LAW Melter Process (LMP) System in 24590-WTP-MDD-PR-01-002, WTP MDD Rev. 13.

### 3.14.3.44 LAW Spent Melter Collection

**Unique ID:** BMR-LAW_MR-15

*LMP-MLTR-00001_2* shall send its contents to FAILED-LAW MELTERS vessel at regular intervals as a simplification to simulate melter replacement.

**Basis:** The melters have a design life of 5 years, which is found in Section 4.1 Configuration Information in 24590-LAW-3ZD-LMP-00001, LMP System Design Description. Engineering judgement was utilized to simulate the melter design life in TOPSim.
3.14.4 Technical Requirements

3.14.4.1 LCP-VSL-00001_2 - LAW Concentrate Receipt Vessel Parameters

**Unique ID:** BMR-LAW_TR-2

*LCP-VSL-00001_2* shall have the following parametric values.

<table>
<thead>
<tr>
<th>Vessel Number</th>
<th>Maximum Volume</th>
<th>Upper Set Volume</th>
<th>Set Volume</th>
<th>Minimum Volume</th>
<th>Effluent Rate (to MFPV)</th>
</tr>
</thead>
<tbody>
<tr>
<td>LCP-VSL-00001_2</td>
<td>14877 gal</td>
<td>12855 gal</td>
<td>10855 gal</td>
<td>3740 gal</td>
<td>88 gpm</td>
</tr>
</tbody>
</table>

LCP Batch Volume = Upper Set Volume - Minimum Volume

The Set Volume is a dynamically calculated lower set point to ensure that partial batch transfer to *LFP-VSL-00001_3* will not occur.

**Basis:** This technical requirement is in Section 3.1.3.1.1 Design Data - LAW Concentrate Receipt Vessel in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

3.14.4.2 GFR-TK-00022_23 - LAW Glass Former Mixer Parameters

**Unique ID:** BMR-LAW_TR-6

*GFR-TK-00022_23* shall have the following parametric values.

<table>
<thead>
<tr>
<th>Vessel Number</th>
<th>Maximum Volume (gal)</th>
<th>Upper Set Volume (gal)</th>
<th>Hopper Batch Volume (gal)</th>
<th>Minimum Volume (gal)</th>
<th>Flow Rate - Maximum (gpm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>GFR-TK-00022_23</td>
<td>3,516</td>
<td>3,516</td>
<td>3,516</td>
<td>0</td>
<td>49</td>
</tr>
</tbody>
</table>


Maximum Volume is defined as Overflow Volume in source document.

Upper Set Volume is defined as Filled Volume (Batch + Heel) in source document.

Minimum Volume is defined as Heel Volume in source document.

**Basis:** This technical requirement is in Section 3.1.3.2.1 Design Data - Glass Former Mixers in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

3.14.4.3 LFP-VSL-00001_3 - LAW Melter Feed Preparation Vessel Parameters

**Unique ID:** BMR-LAW_TR-4

*LFP-VSL-00001_3* shall have the following parametric values.

<table>
<thead>
<tr>
<th>Vessel Number</th>
<th>Maximum Volume (gal)</th>
<th>Upper Set Volume (gal)</th>
<th>Set Volume (gal)</th>
<th>Minimum Volume (gal)</th>
<th>Flow Rate - Maximum (gpm)</th>
<th>Temperature (°F)</th>
</tr>
</thead>
</table>

LFP Batch Volume = Upper Set Volume - Lower Set Volume

Maximum Volume is defined as Overflow Volume in source document.

Upper Set Volume is defined as Filled Volume (Batch + Heel) in source document.

Minimum Volume is defined as Heel Volume in source document.

**Basis:** This technical requirement is found in Section 3.1.3.3.1 Design Data - LAW Melter Feed Preparation Vessel in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

### 3.14.4.4 LFP-VSL-00002_4 - LAW Melter Feed Vessel Parameters

**Unique ID:** BMR-LAW_TR-5

The *LFP-VSL-00002_4* shall have the following parametric values:

<table>
<thead>
<tr>
<th>Vessel Number</th>
<th>Maximum Volume (gal)</th>
<th>Upper Set Volume (gal)</th>
<th>Set Volume (gal)</th>
<th>Minimum Volume (gal)</th>
<th>Temperature (°F)</th>
</tr>
</thead>
<tbody>
<tr>
<td>LFP-VSL-00002_4</td>
<td>5,786</td>
<td>4,377</td>
<td>1,119</td>
<td>977</td>
<td>140</td>
</tr>
</tbody>
</table>

Maximum Volume is defined as Overflow Volume in source document.

Upper Set Volume is defined as Filled Volume (Batch + Heel) in source document.

Minimum Volume is defined as Heel Volume in source document.

**Basis:** These parameters are found in Table B-1 of 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

### 3.14.4.5 LMP-MLTR-00001_2 - LAW Melter Parameters

**Unique ID:** BMR-LAW_TR-1

*LMP-MLTR-00001_2* shall have the following parametric values:

<table>
<thead>
<tr>
<th>Vessel Number</th>
<th>Maximum Volume (gal)</th>
<th>Upper Set Volume (gal)</th>
<th>Minimum Volume (gal)</th>
<th>Flow Rate Maximum (gpm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>LMP-MLTR-00001_2</td>
<td>2,318</td>
<td>2,016</td>
<td>1,875</td>
<td>N/A</td>
</tr>
</tbody>
</table>

SLMP-MLTR-00001_2 Melter Batch Volume = Upper Set Volume - Minimum Volume - Cold Cap

Maximum Volume is defined as Overflow Volume in source document.

Upper Set Volume is defined as Filled Volume (Batch + Heel) in source document.

Minimum Volume is defined as Heel Volume in source document.
**Basis:** This technical requirement is in Section 3.2.3.2 LAW Melter and Table B-1 in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

### 3.14.4.6 LAW-CANISTER Parameters

**Unique ID:** BMR-LAW_TR-9

The *ILAW* Glass Container shall have the following parameters:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total Volume</strong></td>
<td>626 gal</td>
</tr>
<tr>
<td><strong>Glass Mass</strong></td>
<td>5.51 MT</td>
</tr>
<tr>
<td><strong>Average Glass Density</strong></td>
<td>2.58 MT/m³ at 20°C</td>
</tr>
<tr>
<td><strong>Temperature (glass pour)</strong></td>
<td>1150 °C</td>
</tr>
<tr>
<td><strong>Glass Flow Rate</strong></td>
<td>165 gal/hr</td>
</tr>
<tr>
<td><strong>Glass Pour Time</strong></td>
<td>0.853 hr</td>
</tr>
</tbody>
</table>

The *ILAW* glass container shall be filled to 90% of the total volume, 564 gal (2.135 m³).

**Basis:** This technical requirement is in Section 3.2.3.6 LAW Container in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

### 3.14.4.7 LAW Inter-facility Transfer Line Flush Volume (DFLAW)

**Unique ID:** BMR-LAW_TR-3

*LCP-VSL-00001_2* shall receive 200 gal of *inhibited water* included in every *LCP Batch Volume* of pretreated *LAW*.

**Basis:** This technical requirement regarding operations during DFLAW are in Section 3.8.3.4 Operation (System DFLAW) in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

### 3.14.4.8 LAW Concentrate Receipt Batch Composition (Normal Operations)

**Unique ID:** BMR-LAW_TR-22

The LCP Batch Volume, after *WTP PT* startup, shall have the composition of *TCP-VSL-00001* and the heel below the Set Volume in *LCP-VSL-00001_2*.

**Basis:** This technical requirement is in Section 3.1.3.1 LAW Concentrate Receipt Vessel in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

### 3.14.4.9 LAW Concentrate Receipt Batch Composition (DFLAW)

**Unique ID:** BMR-LAW_TR-21

The LCP Batch Volume, during *DFLAW*, shall have the composition of *LAWPS/TSCR* feed, flush from the *Interim LAW Feed Tank*, recycle from *EMF-VSL-00001A/B/C*, and the heel below the Set Volume in *LCP-VSL-00001_2*. When recycle from *EMF* is unavailable, the volume shall comprise of *LAWPS* feed, flush from *Interim LAW Feed Tank* and the heel below the Set Volume in *LCP-VSL-00001_2*.

**Basis:** This technical requirement regarding operations during DFLAW are in Section 3.8.3.4 Operation (System DFLAW) in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.
3.14.4.10 LAW DFLAW to PT Transition Time  
Unique ID: BMR-LAW_TR-17  
The DFLAW to PT Transition time shall be 30 days.  
**Basis:** This technical requirement is based on engineering judgement.

3.14.4.11 LAW Glass Former Sugar Calculation  
Unique ID: BMR-LAW_TR-24  
The mass of sugar \((C_{12}H_{22}O_{11})\) shall be calculated by the following equations:  
\[
\text{Mass of sugar} = \left(\text{Moles of NO}_2 + \text{Moles of NO}_3\right) \times 0.75 - \text{Moles of TOC} \times \frac{\text{MW}_{\text{sugar}}}{12}
\]
Where the moles of NO\(_2\), NO\(_3\) and TOC (total organic carbon) include both the solid and liquid phases.  
**NOTE:** Moles of TOC (as tracked in TOPSim) = (Moles of TOC) + 2*(Moles of C2O4-2)]  
**Basis:** This technical requirement is in Equations 3.2-20 through 22 in Section 3.2.3.4.3 Cold Cap Reactions (System LMP) in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

3.14.4.12 LAW Selected Glass Model  
Unique ID: BMR-LAW_TR-11  
The glass former composition shall be calculated using one of the following: the DOE 2004 model or BARD Rev. 6 model, PNNL 2013 model or the PNNL 2016 model. The default model will use the PNNL 2013 model.  
**Basis:** The default model is called out in Section 2.2.2 Glass Formulation Models in ORP-11242, System Plan Rev. 8.

3.14.4.13 LAW Melter Treatment Capacity  
Unique ID: BMR-LAW_TR-12  
*LMP-MLTR-00001_2* shall have a total operating efficiency at full capacity of 70%, which reduces the treatment capacity to 21 MT/day. The melter design capacity is 15 MT/day/melter.  
**Basis:** This technical requirement is in Table C.7-1.1 in Section C.7(b)(1) of DE-AC27-01RV14136, WTP/DOE Statement of Work.

3.14.4.14 LAW Melter Ramp Rate  
Unique ID: BMR-LAW_TR-18  
*LMP-MLTR-00001_2* shall have the following ramp rate:  

<table>
<thead>
<tr>
<th>Activity</th>
<th>Start Date</th>
<th>Rate (MTG/day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>LAW Vit Hot Commissioning</td>
<td>10/13/2021</td>
<td>9</td>
</tr>
<tr>
<td>LAW Vit Operations, DFLAW mode, Ramp Up</td>
<td>7/31/2022</td>
<td>18</td>
</tr>
<tr>
<td>LAW Vit Operations, DFLAW mode, Full Ops</td>
<td>7/31/2023</td>
<td>21</td>
</tr>
</tbody>
</table>
**Basis:** The DFLAW schedule and process assumptions for use in the next revision to the MYOP are contained in WRPS-1700082, *Meeting Minutes: DFLAW Schedule and Process Assumptions for MYOP*.

### 3.14.4.15 LAW Melter Variable Rate

**Unique ID:** BMR-LAW_TR-20

*LMP-MLTR-00001-2* shall have the following rate:

\[
\text{Melter Rate} = \min(\text{Ramp Rate}, \text{TOE} \times N_{\text{melters}} \times M_{\text{Rate}}, \text{TOE} \times N_{\text{melters}} \times F_{\text{day}}) \, \text{MTG/day}
\]

Where:

- Ramp Rate is the LAW melter ramp rate specified in *BMR-TR-348*.
- TOE is the Total Operating Efficiency of the process, 0.7.
- \(N_{\text{melters}}\) is the number of melters in the facility, 2.
- \(M_{\text{Rate}} = -1E^{-5}X^2 + 0.031X + 0.016\), where \(X\) is the mass of glass per liter of feed slurry (grams waste oxides + grams glass former oxides)/liter slurry.
- \(F_{\text{day}} = (86.4 \times P_{A} \times (1-w) \times r_{f}) / ((1-w) \times S_{E} + 3171.95w)\)

Where:

- \(P_{A}\) is the available power for converting feed to glass, 998.2 kW for each LAW melter,
- \(w\) is the weight fraction of free water in the melter feed vessel (free water mass/(waste mass + frit mass)),
- \(r_{f}\) is the mass of glass per mass of feed solids ((waste oxide mass + glass former oxide mass) / (waste mass + glass former mass - free water mass)),
- \(S_{E}\) is the specific energy per kg feed solids, 1,915 kJ/kg.

**Basis:** This technical requirement is in 24590-WTP-MCR-PE-13-0024, LAW Melt Rate.

### 3.14.4.16 LAW Melter Process Splits

**Unique ID:** BMR-LAW_TR-13

*LMP-MLTR-00001-2* shall use the split factors listed on the tab "LMP-MLTR-00001-2" in SVF-1778.

**Basis:** This technical requirement is in Section 4.8.15 LAW Melter Process (LMP) System in 24590-WTP-MDD-PR-01-002, WTP MDD.

### 3.14.4.17 LAW Melter Air Flowrates

**Unique ID:** BMR-LAW_TR-10

The air added to the *LMP-MLTR-00001-2* shall have a flowrate of 2365 cfm (measured at 25°C and 1 atm), equivalent to 1182.5 cfm for each melter.

**Basis:** This technical requirement is based on Table B-15 of *WTP-MDD, 24590-WTP-MDD-PR-01-002, Rev. 13* and listed as 946 cfm measured in standard conditions: 20°C and 1 atm for
each melter. However, the air addition make-up for the TOPSim model is at a temperature of 25°C and therefore appropriate adjustments were made to the requirement above.

### 3.14.4.18 LAW Glass Melt Reactions

**Unique ID:** BMR-LAW_TR-8

The reactions in the glass melt shall include the following in the order listed, with the extent of reaction as written.

<table>
<thead>
<tr>
<th>Reaction Name</th>
<th>Extent of Reaction</th>
</tr>
</thead>
<tbody>
<tr>
<td>OD-22</td>
<td>1.0</td>
</tr>
<tr>
<td>OD-1</td>
<td>1.0</td>
</tr>
<tr>
<td>OD-3</td>
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<tr>
<td>CL-NA-REACTION</td>
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<tr>
<td>F-NA-REACTION</td>
<td>0.5319</td>
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<tr>
<td>NO3-DECOMPOSITION-VARIABLE</td>
<td>Dynamic*</td>
</tr>
<tr>
<td>NO2-DECOMPOSITION-VARIABLE</td>
<td>Dynamic*</td>
</tr>
<tr>
<td>HG-TO-GAS-REACTION</td>
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<tr>
<td>129-I-TO-GAS</td>
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<td>SO4-DECOMPOSITION</td>
<td>Dynamic**</td>
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<td>CN-DECOMPOSITION</td>
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<tr>
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<td>Extent of Reaction</td>
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</tr>
</tbody>
</table>

*The reaction coefficients are dynamic.
**The conversion factor to calculate extent of reaction is dynamic.

**Basis:** Reactions are found in Section 4.8.15 LAW Melter Process (LMP) System in 24590-WTP-MDD-PR-01-002, WTP MDD.

**3.14.4.19 LAW Glass Melt NOx Stoichiometry Data**

**Unique ID:** BMR-LAW_TR-15

The stoichiometric coefficients shall effect the split of the NO₃⁻ and NO₂⁻ decomposition reactions. The stoichiometric coefficients for the NO₃⁻ and NO₂⁻ decomposition reactions are listed in the following table. The value of M can be found in Technical Requirement LAW Glass Melt and SBS pH Correlation.
Stoichiometric Coefficients for the NO3- and NO2- Decomposition Reactions

<table>
<thead>
<tr>
<th>Reaction Number</th>
<th>Value</th>
<th>Reaction Number</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>r11</td>
<td>1</td>
<td>r21</td>
<td>1</td>
</tr>
<tr>
<td>r12</td>
<td>0.03623 × M</td>
<td>r22</td>
<td>0.03623 × M</td>
</tr>
<tr>
<td>p11</td>
<td>0.2546-0.0121 × (M-1)</td>
<td>p21</td>
<td>0.2546-0.0121 × (M-1)</td>
</tr>
<tr>
<td>p12</td>
<td>0.4239</td>
<td>p22</td>
<td>0.4239</td>
</tr>
<tr>
<td>p13</td>
<td>0.04277</td>
<td>p23</td>
<td>0.04277</td>
</tr>
<tr>
<td>p14</td>
<td>0.024154 × M</td>
<td>p24</td>
<td>0.024154 × M</td>
</tr>
<tr>
<td>p15</td>
<td>1.01339+0.0181 × (M-1)</td>
<td>p25</td>
<td>0.5134+0.0181 × (M-1)</td>
</tr>
</tbody>
</table>

Where the reactions are found in:
- NO3-DECOMPOSITION-VARIABLE and NO2-DECOMPOSITION-VARIABLE.

**Basis:** This technical requirement is found in Section 4.8.15 LAW Melter Process (LMP) System in 24590-WTP-MDD-PR-01-002, WTP MDD.

### 3.14.4.20 LAW Glass Melt and SBS pH Correlation

**Unique ID:** BMR-LAW_TR-14

The "M" variable in the Glass Melt Reactions shall be based on the pH value in LOP-SCB-00001_2 in the LOP system. The "M" value shall be determined from the following table.

**Variable “M” Lookup Table**

<table>
<thead>
<tr>
<th>Current pH</th>
<th>M</th>
<th>Current pH</th>
<th>M</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH &lt;= 3.0</td>
<td>1.05</td>
<td>7.0 &lt; pH &lt;= 7.5</td>
<td>0.99999</td>
</tr>
<tr>
<td>3.0 &lt; pH &lt;= 4.0</td>
<td>1.01</td>
<td>7.5 &lt; pH &lt;= 8.0</td>
<td>0.9999</td>
</tr>
<tr>
<td>4.0 &lt; pH &lt;= 5.0</td>
<td>1.005</td>
<td>8.0 &lt; pH &lt;= 9.0</td>
<td>0.999</td>
</tr>
<tr>
<td>5.0 &lt; pH &lt;= 6.0</td>
<td>1.001</td>
<td>9.0 &lt; pH &lt;= 10.0</td>
<td>0.995</td>
</tr>
<tr>
<td>6.0 &lt; pH &lt;= 6.5</td>
<td>1.0001</td>
<td>10.0 &lt; pH &lt;= 11.0</td>
<td>0.99</td>
</tr>
<tr>
<td>6.5 &lt; pH &lt;= 7.0</td>
<td>1.00001</td>
<td>11.0 &lt; pH</td>
<td>0.95</td>
</tr>
</tbody>
</table>

**Basis:** This technical requirement is found in Section 4.8.15 LAW Melter Process (LMP) System in 24590-WTP-MDD-PR-01-002, WTP MDD.

### 3.14.4.21 LAW Melt SO4 Decomposition Conversion

**Unique ID:** BMR-LAW_TR-19

The conversion factor for the SO4-DECOMPOSITION reaction shall be calculated from the following equations:

1. Calculate the equivalent mass of SO₃ in the glass (MSO₃).
2. Calculate the weight fraction of SO₃ (CSO₃), if all of the SO₄²⁻ reacted.
   - CSO₃ = MSO₃ / GlassMass
3. Calculate the decontamination factor of $\text{SO}_4^{2-}$ (DFSO4) from one of the following conditions:
   - If $\text{CSO}_3 \leq 0.002941$, then $\text{DFSO}_4 = 8000$
   - Else, $\text{DFSO}_4 = 1 / (73.5 \times \text{CSO}_3 - 0.216)$

4. Select the decontamination factor of $\text{SO}_4^{2-}$ based on the maximum between the DFSO4 from the previous step and the value 2.8.
   - $\text{DFSO}_4 = \max(2.8, \text{DFSO}_4)$

5. Calculate the conversion of $\text{SO}_4^{2-}$
   - conversion = $1.0 / \text{DFSO}_4$

Note: extent of reaction = conversion * initial mole of SO4.

**Basis:** This technical requirement is found in Section 4.8.15 LAW Melter Process (LMP) System in 24590-WTP-MDD-PR-01-002, WTP MDD.

### 3.14.4.22 LAW Melter Replacement Interval

**Unique ID:** BMR-LAW_TR-16

*LMP-MLTR-00001_2* shall send 2,016 gal of ILAW glass to *FAILED-LAW Melters* vessel every 2.5 years after start-up. The transfer shall be instantaneous and have the same density as the glass melt.

**Basis:** The 2,016 gal referred to is the set volume of the melter. With the melter design life of 5 years, it is assumed that the two melters will be scheduled on a staggered basis; therefore one melter will be replaced every 2.5 years, on average.

This is found in Appendix B-1 and Section 3.2.3.1 General (LAW Melter Process) of 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

### 3.14.5 LAW Figures and Diagrams

#### 3.14.5.1 LAW Melter Flow Diagram

**Unique ID:** BMR-LAW_FIG-1

![LAW Melter Flow Diagram](image-url)
3.14.5.2 LAW Melter Feed Receipt Detail

Unique ID: BMR-LAW FIG-3

3.14.5.3 LAW Melter Feed Preparation Detail

Unique ID: BMR-LAW FIG-4
3.14.5.4 LAW Melter Detail Diagram

Unique ID: BMR-LAW_FIG-2

![Diagram of LAW Melter System]

3.15 WASTE TREATMENT AND IMMOBILIZATION PLANT LOW-ACTIVITY WASTE VITRIFICATION PRIMARY OFFGAS PROCESS

The function of the LAW primary offgas process system (LOP) is to treat gases generated by the LAW melter system. Treatment of these gases results in meeting air discharge permit limits. Each melter has its own offgas system, but they are modeled as a single train in the HSM, including any equipment and vessels associated with that melter.

The melter offgas from LMP-MLTR-00001_2 enters the LAW Submerged Bed Scrubber (SBS), LOP-SCB-00001_2. The SBS functions to remove particulates from the melter offgas and also cools the offgas to a desired temperature using chilled water. In the HSM split factors are applied to the solid, liquid and gas components entering the SBS from the melter. The fractions of components that are split are sent at saturation conditions to the West Electrostatic Precipitator (WESP), LOP-WESP-00001_2, while the remaining components undergo a series of reactions provided in the HSM requirements. After the reactions have completed, the pH of the SBS solution is calculated and the calculated value is used in the LAW melter to determine the NH3 generation. A second set of reactions take place once the pH is determined and that forces the SBS to a neutral pH. All gas components remaining after the reactions have completed are transferred to the WESP and the liquid and solid components remain in the SBS.

The SBS is designed to remain constant at the set point, volume greater than the set volume is transferred to the SBS Condensate Vessel, LOP-VSL-00001_2. The SBS Condensate Vessel discharges once it fills to its set point. The SBS Condensate Vessel discharges back to the SBS, which then triggers a subsequent SBS discharge to the SBS Condensate Collection Vessel, RLD-VSL-00005.
The WESP receives from the SBS and the HSM applies splits to the liquid, solid, and gas components of the stream. The split components are transferred to the HEPA filtration system; the remaining components undergo a series of reactions listed in the HSM requirements. After the reactions are complete the remaining material is transferred out of the WESP to the C3/C5 Drains/Sump Collection Vessel, RLD-VSL-00004.

3.15.1 System Requirements

3.15.1.1 LAW Primary Offgas Process (LOP)

Unique ID: BMR-LOP_SR-1

The LOP system shall treat melter offgas generated by the LMP.

Basis: N/A

3.15.2 Functional Requirements

3.15.2.1 LMP To LOP

Unique ID: BMR-LOP_FR-3

The LOP shall have the capability to receive melter offgas from LMP.

Basis: This functional requirement comes from section 3.3.1 Functions and Requirements of the LOP/LVP System in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

3.15.2.2 LOP Particle Removal

Unique ID: BMR-LOP_FR-1

The LOP shall have the capability to remove large particulates (>1 micron) from the melter offgas.

Basis: This functional requirement comes from section 3.3.1 Functions and Requirements of the LOP/LVP System in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

3.15.2.3 LOP Aerosols Removal

Unique ID: BMR-LOP_FR-5

The LOP shall have the capability to remove aerosols from the melter offgas.

Basis: This functional requirement comes from section 3.3.1 Functions and Requirements of the LOP/LVP System in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

3.15.2.4 LOP Cooling

Unique ID: BMR-LOP_FR-6

The LOP shall have the capability to cool the melter offgas.

Basis: This functional requirement comes from section 3.3.1 Functions and Requirements of the LOP/LVP System in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.
3.15.2.5 LOP Condensate

**Unique ID:** BMR-LOP_FR-2

The *LOP* shall have the capability to collect condensate generated by *melter offgas* cooling.

**Basis:** This functional requirement comes from section 3.3.2 Process Description of the LOP/LVP System in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

3.15.2.6 LOP Condensate Routing

**Unique ID:** BMR-LOP_FR-4

The *LOP* shall have the capability to route *process condensate* to *RLD*.

**Basis:** This functional requirement comes from section 3.3.2 Process Description of the LOP/LVP System in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

3.15.3 Model Requirements

3.15.3.1 LAW Submerged Bed Scrubber (LOP-SCB-00001_2)

**Unique ID:** BMR-LOP_MR-1

The *LOP* system shall include one submerged bed scrubber (*SBS*) identified as LOP-SCB-00001_2, which represents combined throughput capacity and functionality of two submerged bed scrubbers LOP-SCB-00001 and LOP-SCB-00002 in the LAW primary offgas treatment process.

**Basis:** This model requirement comes from section 3.3.1 Submerged Bed Scrubber and Condensate Vessel (Basis) in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

3.15.3.2 LAW Submerged Bed Scrubber Condensate Vessel (LOP-VSL-00001_2)

**Unique ID:** BMR-LOP_MR-2

The *LOP* system shall include one submerged bed scrubber (*SBS*) condensate vessel identified as LOP-VSL-00001_2, which represents combined throughput capacity and functionality of two *SBS* condensate vessels LOP-VSL-00001 and LOP-VSL-00002 in the LAW primary offgas treatment process.

**Basis:** This model requirement comes from section 3.3.1 Submerged Bed Scrubber and Condensate Vessel (Basis) in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

3.15.3.3 LAW Wet Electrostatic Precipitator (LOP-WESP-00001_2)

**Unique ID:** BMR-LOP_MR-3

The *LOP* system shall include one *Wet Electrostatic Precipitator* (*WESP*) identified as LOP-WESP-00001_2, which represents combined throughput capacity and functionality of two *WESP* Wet Electrostatic Precipitators, LOP-WESP-00001 and LOP-WESP-00002, in the LAW primary offgas treatment process.

**Basis:** This model requirement comes from section 3.3.2 Wet Electrostatic Precipitator (Basis) in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.
3.15.3.4 LAW Submerged Bed Scrubber (LOP-SCB-00001_2) Start-Up Fill

**Unique ID:** BMR-LOP_MR-4

The *LAW Submerged Bed Scrubber (LOP-SCB-00001_2)* shall be filled with demineralized water to the upper set volume when the *LOP* system starts.

**Basis:** This model requirement comes from section 3.3.3.2 Operating Logic - SBS and SBS Condensate Vessel (Basis) in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

3.15.3.5 LAW Submerged Bed Scrubber (LOP-SCB-00001_2) Offgas Receipt

**Unique ID:** BMR-LOP_MR-5

The *LAW Submerged Bed Scrubber (LOP-SCB-00001_2)* shall receive offgas discharge from the *LAW Melter (LMP-MLTR-00001_2)*.

**Basis:** This model requirement comes from section 3.3.1 Functions and Requirements (Systems LOP/LVP) in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

3.15.3.6 LAW Submerged Bed Scrubber (LOP-SCB-00001_2) Condensate Receipt

**Unique ID:** BMR-LOP_MR-28

The *LAW Submerged Bed Scrubber (LOP-SCB-00001_2)* shall receive condensate from *SBS Condensate Vessel (LOP-VSL-00001_2)*.

**Basis:** This model requirement comes from section 3.3.2 Process Description (Systems LOP/LVP) in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

3.15.3.7 LAW Submerged Bed Scrubber (LOP-SCB-00001_2) Simultaneous Receipt and Discharge

**Unique ID:** BMR-LOP_MR-6

The *LAW Submerged Bed Scrubber (LOP-SCB-00001_2)* shall receive and discharge simultaneously.

**Basis:** This model requirement is stated as such for modeling purposes, due to the task-based design of TOPSim. However, in section 3.3.3.1 Submerged Bed Scrubber and Condensate Vessel (Basis) in 24590-WTP-RPT-PT-02-005, BARD Rev. 8 there is reference to "...thereby maintaining a constant liquid depth in the SBS scrubber section."

3.15.3.8 LAW Submerged Bed Scrubber (LOP-SCB-00001_2) Offgas Components Splits

**Unique ID:** BMR-LOP_MR-7

*LOP-SCB-00001_2 - LAW SBS Split Factors* shall be applied to the solid, liquid and gas components in *LAW Submerged Bed Scrubber (LOP-SCB-00001_2)* after *melter offgas* receipt from the *LAW Melter (LMP-MLTR-00001_2)*.

**Basis:** This model requirement comes from section 3.3.3.1.1 Design Data - SBS and SBS Condensate Vessel in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.
3.15.3.9 LAW Submerged Bed Scrubber (LOP-SCB-00001_2) “SBS Reactions

Unique ID: BMR-LOP_MR-8

The LOP-SCB-00001_2 - LAW SBS Reactions and Conversions shall be applied after the split factors application.

Basis: This model requirement comes from section 3.3.3.1.5 Chemistry - SBS in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

3.15.3.10 LAW Submerged Bed Scrubber (LOP-SCB-00001_2) pH Determination

Unique ID: BMR-LOP_MR-9

After the reactions have been applied, the pH of the LOP-SCB-00001_2 liquid shall be calculated and provided to the LAW melter reaction calculation to determine the extent of reactions which derive the ammonia generation in the melter.

Basis: This model requirement is in section 4.8.16 LAW Offgas Process (LOP) Systems of the WTP MDD, 24590-WTP-MDD-PR-01-002.

3.15.3.11 LAW Submerged Bed Scrubber (LOP-SCB-00001_2) “SBS Offgas Saturation

Unique ID: BMR-LOP_MR-11

The offgas from LAW Submerged Bed Scrubber (LOP-SCB-00001_2) shall be discharged at saturation conditions calculated using the Mole Fraction of Water at Saturation equation at the LOP-SCB-00001_2 - LAW SBS Outlet Conditions. Water shall either evaporate or condense to meet the saturation mole fraction. Tritium shall follow water in proportion.

Basis: This model requirement is in section 4.8.16 LAW Offgas Process (LOP) Systems of the WTP MDD, 24590-WTP-MDD-PR-01-002.

3.15.3.12 LAW Submerged Bed Scrubber (LOP-SCB-00001_2) “SBS Neutralization Reactions

Unique ID: BMR-LOP_MR-10

The LOP-SCB-00001_2 - LAW SBS pH Adjustment Reactions shall be applied after the pH is determined.

Basis: This model requirement is in section 4.8.16 LAW Offgas Process (LOP) Systems of the WTP MDD, 24590-WTP-MDD-PR-01-002.

3.15.3.13 LAW Submerged Bed Scrubber (LOP-SCB-00001_2) Offgas Routing

Unique ID: BMR-LOP_MR-12

The LAW Submerged Bed Scrubber (LOP-SCB-00001_2) offgas shall discharge to the LAW Wet Electrostatic Precipitator (LOP-WESP-00001_2) after the reactions application.

Basis: This model requirement comes from section 3.3.3.2 Wet Electrostatic Precipitator (Basis) in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.
3.15.3.14 LAW Submerged Bed Scrubber (LOP-SCB-00001_2) Operating Volume

**Unique ID:** BMR-LOP_MR-13

As condensate is generated in the *LAW Submerged Bed Scrubber (LOP-SCB-00001_2)*, a comparable amount shall be transferred out to *LAW SBS Condensate Vessel (LOP-VSL-00001_2)* to maintain a constant volume in the *LAW Submerged Bed Scrubber (LOP-SCB-00001_2)* at the upper set volume.

**Basis:** This model requirement comes from section 3.3.3.1 Submerged Bed Scrubber and Condensate Vessel (Basis) in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

3.15.3.15 LAW Submerged Bed Scrubber (LOP-SCB-00001_2) Condensate Routing

**Unique ID:** BMR-LOP_MR-17

The following routing constraints shall apply to *LAW Submerged Bed Scrubber (LOP-SCB-00001_2)*:

1. The overflow excess shall be discharged to *LAW SBS Condensate Vessel (LOP-VSL-00001_2)*, when accumulated condensate produced by the melter offgas cooling in *LOP-SCB-00001_2* reaches above the upper set volume and the *LAW SBS Condensate Vessel (LOP-VSL-00001_2)* is below the upper set volume.

2. The *LOP-SCB-00001_2* shall discharge the volume above the upper set volume to SBS Condensate Collection Vessel (RLD-VSL-00005), when *LAW Submerged Bed Scrubber (LOP-SCB-00001_2)* receives a transfer from *LAW SBS Condensate Vessel (LOP-VSL-00001_2)*.

3. The deficit liquid volume shall be supplied by adding demineralized water, when *LAW Submerged Bed Scrubber (LOP-SCB-00001_2)* volume reduces to below the upper set volume.

**Basis:** This model requirement comes from section 3.3.3.1 Submerged Bed Scrubber and Condensate Vessel (Basis) in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

3.15.3.16 LAW SBS Condensate Vessel (LOP-VSL-00001_2) Receipt and Discharge

**Unique ID:** BMR-LOP_MR-18

The *LAW SBS Condensate Vessel (LOP-VSL-00001_2)* shall receive and discharge to the *LAW Submerged Bed Scrubber (LOP-SCB-00001_2)*.

**Basis:** This model requirement comes from section 3.3.3.1 Submerged Bed Scrubber and Condensate Vessel (Basis) in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

3.15.3.17 LAW SBS Condensate Vessel (LOP-VSL-00001_2) Receipt Trigger

**Unique ID:** BMR-LOP_MR-14

The *LAW SBS Condensate Vessel (LOP-VSL-00001_2)* shall receive condensate when the volume is less than the upper set volume.

**Basis:** This model requirement comes from section 3.3.3.1.1 Design Data - SBS and SBS Condensate Vessel (Basis) in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.
3.15.3.18 LAW SBS Condensate Vessel (LOP-VSL-00001_2) Complete Filling

**Unique ID:** BMR-LOP_MR-15

The *LAW SBS Condensate Vessel (LOP-VSL-00001_2)* shall complete filling when *LOP-VSL-00001_2* reaches upper set volume.

**Basis:** This model requirement comes from section 3.3.3.1 Submerged Bed Scrubber and Condensate Vessel (Basis) in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

3.15.3.19 LAW SBS Condensate Vessel (LOP-VSL-00001_2) Discharge Trigger

**Unique ID:** BMR-LOP_MR-16

The *LAW SBS Condensate Vessel (LOP-VSL-00001_2)* shall trigger a discharge at the upper set volume.

**Basis:** This model requirement is in section 4.8.16 LAW Offgas Process (LOP) Systems of the WTP MDD, 24590-WTP-MDD-PR-01-002.

3.15.3.20 LAW SBS Condensate Vessel (LOP-VSL-00001_2) Discharge Routing

**Unique ID:** BMR-LOP_MR-29

The *LAW SBS Condensate Vessel (LOP-VSL-00001_2)* shall discharge condensate to the *LAW Submerged Bed Scrubber (LOP-SCB-00001_2)*.

**Basis:** This model requirement comes from section 3.3.3.1.2 Operating Logic - SBS and SBS Condensate Vessel in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

3.15.3.21 LAW SBS Condensate Vessel (LOP-VSL-00001_2) Transfer Complete

**Unique ID:** BMR-LOP_MR-19

Discharge from the *LAW SBS Condensate Vessel (LOP-SCB-00001_2)* shall end when the *LAW SBS Condensate Vessel (LOP-VSL-00001_2)* reaches minimum volume.

**Basis:** This model requirement comes from section 3.3.3.1.2 Operating Logic - SBS and SBS Condensate Vessel in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

3.15.3.22 LAW Wet Electrostatic Precipitator (LOP-WESP-00001_2) Simultaneous Receipt and Discharge

**Unique ID:** BMR-LOP_MR-20

The *LAW Wet Electrostatic Precipitator (LOP-WESP-00001_2)* shall receive and discharge simultaneously.

**Basis:** This model requirement is stated as such for modeling purposes, due to the task-based design of TOPSim. However, in section 3.3.3.2 Wet Electrostatic Precipitator in 24590-WTP-RPT-PT-02-005, BARD Rev. 8 there is reference to the inlet provided with a demineralized water spray and the collected liquid gravity draining into the C3/C5 drains.
3.15.3.23 LAW Wet Electrostatic Precipitator (LOP-WESP-00001_2) Removal Splits

Unique ID: BMR-LOP_MR-21

The *LOP-WESP-00001_2 - LAW WESP Split Factors* shall be applied to the liquid, solid and gas components as the cooled offgas enters the *LAW Wet Electrostatic Precipitator (LOP-WESP-00001_2)*.

**Basis:** This model requirement is in section 4.8.16 LAW Offgas Process (LOP) Systems of the WTP MDD, 24590-WTP-MDD-PR-01-002.

3.15.3.24 LAW Wet Electrostatic Precipitator (LOP-WESP-00001_2) â€“ WESP Reactions

Unique ID: BMR-LOP_MR-22

The *LOP-WESP-00001_2 - LAW WESP Reactions and Conversions* shall be applied after the splits are completed.

**Basis:** This model requirement is in section 4.8.16 LAW Offgas Process (LOP) Systems of the WTP MDD, 24590-WTP-MDD-PR-01-002.

3.15.3.25 LAW Wet Electrostatic Precipitator (LOP-WESP-00001_2) â€“ WESP Offgas Saturation

Unique ID: BMR-LOP_MR-23

The offgas from *LAW Wet Electrostatic Precipitator (LOP-WESP-00001_2)* shall be discharged at saturation conditions calculated using the *Mole Fraction of Water at Saturation* equation at the *LOP-WESP-00001_2 - LAW WESP Outlet Conditions* after the *LOP-WESP-00001_2 Reactions and Conversions* is applied. Then, water shall either evaporate or condense to meet the saturation mole fraction. Tritium shall follow water in proportion.

**Basis:** This model requirement is in section 4.8.16 LAW Offgas Process (LOP) Systems of the WTP MDD, 24590-WTP-MDD-PR-01-002.

3.15.3.26 LAW Wet Electrostatic Precipitator (LOP-WESP-00001_2) â€“ WESP Water Addition

Unique ID: BMR-LOP_MR-25

Deminerlized water shall be added to the *LAW Wet Electrostatic Precipitator (LOP-WESP-00001_2)* at *LOP-WESP-00001_2 - LAW WESP Water Flowrate*.

**Basis:** This model requirement comes from section 3.3.3.2.2 Operating Logic - WESP in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

3.15.3.27 LAW Wet Electrostatic Precipitator (LOP-WESP-00001_2) Condensate Discharge

Unique ID: BMR-LOP_MR-26

The *LAW Wet Electrostatic Precipitator (LOP-WESP-00001_2)* shall discharge liquid to *C3/C5 Drains/Sump Collection Vessel (RLD-VSL-00004)* after the reactions are applied.
Basis: This model requirement comes from section 3.3.3.2 Wet Electrostatic Precipitator in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

3.15.3.28 LAW Wet Electrostatic Precipitator (LOP-WESP-00001_2) Offgas Routing

Unique ID: BMR-LOP_MR-27

The LAW Wet Electrostatic Precipitator (LOP-WESP-00001_2) offgas shall discharge to LVP High Efficiency Particulate Air Filter (LVP-HEPA-00001AB) after the reactions are applied.

Basis: This model requirement comes from section 3.3.3 Vessel Ventilation in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

3.15.4 Technical Requirements

3.15.4.1 LOP-SCB-00001_2 - LAW Submerged Bed Scrubber Parameters

Unique ID: BMR-LOP_TR-8

The modeled LOP-SCB-00001_2 - LAW Submerged Bed Scrubber shall have the following tank parameters.

<table>
<thead>
<tr>
<th>Vessel Number</th>
<th>Maximum Volume (gal)</th>
<th>Upper Set Volume (gal)</th>
<th>Set Volume (gal)</th>
<th>Minimum Volume (gal)</th>
<th>Flow Rate - Maximum (gpm)</th>
<th>Temperature (°C)</th>
<th>Pressure (Atm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>LOP-SCB-00001_2</td>
<td>3,329</td>
<td>3,329</td>
<td>3,329</td>
<td>0</td>
<td>82</td>
<td>50</td>
<td>1</td>
</tr>
</tbody>
</table>


Maximum Volume is defined as Overflow Volume in source document.

Upper Set Volume is defined as Filled Volume (Batch + Heel) in source document.

Minimum Volume is defined as Heel Volume in source document.


The Temperature can be found in Section 3.3.3.1.2 Operating Logic - SBS and SBS Condensate Vessel of 24590-WTP-RPT-PT-02-005, BARD Rev. 8

3.15.4.2 LOP-VSL-00001_2 - LAW SBS Condensate Vessel Parameters

Unique ID: BMR-LOP_TR-9

The modeled LOP-VSL-00001_2 - LAW SBS Condensate Vessel shall have the following tank parameters.

<table>
<thead>
<tr>
<th>Vessel Number</th>
<th>Maximum Volume (gal)</th>
<th>Upper Set Volume (gal)</th>
<th>Set Volume (gal)</th>
<th>Minimum Volume (gal)</th>
<th>Flow Rate - Maximum (gpm)</th>
<th>Maximum Temperature (°F)</th>
</tr>
</thead>
</table>

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Maximum Volume is defined as Overflow Volume in source document.

Upper Set Volume is defined as Filled Volume (Batch + Heel) in source document.

Minimum Volume is defined as Heel Volume in source document.

**Basis:** The source is Appendix B of 24590-WTP-RPT-PT-02-005, BARD Rev. 8

### 3.15.4.3 LOP-SCB-00001_2 - LAW SBS Split Factors

**Unique ID:** BMR-LOP_TR-1

The *LOP-SCB-00001_2 - LAW Submerged Bed Scrubber* shall use the split factors listed in SVF-1778 from the tab labeled "LOP-SCB-00001-2".

**Basis:** This technical requirement for the SBS is listed in SVF-1778, HTWOS Equipment Splits Rev. 8, which in turn is derived from 24590-WTP-MDD-PR-01-002, WTP MDD

### 3.15.4.4 LOP-SCB-00001_2 - LAW SBS Reactions and Conversions

**Unique ID:** BMR-LOP_TR-2

The *LOP-SCB-00001_2 - LAW Submerged Bed Scrubber* general reactions and conversions are as follows:

<table>
<thead>
<tr>
<th>Reaction No</th>
<th>Reaction Name</th>
<th>Reaction</th>
<th>Conversion Factor(Fraction)</th>
<th>(a)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>HG-Gas-to Liquid</td>
<td>1.0 Hg+2(g) → 1.0 Hg+2(l)</td>
<td>Equation Below</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>RXN-LAW-SBS-BO4</td>
<td>2.0 B+3(s) + 1.5 O2(g) + 3.0 H2O(l) → 2.0 H+(l) + 2.0 B+3(l) + 4.0 O(BOUND)(l) + 2.0 H2O(l)</td>
<td>1.0</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>RXN-LAW-SBS-HCL</td>
<td>1.0 HCl(g) → 1.0 H+(l) + 1.0 Cl-(l)</td>
<td>0.8588</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>RXN-LAW-SBS-HF</td>
<td>1.0 HF(g) → 1.0 H+(l) + 1.0 F-(l)</td>
<td>0.8384</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>RXN-LAW-SBS-NO2</td>
<td>3.0 NO2(g) + 1.0 H2O(l) → 2.0 H+(l) + 2.0 NO3-(l) + 1.0 NO(g)</td>
<td>0.002</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>RXN-LAW-SBS-NO</td>
<td>4.0 NO(g) + 2.0 H2O(l) + 3.0 O2(g) → 4.0 H+(l) + 4.0 NO3-(l)</td>
<td>0.0548</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>RXN-LAW-SBS-P2O5</td>
<td>1.0 P2O5(g) + 3.0 H2O(l) → 6.0 H+(l) + 0.5 PO4-3(l) + 1.5 PO4-3(s)</td>
<td>0.6</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>RXN-LAW-SBS-SO2</td>
<td>2.0 SO2(g) + 2.0 H2O(l) + 1.0 O2(g) → 4.0 H+(l) + 2.0 SO4-2(l)</td>
<td>0.8721</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>RXN-LAW-SBS-129-I</td>
<td>1.0 129-I(g) → 1.0 129-I(l)</td>
<td>0.798</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>LAW-CL-SCRUBBER-REACTION</td>
<td>1.0 Na+(s) + 1.0 Cl-(s) → 1.0 Na+(l) + 1.0 Cl-(l)</td>
<td>1.0</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>LAW-F-SCRUBBER-REACTION</td>
<td>1.0 Na+(s) + 1.0 F-(s) → 1.0 Na+(l) + 1.0 F-(l)</td>
<td>1.0</td>
<td></td>
</tr>
</tbody>
</table>
### Reaction No | Reaction Name | Reaction | Conversion Factor(Fraction) (a)
--- | --- | --- | ---
12 | RXN-LAW-SBS-MAKE-OH-NA | $4.0 \text{Na}^+(s) + 1.0 \text{O}_2(g) + 2.0 \text{H}_2\text{O}(l) \rightarrow 4.0 \text{Na}^+(l) + 4.0 \text{OH}^-(l)$ | 1.0 |
13 | RXN-LAW-SBS-MAKE-OH-K | $4.0 \text{K}^+(s) + 1.0 \text{O}_2(g) + 2.0 \text{H}_2\text{O}(l) \rightarrow 4.0 \text{K}^+(l) + 4.0 \text{OH}^-(l)$ | 1.0 |
14 | RXN-LAW-SBS-MAKE-OH-CA | $2.0 \text{Ca}^{+2}(s) + 1.0 \text{O}_2(g) + 2.0 \text{H}_2\text{O}(l) \rightarrow 2.0 \text{Ca}^{+2}(l) + 4.0 \text{OH}^-(l)$ | 0.3 |
15 | RXN-LAW-SBS-MAKE-OH-SR | $2.0 \text{Sr}^{+2}(s) + 1.0 \text{O}_2(g) + 2.0 \text{H}_2\text{O}(l) \rightarrow 2.0 \text{Sr}^{+2}(l) + 4.0 \text{OH}^-(l)$ | 0.5 |
16 | RXN-LAW-SBS-MAKE-OH-90-SR | $2.0 \text{90-Sr}(s) + 1.0 \text{O}_2(g) + 2.0 \text{H}_2\text{O}(l) \rightarrow 2.0 \text{90-Sr}(l) + 4.0 \text{OH}^-(l)$ | 0.5 |
17 | RXN-LAW-SBS-MAKE-OH-LI | $4.0 \text{Li}^+(s) + 1.0 \text{O}_2(g) + 2.0 \text{H}_2\text{O}(l) \rightarrow 4.0 \text{Li}^+(l) + 4.0 \text{OH}^-(l)$ | 1.0 |
18 | RXN-LAW-SBS-NH3-CONDENSE | $1.0 \text{NH}_3(g) \rightarrow 1.0 \text{NH}_3(l)$ | 0.90 |
19 | RXN-LAW-SBS-NH3 | $1.0 \text{NH}_3(l) + 1.0 \text{H}_2\text{O}(l) \rightarrow 1.0 \text{NH}_4^+(l) + 1.0 \text{OH}^-(l)$ | Equation Below (c) |
20 | RXN-WTP-H-OH-NEUT | $\text{H}^+(l) + \text{OH}^-(l) \rightarrow \text{H}_2\text{O}(l)$ | 1.0 |
21 | EVAPORATE-H2O or CONDENSE-H2O | $\text{H}_2\text{O}(l) \rightarrow \text{H}_2\text{O}(g)$ or $\text{H}_2\text{O}(g) \rightarrow \text{H}_2\text{O}(l)$ | Based on Saturation calculation |
22 | EVAPORATE-3-H or CONDENSE-3-H | $1.0 \text{3-H}(l) \rightarrow 1.0 \text{3-H}(g)$ or $1.0 \text{3-H}(g) \rightarrow 1.0 \text{3-H}(l)$ | Follows water |

(a) Conversion Factor for a reaction until one of the reactants has been depleted.

(b) Conversion Factor (CF) of the mercury reaction is dependent upon the mercury to chloride ratio in the LAW melter feed, for example:

CF = 0.833 if $\text{Hg}^{+2} (l, s) / \text{Cl}^- (l, s) \leq 0.1$  
= 0.559 if $0.1 < \text{Hg}^{+2} (l, s) / \text{Cl}^- (l, s) \leq 0.5$  
= 0.286 if $\text{Hg}^{+2} (l, s) / \text{Cl}^- (l, s) > 0.5$

(c) Conversion of $\text{NH}_3$ to $\text{NH}_4^+$ shall be calculated based on the following equation:

$$\text{NH}_4^+_{\text{CF}} = \frac{\text{NH}_3_{\text{begin}} - 0.9 \times 5.682^{-3} \times \text{NH}_3_{\text{gas}}}{\text{NH}_3_{\text{begin}}}$$

Where:

$\text{NH}_4^+_{\text{CF}}$ = The conversion factor for RXN-LAW-SBS-NH3.

$\text{NH}_3_{\text{begin}}$ = Moles of $\text{NH}_3$ liquid before the reaction.

$\text{NH}_3_{\text{gas}}$ = Moles of $\text{NH}_3$ gas before the reaction.

### 3.15.4.5 LOP-SCB-00001_2 - LAW SBS pH Adjustment Reactions

**Unique ID:** BMR-LOP_TR-3

The *LOP-SCB-00001_2 - LAW Submerged Bed Scrubber* pH Adjustment reactions are as follows:

If the pH < 7 then apply the following reactions:

<table>
<thead>
<tr>
<th>Reaction Name</th>
<th>Reaction</th>
<th>Conversion</th>
</tr>
</thead>
<tbody>
<tr>
<td>RXN-WTP-N03-NEUT</td>
<td>1.0 NO3-(l) + 10.0 H+(l) → 1.0 NH4+(l) + 3.0 H2O(l)</td>
<td>until H+ or NO3- is consumed</td>
</tr>
<tr>
<td>RXN-WTP-N02-NEUT</td>
<td>1.0 NO2-(l) + 8.0 H+(l) → 1.0 NH4+(l) + 2.0 H2O(l)</td>
<td>until H+ or NO2- is consumed</td>
</tr>
<tr>
<td>RXN-WTP-H-OH-NEUT</td>
<td>H+ (l) + OH- (l) → H2O (l)</td>
<td>1.0</td>
</tr>
</tbody>
</table>

If the pH > 7 then apply the following reaction:

<table>
<thead>
<tr>
<th>Reaction Name</th>
<th>Reaction</th>
<th>Conversion</th>
</tr>
</thead>
<tbody>
<tr>
<td>RXN-WTP-NH4</td>
<td>1.0 NH4+(l) + 2.0 H2O(l) → 8.0 H+(l) + 1.0 NO2-(l)</td>
<td>until the pH=7.0 or NH4+ is consumed</td>
</tr>
<tr>
<td>RXN-WTP-H-OH-NEUT</td>
<td>H+ (l) + OH- (l) → H2O (l)</td>
<td>1.0</td>
</tr>
</tbody>
</table>


### 3.15.4.6 LOP-SCB-00001_2 - LAW SBS Outlet Conditions

**Unique ID:** BMR-LOP_TR-10

The *LOP-SCB-00001_2 - LAW Submerged Bed Scrubber* outlet conditions shall be 50°C and 1.0 atmospheres.

**Basis:** This technical requirement comes from section 3.3.3.1.3 Energy Contribution - SBS and SBS Condensate Receipt Vessel in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.
3.15.4.7 LOP-WESP-00001_2 - LAW WESP Split Factors

Unique ID: BMR-LOP_TR-4

The *LOP-WESP-00001_2 - LAW Wet Electrostatic Precipitator* shall use the split factors listed in SVF-1778 from the tab labeled "LOP-WESP-00001-2".

**Basis:** This technical requirement for the SBS is listed in SVF-1778, HTWOS Equipment Splits Rev. 8, which in turn is derived from 24590-WTP-MDD-PR-01-002, WTP MDD

3.15.4.8 LOP-WESP-00001_2 - LAW WESP Reactions and Conversions

Unique ID: BMR-LOP_TR-11

The *LOP-WESP-00001_2 - LAW Wet Electrostatic Precipitator* general reactions and conversions are as follows:

<table>
<thead>
<tr>
<th>Reaction No</th>
<th>Reaction Name</th>
<th>Reaction</th>
<th>Conversion Factor(Fraction)(a)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>RXN-LAW-SBS-HCL</td>
<td>1.0 HCl(g) → 1.0 H+(l) + 1.0 Cl-(l)</td>
<td>0.2308</td>
</tr>
<tr>
<td>2</td>
<td>RXN-LAW-SBS-HF</td>
<td>1.0 HF(g) → 1.0 H+(l) + 1.0 F-(l)</td>
<td>0.4764</td>
</tr>
<tr>
<td>3</td>
<td>RXN-LAW-WESP-129-I</td>
<td>1.0 129-I(g) → 1.0 129-I(l)</td>
<td>0.1071</td>
</tr>
<tr>
<td>4</td>
<td>RXN-LAW-SBS-SO2</td>
<td>2.0 SO2(g) + 2.0 H2O(l) + 1.0 O2(g) → 4.0 H+(l) + 2.0 SO4-2(l)</td>
<td>0.9471</td>
</tr>
<tr>
<td>5</td>
<td>RXN-LAW-WESP-P2O5</td>
<td>1.0 P2O5(g) + 3.0 H2O(l) → 6.0 H+(l) + 0.5 PO4-3(l) + 1.5 PO4-3(s)</td>
<td>0.8</td>
</tr>
<tr>
<td>6</td>
<td>RXN-LAW-WESP-NO</td>
<td>4.0 NO(g) + 2.0 H2O(l) + 3.0 O2(g) → 4.0 H+(l) + 4.0 NO3-(l)</td>
<td>0.01</td>
</tr>
<tr>
<td>7</td>
<td>RXN-LAW-SBS-BO4</td>
<td>2.0 B+3(s) + 1.5 O2(g) + 3.0 H2O(l) → 2.0 H+(l) + 2.0 B+3(l) + 4.0 O(BOUND)(l) + 2.0 H2O(l)</td>
<td>1.0</td>
</tr>
<tr>
<td>8</td>
<td>RXN-WTP-H-OH-NEUT</td>
<td>H+ (l) + OH- (l) → H2O (l)</td>
<td>1.0</td>
</tr>
</tbody>
</table>

(a) Conversion Factor for a reaction until one of the reactants has been depleted.

**Basis:** Reactions are found in Section 3.3.3.2.4 Services - WESP in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

**NOTE:** *RXN-LAW-WESP-NO* is incorrect in *Dynamic (G2) Model Design Document, Rev. 13*. Therefore, only the BARD reference should be used for the reactions.


3.15.4.9 LOP-WESP-00001_2 - LAW WESP Water Flowrate

Unique ID: BMR-LOP_TR-5

The *LOP-WESP-00001_2 - LAW Wet Electrostatic Precipitator* water addition rate shall be 0.72 gpm for the *LOP-WESP-00001_2 - LAW Wet Electrostatic Precipitator*. This corresponds to 0.36 gpm per melter, and will be adjusted proportional to the ramp up production rate and facility availability.
Basis: This is based on 24590-WTP-RPT-PT-02-005, BARD Rev. 8, Section 3.3.3.2 Operating Logic - WESP. Also, according to 24590-WTP-MDD-PR-01-002, WTP MDD Rev. 13, this water rate is based on 15 metric tons of glass per day melter operation and is proportional to the melter production rate if ramp up occurs.

3.15.4.10 LOP-WESP-00001_2 - LAW WESP Outlet Conditions

Unique ID: BMR-LOP_TR-7

The LOP-WESP-00001_2 - LAW Wet Electrostatic Precipitator outlet conditions shall be 50°C and 1 atmosphere.

Basis: This technical requirement comes from section 3.3.3.3 Energy Contribution - WESP in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

3.16 WASTE TREATMENT AND IMMOBILIZATION PLANT LOW-ACTIVITY WASTE VITRIFICATION SECONDARY OFFGAS PROCESS

The function of the LAW secondary offgas/vessel vent process system (LVP) is to treat gases generated by the LAW vessel vent system, discharging from the LOP. Treatment of these gases results in meeting air discharge permit limits. The LVP is designed to handle the maximum sustained flow rate from both WTP melters. This treatment system removes almost all of the remaining particulates, mercury, NOx, and miscellaneous acid gases.

The HEPA filtration system, LVP-HEPA-00001AB receives offgas from the WESP. Liquid and solid components from the offgas feed are captured according to the splits provided in the HSM requirements. The accumulation factor for most components is 99.99994% for the HEPA. The treated gas is then routed to the LAW carbon absorber, LVP-ADBR-00001AB, which uses activated carbon absorbers to remove mercury, halides, and acid gases, including 129I, in the offgas by adsorption. A large percentage of the liquid and solid components entering the LAW carbon absorber are captured, while a few of the gas components are removed. The materials leaving the LAW carbon absorber are routed to the LAW Catalytic Oxidizer Reducer, LVP-SCR-00001_2.

The primary purpose of the LAW Catalytic Oxidizer Reducer, LVP-SCR-00001_2, is to remove NO and NO2 from the offgas. NH3 gas is added as necessary based on the amount of NO, NO2 and NH3 entering LVP-SCR-00001_2. After the reactions have been applied, the LVP-SCR-00001_2 discharges to the LAW Caustic Scrubber, LVP-SCB-00001. Upon arriving, the splits provided in the HSM requirements are applied and then reactions are completed per the HSM requirements. The offgas is discharged at saturation conditions to the LAW Offgas Stack, LAW-OFFGAS-STACK. After the offgas reactions, the pH of the Caustic Scrubber liquid contents is adjusted by adding enough 5.0M NaOH or water to meet the target pH, as given in the HSM requirements. Water is continuously added to the caustic scrubber to aid in cooling of the offgas. When the vessel fills to its upper limit with condensate and/or the maximum SpG is reached, the contents are transferred out to the LERF Basins during DFLAW and to the Alkaline Effluent Vessels, RLD-VSL-00017A/B after PT startup.
3.16.1 System Requirements

3.16.1.1 LAW Secondary Offgas/Vessel Vent Process (LVP)

**Unique ID:** BMR-LVP_SR-1

The LVP shall receive treated *melter offgas* from the LOP system and provide additional treatment in order to meet liquid and gaseous effluent facility discharge limits.

**Basis:** N/A

3.16.2 Functional Requirements

3.16.2.1 LOP To LVP

**Unique ID:** BMR-LVP_FR-1

The LVP shall have the capability to receive offgas from the LOP system.

**Basis:** This functional requirement is found in Section 2.3 Basic Operational Overview in 24590-LAW-3ZD-LOP-00001, LOP and LVP System Design Description.

3.16.2.2 LVP Particulate Removal

**Unique ID:** BMR-LVP_FR-3

The LVP shall have the capability to remove particulate from the *melter offgas*.

**Basis:** This functional requirement is found in Section 2.3 Basic Operational Overview in 24590-LAW-3ZD-LOP-00001, LOP and LVP System Design Description.

3.16.2.3 LVP Chemical Adsorption

**Unique ID:** BMR-LVP_FR-4

The LVP shall have the capability to remove mercury, halides and acid gases (including $^{129}$I) in the offgas by adsorption.

**Basis:** This functional requirement is found in Section 2.3 Basic Operational Overview in 24590-LAW-3ZD-LOP-00001, LOP and LVP System Design Description.

3.16.2.4 LVP NOx, CO and VOC Removal

**Unique ID:** BMR-LVP_FR-5

The LVP shall have the capability to remove NO$_x$, CO and VOC by chemical reduction.

**Basis:** This functional requirement is found in Section 2.3 Basic Operational Overview in 24590-LAW-3ZD-LOP-00001, LOP and LVP System Design Description.

3.16.2.5 LVP Acid Gas Removal

**Unique ID:** BMR-LVP_FR-6

The LVP shall have the capability to remove acid gases (e.g. SO$_x$) from the offgas.

**Basis:** This functional requirement is found in Section 2.3 Basic Operational Overview in 24590-LAW-3ZD-LOP-00001, LOP and LVP System Design Description.
3.16.2.6 LVP Cooling

Unique ID: BMR-LVP_FR-9

The *LVP* system shall have the capability to cool the treated *melter offgas*.

**Basis:** This functional requirement is found in Section 2.3 Basic Operational Overview in 24590-LAW-3ZD-LOP-00001, LOP and LVP System Design Description.

3.16.2.7 LVP Condensate Collection

Unique ID: BMR-LVP_FR-10

The *LVP* system shall have the capability to collect liquid condensate.

**Basis:** This functional requirement is found in Section 2.3 Basic Operational Overview in 24590-LAW-3ZD-LOP-00001, LOP and LVP System Design Description.

3.16.2.8 LVP Air Movement

Unique ID: BMR-LVP_FR-8

The *LVP* system shall have the capability to provide air movement for the *melter offgas* up through the *LAW* Vitrification Facility stack and to maintain the process under a vacuum relative to the surroundings.

**Basis:** This functional requirement is found in Section 4.1 Configuration Information (System Description) in 24590-LAW-3ZD-LOP-00001, LOP and LVP System Design Description.

3.16.2.9 LVP Liquid Effluent Routing

Unique ID: BMR-LVP_FR-7

The *LVP* system shall have the capability to discharge *liquid effluent* to LERF, either directly or through the *RLD* system.

**Basis:** This functional requirement is found in Section 2.3 Basic Operational Overview in 24590-LAW-3ZD-LOP-00001, LOP and LVP System Design Description.

3.16.2.10 LVP Gaseous Effluent Routing

Unique ID: BMR-LVP_FR-2

The *LVP* shall have the capability to discharge the treated *gaseous effluent* out the *LAW* Vitrification Facility stack.

**Basis:** This functional requirement is found in Section 2.3 Basic Operational Overview in 24590-LAW-3ZD-LOP-00001, LOP and LVP System Design Description.

3.16.3 Model Requirements

3.16.3.1 LVP HEPA Filters (LVP-HEPA-00001AB)

Unique ID: BMR-LVP_MR-3

The *LVP* shall include a *HEPA* filter unit identified as LVP-HEPA-00001AB, which represents the functionality of all of the *HEPA* filters and preheaters associated with the *LAW* offgas.
Basis: For ease in modeling, the main train and the backup train of HEPA filters are modeled as one unit, LVP-HEPA-00001AB, according to Section 4.8.16 LAW Offgas Process (LOP) Systems 24590-WTP-MDD-PR-01-002, WTP MDD.

3.16.3.2 LVP Carbon Adsorber (LVP-ADBR-00001AB)
Unique ID: BMR-LVP_MR-4
The LVP shall include an activated carbon adsorber, identified as LVP-ADBR-00001AB, which represents the functionality of both LVP adsorber units.

Basis: This model requirement can be found in Section 3.3.3.6 Activated Carbon Adsorbers in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

3.16.3.3 LVP Catalytic Oxidizer Reducer (LVP-SCR-00001_2)
Unique ID: BMR-LVP_MR-5
The LVP shall include a catalytic oxidizer reducer, identified as LVP-SCR-00001_2, which represents the functionality of the thermal catalytic oxidizer (LVP-SCO-00001) and the selective catalytic reducer (LVP-SCR-00001).

Basis: This model requirement's system equipment can be found in Section 3.3.2 Process Description in 24590-WTP-RPT-PT-02-005, BARD Rev. 8, and in more detail in Section 4.1.1.2 in 24590-LAW-3ZD-LOP-00001, LOP and LVP System Design Description.

3.16.3.4 LVP Caustic Scrubber Column (LVP-SCB-00001)
Unique ID: BMR-LVP_MR-6
The LVP shall include a caustic scrubber column, identified as LVP-SCB-00001, which represents the functionality of the LVP caustic scrubber and associated collection vessel.

Basis: This model requirement can be found in Section 3.3.3.11.2 Operating Logic - Caustic Scrubber System in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

3.16.3.5 LVP-HEPA-00001AB Offgas Receipt
Unique ID: BMR-LVP_MR-7
The LVP-HEPA-00001AB - High Efficiency Particulate Air Filter shall receive offgas from the LOP-WESP-00001_2 - LAW Wet Electrostatic Precipitator.

Basis: This functional requirement is found in Section 2.3 Basic Operational Overview in 24590-LAW-3ZD-LOP-00001, LOP and LVP System Design Description.

3.16.3.6 LVP-HEPA-00001AB - High Efficiency Particulate Air Filter Contaminant Accumulation
Unique ID: BMR-LVP_MR-12
The amount of contaminants captured and accumulated on the LVP-HEPA-00001AB - High Efficiency Particulate Air Filter shall be calculated from the specified split factors, after receiving offgas.

Basis: This model requirement is from Section 3.3.3.5.1 Design Data - HEPA Filters in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.
3.16.3.7 LVP-HEPA-00001AB Offgas Discharge Routing

Unique ID: BMR-LVP_MR-8

The LVP-HEPA-00001AB - High Efficiency Particulate Air Filter shall discharge to the LVP-ADBR-00001AB - Carbon Adsorber, after the splits have been applied.

Basis: This functional requirement is found in Section 2.3 Basic Operational Overview in 24590-LAW-3ZD-LOP-00001, LOP and LVP System Design Description.

3.16.3.8 LVP-ADBR-00001AB - Carbon Adsorber Contaminant Accumulation

Unique ID: BMR-LVP_MR-1

The LVP-ADBR-00001AB - Carbon Adsorber shall accumulate contaminants based on the specified split factors, after receiving offgas.

Basis: This model requirement is from Section 3.3.3.6.1 Design Data - Activated Carbon Adsorbers in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

3.16.3.9 LVP-ADBR-00001AB - Carbon Adsorber Routing

Unique ID: BMR-LVP_MR-9

The LVP-ADBR-00001AB - Carbon Adsorber shall discharge to the LVP-SCR-00001_2 - Catalytic Oxidizer Reducer, after the splits have been applied.

Basis: This functional requirement is found in Section 2.3 Basic Operational Overview in 24590-LAW-3ZD-LOP-00001, LOP and LVP System Design Description.

3.16.3.10 LVP-SCR-00001_2 - Catalytic Oxidizer Reducer Split Application

Unique ID: BMR-LVP_MR-22

The LVP-SCR-00001_2 - Selective Catalytic Reducer shall apply the specified factors, after receiving offgas. Note - that there are no modeled contaminants which accumulate based on the split factors.

Basis: This model requirement is from Section 4.8.16 LAW Offgas Process (LOP) Systems in 24590-WTP-MDD-PR-01-002, WTP MDD.

3.16.3.11 LVP-SCR-00001_2 - Catalytic Oxidizer Reducer Reactions

Unique ID: BMR-LVP_MR-13

The Catalytic Oxidizer Reducer Reactions and Extents shall be applied after the splits in the LVP-SCR-00001_2 - Catalytic Oxidizer Reducer.

Basis: This model requirement is from Section 3.3.3.10.1 Design Data - SCO in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

3.16.3.12 LVP-SCR-00001_2 - Catalytic Oxidizer Reducer Ammonia Addition

Unique ID: BMR-LVP_MR-14

Pure ammonia gas (NH₃) shall be added to the LVP-SCR-00001_2 - Catalytic Oxidizer Reducer as necessary to satisfy the stoichiometric requirements of the LVP-SCR-00001_2 -
Catalytic Oxidizer Reducer Reactions and Extents and to meet the required amount of excess ammonia.

**Basis:** This model requirement is from Section 3.3.3.10.1 Design Data - SCO in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

### 3.16.3.13 LVP-SCR-00001 - Catalytic Oxidizer Reducer Routing

**Unique ID:** BMR-LVP_MR-10

The *LVP-SCR-00001 - Catalytic Oxidizer Reducer* shall discharge to the *LVP-SCB-00001 - Caustic Scrubber Column*, after the reactions have been applied.

**Basis:** This functional requirement is found in Section 2.3 Basic Operational Overview in 24590-LAW-3ZD-LOP-00001, LOP and LVP System Design Description.

### 3.16.3.14 LVP-SCB-00001 - Caustic Scrubber Column Splits

**Unique ID:** BMR-LVP_MR-2

The *LVP-SCB-00001 - Caustic Scrubber Column* shall remove contaminants based on the specified split factors, after receiving offgas.

**Basis:** This model requirement is from Section 3.3.3.11.1 Design Data - Caustic Scrubber System in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

### 3.16.3.15 LVP-SCB-00001 - Caustic Scrubber Column Reactions

**Unique ID:** BMR-LVP_MR-15

The *LVP-SCB-00001 - Caustic Scrubber Column Reactions and Extents* shall be applied to the remaining material in the *LVP-SCB-00001 - Caustic Scrubber Column* following the application of the splits.

**Basis:** This model requirement is from Section 3.3.3.11.5 Chemistry - Caustic Scrubber System in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

### 3.16.3.16 LVP-SCB-00001 - Caustic Scrubber Column Quench Water

**Unique ID:** BMR-LVP_MR-18

*Water* shall be continuously added to the *LVP-SCB-00001 - Caustic Scrubber Column* at the *LVP-SCB-00001 - Quench Water Flow rate* when the melter is running. The water addition shall be stopped when the melter is not running.

**Basis:** This model requirement is in Attachment A2 of 24590-WTP-MRQ-PE-14-0019, Direct LAW with Evaporator.

### 3.16.3.17 LVP-SCB-00001 - Caustic Scrubber Column pH Adjustment

**Unique ID:** BMR-LVP_MR-16

After the offgas reactions, the pH of the *LVP-SCB-00001 - Caustic Scrubber Column* content shall be adjusted by adding enough 5.0M NaOH or Water to meet the *LVP-SCB-00001 - Target pH*, applying the *LVP-SCB-00001 - pH Adjustment Reactions*.
Basis: This model requirement is from Section 4.1.1.2.10 Caustic Scrubber in 24590-LAW-3ZD-LOP-00001, LOP and LVP System Design Description.

3.16.3.18 LVP-SCB-00001 - Caustic Scrubber Column Condensate Routing

Unique ID: BMR-LVP_MR-11

The LVP-SCB-00001 - Caustic Scrubber Column shall discharge the condensate stream to one of the LERF-BASIN-1/2 - LERF Basins during DFLAW operation and to the RLD-VSL-00017A/B - Alkaline Effluent Vessels after the Pretreatment Facility start-up.

Basis: This model requirement is in Section 3.3.3.11.2 Operating Logic - Caustic Scrubber System in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

3.16.3.19 LVP-SCB-00001 - Caustic Scrubber Column Offgas Routing

Unique ID: BMR-LVP_MR-21

The LVP-SCB-00001 - Caustic Scrubber Column shall discharge the offgas stream to the LAW-OFFGAS-STACK.

Basis: This functional requirement is found in Section 2.3 Basic Operational Overview in 24590-LAW-3ZD-LOP-00001, LOP and LVP System Design Description.

3.16.3.20 LVP-SCB-00001 - Caustic Scrubber Column Offgas Saturation

Unique ID: BMR-LVP_MR-17

Offgas from LVP-SCB-00001 - Caustic Scrubber Column shall be discharged at saturation conditions calculated using the Mole Fraction of Water at Saturation equation at the LVP-SCB-00001 - Outlet Conditions. Water shall either evaporate or condense to meet the saturation mole fraction. Tritium shall follow water proportionally.

Basis: This model requirement is found in Section 4.8.16 LAW Offgas Process (LOP) Systems in 24590-WTP-MDD-PR-01-002, WTP MDD.

3.16.3.21 LVP-SCB-00001 - Caustic Scrubber Column Discharge Trigger

Unique ID: BMR-LVP_MR-19

The LVP-SCB-00001 - Caustic Scrubber Column conditions for discharge are as follows:

1. The LVP-SCB-00001 - Caustic Scrubber Column Maximum SpG is reached AND the downstream vessel is available.
2. The LVP-SCB-00001 - Caustic Scrubber Column has filled to the set volume AND the downstream vessel is available.
3. If either the maximum SpG or the set volume has been reached AND the downstream vessel is not available then the LVP-SCB-00001 - Caustic Scrubber Column allowed to fill to the upper set volume.

Basis: This model requirement is in Attachment A2 of 24590-WTP-MRQ-PE-14-0019, Direct LAW with Evaporator.
3.16.3.22  LVP-SCB-00001 - Caustic Scrubber Column Complete Discharge

**Unique ID:** BMR-LVP_MR-20

The *LVP-SCB-00001 - Caustic Scrubber Column* shall stop discharging when emptied to the minimum volume or the destination tank has reached its upper set volume.

**Basis:** This model requirement is found in Section 4.8.16 LAW Offgas Process (LOP) Systems in 24590-WTP-MDD-PR-01-002, WTP MDD.

### 3.16.4 Technical Requirements

#### 3.16.4.1 LVP-SCB-00001 - Caustic Scrubber Column Vessel Parameters

**Unique ID:** BMR-LVP_TR-12

The modeled *LVP-SCB-00001 - Caustic Scrubber Column* shall have the following parametric values.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>LVP-SCB-00001</td>
<td>7,325</td>
<td>6,032</td>
<td>5,032</td>
<td>2,032</td>
<td>200</td>
<td>53.9</td>
<td>1</td>
</tr>
</tbody>
</table>

Note: The modeled LVP-SCB-00001 includes LVP-TK-00001 and the volumes are consistent with LVP-TK-00001.

**Basis:** This model requirement is found in Appendix E in LAW Offgas Process (LOP) Systems in 24590-WTP-MDD-PR-01-002, WTP MDD.

#### 3.16.4.2 LVP-HEPA-00001AB - High Efficiency Particulate Air Filter Split Factors

**Unique ID:** BMR-LVP_TR-3

*LVP-HEPA-00001AB - High Efficiency Particulate Air Filter* accumulation calculation shall use the split factors listed in SVF-1778 from the tab labeled "LVP-HEPA-00001AB".

**Basis:** This technical requirement is listed in SVF-1778, HTWOS Equipment Splits Rev. 8, which in turn is derived from 24590-WTP-MDD-PR-01-002, WTP MDD.

#### 3.16.4.3 LVP-ADBR-00001AB - Carbon Adsorber Split Factors

**Unique ID:** BMR-LVP_TR-5

The *LVP-ADBR-00001AB - Carbon Adsorber* shall accumulate components using the split factors listed in SVF-1778 from the tab labeled "LVP-ADBR-00001AB".

**Basis:** This technical requirement is listed in SVF-1778, HTWOS Equipment Splits Rev. 8, which in turn is derived from 24590-WTP-MDD-PR-01-002, WTP MDD.
3.16.4.4 LVP-SCR-00001_2 - Catalytic Oxidizer Reducer Split Factors

Unique ID: BMR-LVP_TR-6

The LVP-SCR-00001_2 - Catalytic Oxidizer Reducer accumulation calculation shall use the split factors listed in SVF-1778 from the tab labeled "LVP-SCR-00001-2".

Basis: This technical requirement is listed in SVF-1778, HTWOS Equipment Splits Rev. 8, which in turn is derived from 24590-WTP-MDD-PR-01-002, WTP MDD

3.16.4.5 LVP-SCR-00001_2 - Catalytic Oxidizer Reducer Reactions and Extents

Unique ID: BMR-LVP_TR-1

The following reactions and extents shall apply to the LVP-SCR-00001_2 - Catalytic Oxidizer Reducer

Catalytic Oxidizer Reactions and Extents

<table>
<thead>
<tr>
<th>Rx#</th>
<th>Reaction Name</th>
<th>Reaction</th>
<th>Conversion (fraction)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>RXN-LAW-CO-NO-NH3</td>
<td>4.0 NO(g) + 4.0 NH₃(g) + 1.0 O₂(g) → 4.0 N₂(g) + 6.0 H₂O(g)</td>
<td>0.98</td>
</tr>
<tr>
<td>2</td>
<td>RXN-LAW-CO-NO2-NH3</td>
<td>2.0 NO₂(g) + 4.0 NH₃(g) + 1.0 O₂(g) → 3.0 N₂(g) + 6.0 H₂O(g)</td>
<td>0.98</td>
</tr>
<tr>
<td>3</td>
<td>RXN-LAW-CO-SO2-SO3</td>
<td>1.0 SO₂(g) + 0.5 O₂(g) → 1.0 SO₃(g)</td>
<td>0.95</td>
</tr>
</tbody>
</table>

The extent of reactions shall be equal to the conversion factor or until one of the reactants has been depleted.


Basis: This technical requirement is from Section 4.8.16 LAW Offgas Process (LOP) Systems in 24590-WTP-MDD-PR-01-002, WTP MDD.

3.16.4.6 LVP-SCR-00001_2 - Catalytic Oxidizer Reducer Excess Ammonia

Unique ID: BMR-LVP_TR-7

The LVP-SCR-00001_2 excess gaseous ammonia (NH₃) concentration target shall be 78 ppm.

Basis: This technical requirement is from Section 4.8.16 LAW Offgas Process (LOP) Systems in 24590-WTP-MDD-PR-01-002, WTP MDD.
3.16.4.7 LVP-SCB-00001 - Caustic Scrubber Column Split Factors

Unique ID: BMR-LVP_TR-4

The *LVP-SCB-00001 - Caustic Scrubber Column* accumulation calculation shall use the split factors listed in SVF-1778 from the tab labeled "LVP-SCB-00001".

**Basis:** This technical requirement is listed in SVF-1778, HTWOS Equipment Splits Rev. 8, which in turn is derived from 24590-WTP-MDD-PR-01-002, WTP MDD

3.16.4.8 LVP-SCB-00001 - Caustic Scrubber Column Reactions and Extents

Unique ID: BMR-LVP_TR-2

The following reactions and extents shall be applied to the *LVP-SCB-00001 - Caustic Scrubber Column*

<table>
<thead>
<tr>
<th>Rx#</th>
<th>Reaction Name</th>
<th>Reaction</th>
<th>Conversion (fraction)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>RXN-LAW-CAUSCRUB-CO2</td>
<td>1.0 CO2(g) + 1.0 H2O(l) → 2.0 H+(l) + 1.0 CO3-2(l)</td>
<td>0.017</td>
</tr>
<tr>
<td>2</td>
<td>RXN-LAW-CAUSCRUB-NH3-CONDENSE</td>
<td>1.0 NH3(g) → 1.0 NH3(l)</td>
<td>0.2857</td>
</tr>
<tr>
<td>3</td>
<td>RXN-LAW-CAUSCRUB-NH3-REACTION</td>
<td>1.0 NH3(l) + 1.0 H2O(l) → 1.0 NH4+(l) + 1.0 OH-(l) <em>Calculated per equation below</em></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>RXN-LAW-CAUSCRUB-HCL</td>
<td>1.0 HCl(g) → 1.0 H+(l) + 1.0 Cl-(l)</td>
<td>0.99</td>
</tr>
<tr>
<td>5</td>
<td>RXN-LAW-CAUSCRUB-HF</td>
<td>1.0 HF(g) → 1.0 H+(l) + 1.0 F-(l)</td>
<td>0.9874</td>
</tr>
<tr>
<td>6</td>
<td>RXN-LAW-CAUSCRUB-NO2</td>
<td>3.0 NO2(g) + 1.0 H2O(l) → 2.0 H+(l) + 2.0 NO3-(l) + 1.0 NO(g)</td>
<td>0.2248</td>
</tr>
<tr>
<td>7</td>
<td>RXN-LAW-CAUSCRUB-NO</td>
<td>4.0 NO(g) + 2.0 H2O(l) + 3.0 O2(g) → 4.0 H+(l) + 4.0 NO3-(l)</td>
<td>0.2248</td>
</tr>
<tr>
<td>9</td>
<td>RXN-LAW-SBS-SO2</td>
<td>2.0 SO2(g) + 2.0 H2O(l) + 1.0 O2(g) → 4.0 H+(l) + 2.0 SO4-2(l)</td>
<td>0.97</td>
</tr>
<tr>
<td>10</td>
<td>RXN-LAW-CAUSCRUB-SO3</td>
<td>1.0 SO3(g) + 1.0 H2O(l) → 2.0 H+(l) + 1.0 SO4-2(l)</td>
<td>0.97</td>
</tr>
<tr>
<td>11</td>
<td>EVAPORATE-H2O or CONDENSE-H2O</td>
<td>H2O (l) → H2O (g) or H2O (g) → H2O (l)</td>
<td>Based on Saturation calculation</td>
</tr>
<tr>
<td>12</td>
<td>EVAPORATE-3-H or CONDENSE-3-H</td>
<td>1.0 3-H(l) → 1.0 3-H(g) or 1.0 3-H(g) → 1.0 3-H(l)</td>
<td>Follows water</td>
</tr>
</tbody>
</table>
The extent of reactions shall be equal to the conversion factor or until one of the reactants has been depleted.


The extent of reaction for the conversion of \( \text{NH}_3 \) to \( \text{NH}_4^+ \) is calculated based on the equation below.

\[
\text{NH}_4^{CF} = \frac{\text{NH}_3^{begin} - 0.9 \times 5.682^{-3} \times \text{NH}_3^{gas}}{\text{NH}_3^{begin}}
\]

Where:
- \( \text{NH}_4^{CF} \) = The conversion factor for RXN-LAW-SBS-NH3.
- \( \text{NH}_3^{begin} \) = Moles of \( \text{NH}_3 \) liquid before the reaction.
- \( \text{NH}_3^{gas} \) = Moles of \( \text{NH}_3 \) gas before the reaction.

**Basis:** This model requirement is in Attachment A2 of 24590-WTP-MRQ-PE-14-0019, Direct LAW with Evaporator.

### 3.16.4.9 LVP-SCB-00001 - Caustic Scrubber Column Target pH

**Unique ID:** BMR-LVP_TR-8

The target pH for the **LVP-SCB-00001 - Caustic Scrubber Column** shall be 9.0.

**Basis:** This model requirement is found in Section 4.8.16 LAW Offgas Process (LOP) Systems in 24590-WTP-MDD-PR-01-002, WTP MDD.

**NOTE:** A proposed change to the target pH = 9.75 is provided in Attachment A2 of 24590-WTP-MRQ-PE-14-0019, Direct LAW with Evaporator.

### 3.16.4.10 LVP-SCB-00001 - Caustic Scrubber Column pH Adjustment Reactions

**Unique ID:** BMR-LVP_TR-9

The **LVP-SCB-00001 - Caustic Scrubber Column** pH Adjustment reactions are:

- **RXN-NH4-NEUTRALIZATION** Conversion = 1.0
- **NEUT-REACTION** Conversion = 1.0
Basis: The pH adjustment is found in Section 3.3.6.1 Ammonia in Water and Flowsheet Calculations in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

3.16.4.11 LVP-SCB-00001 - Caustic Scrubber Column Outlet Conditions

Unique ID: BMR-LVP_TR-10

The LVP-SCB-00001 - Caustic Scrubber Column outlet conditions shall be 53.9 °C (129 F) and 1 atmosphere.

Basis: This model requirement is in Attachment A2 of 24590-WTP-MRQ-PE-14-0019, Direct LAW with Evaporator.

3.16.4.12 LVP-SCB-00001 - Caustic Scrubber Column Quench Water Flowrate

Unique ID: BMR-LVP_TR-11

The LVP-SCB-00001 - Caustic Scrubber Column quench water shall be added at 3 gallons per minute.

Basis: This model requirement is in Attachment A2 of 24590-WTP-MRQ-PE-14-0019, Direct LAW with Evaporator.

3.16.4.13 LVP-SCB-00001 - Caustic Scrubber Column Maximum SpG

Unique ID: BMR-LVP_TR-13

The LVP-SCB-00001 - Caustic Scrubber Column maximum SpG is 1.1.

Basis: This model requirement is in Attachment A2 of 24590-WTP-MRQ-PE-14-0019, Direct LAW with Evaporator.
3.16.5 LVP Figures and Diagrams

3.16.5.1 Simplified LVP Flow Diagram

Unique ID: BMR-LVP FIG-5

![Simplified LVP Flow Diagram]

3.16.5.2 LVP HEPA and Carbon Adsorber Model Diagram

Unique ID: BMR-LVP FIG-6

![LVP HEPA and Carbon Adsorber Model Diagram]
3.16.5.3  LVP NOX Catalytic Oxidizer Reducer Model Diagram

Unique ID: BMR-LVP_FIG-7

3.16.5.4  LVP Caustic Scrubber Model Diagram

Unique ID: BMR-LVP_FIG-8

3.17  WASTE TREATMENT AND IMMOBILIZATION PLANT EFFLUENT MANAGEMENT FACILITY

The purpose of the Effluent Management System (EMF) system is to concentrate dilute process condensate from the WTP LAW Vitrification Offgas system for recycle to LAW Vitrification, thereby eliminating returns to Tank Farms during DFLAW. The EMF system concentrates dilute process condensate by evaporation, and recycles it back to the Melter Concentrate Receipt Vessel in LAW Vitrification. The system consists of the EMF Evaporator Feed Vessel, the EMF Evaporator, the EMF Demister/Condenser, and the three EMF Concentrate Receipt Vessels. The EMF Evaporator feed vessel is modeled in TOPSim as two vessels to allow for
simultaneous transfers into the feed vessel, while the evaporator is being fed. Care is taken not to split the transfers from the LAW Vitrification Offgas system (i.e., from RLD-VSL-00005) across the two feed vessels to help ensure a consistent EMF Evaporator feed composition. The EMF Evaporator Feed vessel also receives inhibited water flushes following transfers from LAWPS to LAW Vitrification. Prior to feeding the EMF Evaporator, the pH of the feed is adjusted as needed for corrosion prevention.

The EMF Evaporator Feed is concentrated to one of three endpoint criteria, depending on which is reached first. The criteria are based on specific gravity (SpG), chlorine concentration, or cesium concentration (137-Cs). When the concentrated process condensate and flushes have reached the endpoint criteria, it is routed sequentially to three EMF Concentrate Storage Vessels. The storage vessels are emptied sequentially, while concentrated condensate is recycled to LAW Vitrification. The quantity of recycle to LAW Vitrification per batch is calculated as a function of the volume residing in the EMF Concentrate Storage Vessels at any given time.

Evaporated water is condensed in the EMF Demister/Condenser. Split factors are applied to non-condensable species in the EMF Evaporator and EMF Demister condenser in TOPSim to simulate carryover. The evaporated water and non-condensable species that have been carried over is split into two streams. One of the streams is condensed liquid plus non-condensable species that is routed to LERF. The other stream, containing water vapor (at saturation) and non-condensable species is routed to the EMF Stack.

3.17.1 System Requirements

3.17.1.1 Concentrate Dilute Process Condensate

Unique ID: BMR-EMF_SR-1

The EMF shall concentrate dilute process condensate.

Basis: N/A

3.17.2 Functional Requirements

3.17.2.1 Receive Process Condensate

Unique ID: BMR-EMF_FR-1

The EMF shall have the capability to receive process condensate from the RLD system.

Basis: N/A

3.17.2.2 Receive Line Flushes

Unique ID: BMR-EMF_FR-7

The EMF shall have the capability to receive a fraction of the LAWPS to LCP line flush.

Basis: N/A
3.17.2.3 Chemically Adjust EMF Evaporator Feed

Unique ID: BMR-EMF_FR-9

The EMF shall have the capability to adjust the chemistry of the dilute process condensate and line flushes for EMF Evaporator (EMF-SEP-00001) feed.

Basis: N/A

3.17.2.4 Concentrate Process Condensate

Unique ID: BMR-EMF_FR-2

The EMF shall have the capability to concentrate process condensate and line flushes by evaporation.

Basis: N/A

3.17.2.5 Condense Vapor in EMF Evaporator Overheads

Unique ID: BMR-EMF_FR-8

The EMF shall have the capability to condense the vapor in the evaporator overheads.

Basis: N/A

3.17.2.6 Offgas Routing

Unique ID: BMR-EMF_FR-3

The EMF shall have the capability to route gaseous effluent to the EMF stack.

Basis: N/A

3.17.2.7 Condensate Waste Routing

Unique ID: BMR-EMF_FR-4

The EMF shall have the capability to route condenser liquid effluent to LERF.

Basis: N/A

3.17.2.8 Concentrated Waste Storage

Unique ID: BMR-EMF_FR-5

The EMF shall have the capability to store concentrated process condensate and line flushes.

Basis: N/A

3.17.2.9 Concentrated Waste Sampling

Unique ID: BMR-EMF_FR-6

The EMF shall have the capability to sample the concentrated process condensate and line flushes.

Basis: N/A
3.17.2.10  Concentrated Waste Routing

Unique ID: BMR-EMF_FR-10

The EMF shall have the capability to route concentrated process condensate and line flushes from EMF-VSL-00001A/B/C to LCP-VSL-00001_2.

Basis: N/A

3.17.3  Model Requirements

3.17.3.1  EMF SBS Condensate Receipt Vessel (EMF-VSL-00002A/B)

Unique ID: BMR-EMF_MR-1

The EMF shall include two EMF SBS Condensate Receipt vessels identified as EMF-VSL-00002A and EMF-VSL-00002B, which represent one feed vessel (EMF-VSL-00002).

Basis: This is an enabling assumption to allow for simultaneous transfers into and out of the feed vessel at the same time.

3.17.3.2  EMF Evaporator (EMF-SEP-00001)

Unique ID: BMR-EMF_MR-2

The EMF shall include an evaporator vessel identified as EMF-SEP-00001.

Basis: EMF-SEP-00001 naming and functionality conform to that used for the TLP Evaporator, which is similar.

3.17.3.3  EMF Evaporator Demister/Condenser (EMF-DMST-00001)

Unique ID: BMR-EMF_MR-3

The EMF shall include a demister/condenser unit identified as EMF-DMST-00001, which represents the functionality of both a demister and condenser.

Basis: EMF-DMST-00001 naming and functionality conform to that used for the TLP Evaporator, which is similar to the EMF Evaporator.

3.17.3.4  EMF Evaporator Bottoms Vessel (EMF-SEP-00001A)

Unique ID: BMR-EMF_MR-25

The EMF shall include an evaporator bottoms vessel EMF-SEP-00001A. This vessel represents the bottom of the evaporator where concentrate is collected.

Basis: This vessel was included in the model in order to represent the hold-up of the EMF Evaporator, since it affects the dynamics of the simulation.

3.17.3.5  EMF Concentrate Storage Vessels (EMF-VSL-00001A/B/C)

Unique ID: BMR-EMF_MR-21

The EMF shall include three EMF Concentrate Storage Vessels identified as EMF-VSL-00001A, EMF-VSL-00001B, and EMF-VSL-00001C.

Basis: There are three EMF Concentrate Storage Vessels included in 24590-WTP-MRR-PENG-16-001, Rev. 0.
3.17.3.6 EMF SBS Condensate Receipt Vessel (EMF-VSL-00002A/B) Process Condensate Receipt

**Unique ID:** BMR-EMF_MR-4

The *EMF SBS Condensate Receipt Vessels (EMF-VSL-00002A/B)* shall receive the process condensate transferred from the *SBS Condensate Collection Vessel (RLD-VSL-00005)*.

**Basis:** The purpose of the EMF Evaporator is to concentrate secondary wastes during DFLAW for recycle to LAW vitrification, primarily dilute off-gas condensate from the LAW melters, which is collected in RLD-VSL-00005.

3.17.3.7 EMF SBS Condensate Receipt Vessel (EMF-VSL-00002A/B) Receipt Trigger

**Unique ID:** BMR-EMF_MR-5

The *EMF SBS Condensate Receipt Vessel (EMF-VSL-00002A/B)* shall be available to receive when the volume is less than the set volume.

**Basis:** Enabling assumption. Ensures that flushes can be accepted as long as the vessels are below the setpoint.

3.17.3.8 EMF SBS Condensate Receipt Vessel (EMF-VSL-00002A/B) Flush Receipt

**Unique ID:** BMR-EMF_MR-22

The EMF SBS Condensate Receipt Vessels (EMF-VSL-00002A/B) shall receive a fraction of the LAWPS to LCP inhibited water line flush.

**Basis:** Per 24590-WTP-MRR-PENG-16-001, Rev. 0, 200 gallons of the LAWPS to LCP inhibited water line flush reports to LCP-VSL-00001_2 and the remainder reports to EMF-VSL-00002A/B.

3.17.3.9 EMF SBS Condensate Receipt Vessel (EMF-VSL-00002A/B) Stop Filling

**Unique ID:** BMR-EMF_MR-6

The *EMF SBS Condensate Receipt Vessels (EMF-VSL-00002A/B)* shall stop filling when the volume is at the set volume.

**Basis:** N/A

3.17.3.10 EMF SBS Condensate Receipt Vessel (EMF-VSL-00002A/B) pH Adjustment

**Unique ID:** BMR-EMF_MR-7

Immediately after a transfer from RLD-VSL-00005 to EMF-VSL-00002A/B or the addition of an inhibited water line flush, the pH of EMF-VSL-00002A/B shall be adjusted by adding caustic to meet the *EMF SBS Condensate Receipt Vessel target pH*.

**Basis:** Transfers from RLD-VSL-00005 to EMF-VSL-00002A/B will be neutral to acidic, and must be adjusted to basic pH for chemistry control.
3.17.3.11 EMF SBS Condensate Receipt Vessel (EMF-VSL-00002A/B) Neutralization Reactions

Unique ID: BMR-EMF_MR-23

After caustic addition to EMF-VSL-00002A/B, neutralization reactions are applied.

Basis: Neutralization reactions must be applied after caustic addition in order to achieve the specified pH.

3.17.3.12 EMF SBS Condensate Receipt Vessel (EMF-VSL-00002A/B) Routing

Unique ID: BMR-EMF_MR-8

The contents of the EMF SBS Condensate Receipt Vessel (EMF-VSL-00002A/B) shall be transferred to the EMF Evaporator (EMF-SEP-00001).

Basis: Routing provided in 24590-WTP-MRR-PENG-16-001, Rev. 0.

3.17.3.13 EMF SBS Condensate Receipt Vessel (EMF-VSL-00002A/B) Start Transferring

Unique ID: BMR-EMF_MR-41

The EMF SBS Condensate Receipt Vessels (EMF-VSL-00002A/B) shall start transferring to the EMF Evaporator (EMF-SEP-00001) when its volume reaches the EMF-VSL-00002A/B Minimum Pump-able Volume, which is the volume above the minimum volume of EMF-VSL-00002A/B at which EMF-VSL-00002A/B starts transferring to EMF-SEP-00001.

Basis: Enabling Assumption. Ensures that there is enough dilute condensate available in EMF-VSL-00002A/B to sustain feed to the EMF Evaporator.

3.17.3.14 EMF SBS Condensate Receipt Vessel (EMF-VSL-00002A/B) Stop Transferring

Unique ID: BMR-EMF_MR-9

The EMF SBS Condensate Receipt Vessels (EMF-VSL-00002A/B) shall stop transferring when they have reached their minimum volume.

Basis: N/A

3.17.3.15 EMF Evaporator (EMF-SEP-00001) Routing

Unique ID: BMR-EMF_MR-10

The EMF Evaporator (EMF-SEP-00001) shall route vapors to the EMF Evaporator Demister/Condenser (EMF-DMST-00001) and the liquid concentrate to the EMF Evaporator Bottoms Vessel (EMF-SEP-00001A).

Basis: Routing per 24590-WTP-MRR-PENG-16-001, Rev. 0.

3.17.3.16 EMF Evaporator (EMF-SEP-00001) Feed Receipt

Unique ID: BMR-EMF_MR-11

The EMF Evaporator (EMF-SEP-00001) shall receive feed from the EMF SBS Condensate Receipt Vessels (EMF-VSL-00002A/B).

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Basis: Per 24590-WTP-MRR-PENG-16-001, Rev. 0.

3.17.3.17  EMF Evaporator (EMF-SEP-00001) Water Boil-Off

Unique ID: BMR-EMF_MR-39

The rate of water boil-off in the EMF Evaporator (EMF-SEP-00001) shall not exceed the EMF maximum boil-off rate.

Basis: The maximum boil-off rate is based on EMF Evaporator throughput requirements. The dilute condensate and flushes must be concentrated at a high enough rate to support 100% recycle to LAW vitrification.

3.17.3.18  EMF Evaporator (EMF-SEP-00001) Concentrate End Point

Unique ID: BMR-EMF_MR-13

The EMF Evaporator (EMF-SEP-00001) shall concentrate the feed to the EMF Evaporator Target Endpoint.

Basis: The endpoint is determined by the 137-Cs concentration, the chloride content, or SpG, whichever is reached first.

3.17.3.19  EMF Evaporator (EMF-SEP-00001) Offgas Component Splits

Unique ID: BMR-EMF_MR-14

The predicted components carried into the vapor stream from the EMF Evaporator (EMF-SEP-00001) shall be calculated based on the method described in RPP-RPT-52097, Recommendation for Updating Evaporator Partition Coefficients with partition coefficients from SVF-1778.

Basis: Bases provided in requirement.

3.17.3.20  EMF Evaporator Demister/Condenser (EMF-DMST-00001) Routing

Unique ID: BMR-EMF_MR-15

The EMF Evaporator Demister/Condenser (EMF-DMST-00001) vapor shall be routed to the EMF-Stack and condensate shall be routed to LERF.

Basis: The routing is provided in 24590-WTP-MRR-PENG-16-001, Rev. 0.

3.17.3.21  EMF Evaporator Demister/Condenser (EMF-DMST-00001) Component Splits

Unique ID: BMR-EMF_MR-16

The predicted component splits for the EMF Evaporator Demister/Condenser (EMF-DMST-00001) offgas and condensate shall be based on the TLP-DMST-00001 split factors.

Basis: The TLP evaporator and demister are the most similar to the EMF evaporator and demister, and the component splits are assumed to be the same for the EMF evaporator and demister as for the TLP evaporator and demister in the absence of data.
3.17.3.22 EMF Evaporator Demister/Condenser (EMF-DMST-00001) Water Addition

**Unique ID:** BMR-EMF_MR-17

The *EMF Evaporator Demister/Condenser (EMF-DMST-00001)* shall include the *EMF-DMST-00001 Water Addition* when operating, which represents the amount of steam added (as condensate) while using the vacuum eductor system to maintain a vacuum between the evaporator and condensers.

**Basis:** The EMF Evaporator Demister/Condenser (EMF-DMST-00001) is assumed to be identical to that of the TLP Evaporator Demister/Condenser (TLP-DMST-00001).

3.17.3.23 EMF Evaporator Demister/Condenser (EMF-DMST-00001) Air Addition

**Unique ID:** BMR-EMF_MR-18

The *EMF Evaporator Demister/Condenser (EMF-DMST-00001)* shall include the *EMF-DMST-00001 Air Addition* when operating, which represents the control air used to maintain a relatively constant air flow to the vacuum eductor.

**Basis:** The EMF Evaporator Demister/Condenser (EMF-DMST-00001) is assumed to be identical to that of the TLP Evaporator Demister/Condenser (TLP-DMST-00001).

3.17.3.24 EMF Evaporator Demister/Condenser (EMF-DMST-00001) Receipt Trigger

**Unique ID:** BMR-EMF_MR-36

The *EMF Evaporator Demister/Condenser (EMF-DMST-00001)* shall be available to receive condensate when the volume is less than the set volume.

**Basis:** N/A

3.17.3.25 EMF Evaporator Demister/Condenser (EMF-DMST-00001) Complete Filling

**Unique ID:** BMR-EMF_MR-37

The *EMF Evaporator Demister/Condenser (EMF-DMST-00001)* shall complete filling when the volume is at the set volume.

**Basis:** N/A

3.17.3.26 EMF Evaporator Demister/Condenser (EMF-DMST-00001) Transfer Complete

**Unique ID:** BMR-EMF_MR-38

The *EMF Evaporator Demister/Condenser (EMF-DMST-00001)* shall complete transferring when it has reached its minimum volume.

**Basis:** N/A
3.17.3.27 EMF Evaporator Demister/Condenser (EMF-DMST-00001) Offgas Conditions

Unique ID: BMR-EMF_MR-19

Offgas from the EMF Evaporator Demister/Condenser (EMF-DMST-00001) shall be discharged at saturation conditions at the condenser outlet temperature and pressure, which is calculated by using the Mole Fraction of Water at Saturation equation at the EMF-DMST-00001 Outlet Conditions.

Basis: This is consistent with TLP Evaporator Modeling and results in a more accurate accounting of the water reporting to the EMF Stack versus LERF.

3.17.3.28 EMF Evaporator Bottoms Vessel (EMF-SEP-00001A) Routing

Unique ID: BMR-EMF_MR-29

The concentrate from the EMF Evaporator Bottoms Vessel (EMF-SEP-00001A) shall be routed to the EMF Concentrate Storage Vessels (EMF-VSL-00001A/B/C).

Basis: EMF-SEP-00001A represents the EMF Evaporator bottoms hold-up volume. Per 24590-WTP-MRR-PENG-16-001, Rev. 0, the EMF Evaporator bottoms are routed to the EMF Concentrate Storage Vessels (EMF-VSL-00001A/B/C).

3.17.3.29 EMF Evaporator Bottoms Vessel (EMF-SEP-00001A) Concentrate Receipt

Unique ID: BMR-EMF_MR-26

The EMF Evaporator Bottoms Vessel (EMF-SEP-00001A) shall receive concentrate from the EMF Evaporator (EMF-SEP-00001).

Basis: EMF-SEP-00001A represents the EMF Evaporator bottoms hold-up volume.

3.17.3.30 EMF Evaporator Bottoms Vessel (EMF-SEP-00001A) Receipt Trigger

Unique ID: BMR-EMF_MR-27

The EMF Evaporator Bottoms Vessel (EMF-SEP-00001A) shall be available to receive waste when the volume is less than the set volume.

Basis: N/A

3.17.3.31 EMF Evaporator Bottoms Vessel (EMF-SEP-00001A) Complete Filling

Unique ID: BMR-EMF_MR-28

The EMF Evaporator Bottoms Vessel (EMF-SEP-00001A) shall complete filling when the volume is at the set volume.

Basis: N/A

3.17.3.32 EMF Evaporator Bottoms Vessel (EMF-SEP-00001A) Discharge

Unique ID: BMR-EMF_MR-12

The EMF Evaporator Bottoms Vessel (EMF-SEP-00001A) shall discharge a volume at a rate sufficient to approximate constant volume operations.
Basis: The EMF evaporator is designed to maintain a constant volume of bottoms hold-up with continuous transfer to EMF-VSL-00001A/B/C, the goal of the modeling approach is to approach continuous operations.

3.17.3.33 EMF Evaporator Bottoms Vessel (EMF-SEP-00001A) Transfer Complete
Unique ID: BMR-EMF_MR-30
The EMF Evaporator Bottoms Vessel (EMF-SEP-00001A) shall complete transferring when it has reached its minimum volume.
Basis: N/A

3.17.3.34 EMF Concentrate Storage Vessels (EMF-VSL-00001A/B/C) Sequential Operations
Unique ID: BMR-EMF_MR-20
The EMF Concentrate Storage Vessels (EMF-VSL-00001A/B/C) shall operate in sequential fashion (e.g., A, B, C, A, B, C ... with only one tank filling at any given time and one tank emptying at a given time).
Basis: As specified in 24590-WTP-MRR-PENG-16-001, Rev. 0. This approach allows for sampling and isolation of recycles to LAW vitrification.

3.17.3.35 EMF Concentrate Storage Vessels (EMF-VSL-00001A/B/C) Concentrate Receipt
Unique ID: BMR-EMF_MR-24
The EMF Concentrate Storage Vessels (EMF-VSL-00001A/B/C) shall be available to receive concentrated process condensate and line flushes from the EMF Evaporator Bottoms Vessel (EMF-VSL-00001A) when the volume is less than the set volume and the vessel is in receive mode.
Basis: N/A

3.17.3.36 EMF Concentrate Storage Vessels (EMF-VSL-00001A/B/C) Complete Filling
Unique ID: BMR-EMF_MR-32
The EMF Concentrate Storage Vessels (EMF-VSL-00001A/B/C) shall complete filling when the volume is at the set volume.
Basis: N/A

3.17.3.37 EMF Concentrate Storage Vessels (EMF-VSL-00001A/B/C) Sample Trigger
Unique ID: BMR-EMF_MR-33
The EMF Concentrate Storage Vessels (EMF-VSL-00001A/B/C) shall be sampled when filled to the set volume.
Basis: The composition of recycles must be known, along with the composition of the pre-treated LAW waste, in order to formulate the LAW glass.
3.17.3.38 EMF Concentrate Storage Vessels (EMF-VSL-00001A/B/C) Sample Hold Duration

**Unique ID:** BMR-EMF_MR-34

The Sample Hold Duration for the EMF Concentrate Storage Vessels (EMF-VSL-00001A/B/C) shall be a function of the time of day the sample was taken.

**Basis:** The lab is not scheduled to be open 24 hours/day, so some samples will have a longer turnaround time than others if they are submitted during off-hours.

3.17.3.39 EMF Concentrate Storage Vessels (EMF-VSL-00001A/B/C) Routing

**Unique ID:** BMR-EMF_MR-31

The EMF Concentrate Storage Vessels (EMF-VSL-00001A/B/C) shall route a calculated volume of concentrated process condensate and line flushes to LAW Vitrification (LCP-VSL-00001_2).

**Basis:** The volume of concentrated secondary waste to be recycled in each LCP-VSL-00001_2 batch is calculated using a method that ensures that the feed to the melter is as consistent as practically possible, while ensuring that 100% of the concentrated secondary waste is recycled LAW vitrification.

3.17.3.40 EMF Concentrate Storage Vessels (EMF-VSL-00001A/B/C) Recycle Volume

**Unique ID:** BMR-EMF_MR-40

The volume available in EMF-VSL-00001A/B/C shall be considered when determining how much volume is to be recycled to LCP-VSL-00001_2, such that the volume recycled changes little from batch-to-batch to prevent swings in glass formulation.

**Basis:** The volume of concentrated secondary waste to be recycled in each LCP-VSL-00001_2 batch is calculated using a method that ensures that the feed to the melter is as consistent as practically possible, while ensuring that 100% of the concentrated secondary waste is recycled LAW vitrification.

3.17.3.41 EMF Concentrate Storage Vessels (EMF-VSL-00001A/B/C) Transfer Complete

**Unique ID:** BMR-EMF_MR-35

The EMF Concentrate Storage Vessels (EMF-VSL-00001A/B/C) shall complete transferring when the volume remaining in the discharging vessel currently available for transfer (current volume - minimum volume) is less than the volume requested by LAW Vitrification, or when the discharging vessel reaches its minimum volume.

**Basis:** N/A
3.17.4 Technical Requirements

3.17.4.1 EMF SBS Condensate Receipt Vessel (EMF-VSL-00002A/B) Attributes

**Unique ID:** BMR-EMF_TR-1

The *EMF SBS Condensate Receipt Vessels (EMF-VSL-00002A and EMF-VSL-00002B)* shall have the following parametric values.

<table>
<thead>
<tr>
<th>Vessel #</th>
<th>Overflow Volume (gal)</th>
<th>Maximum Volume (gal)</th>
<th>Upper Set Volume (gal)</th>
<th>Set Volume (gal)</th>
<th>Minimum Volume (gal)</th>
<th>Flow rate (gpm)</th>
<th>Temperature (C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>EMF-VSL-00002</td>
<td>N/A</td>
<td>35,000</td>
<td>33,000</td>
<td>33,000</td>
<td>3,000</td>
<td>15</td>
<td>25</td>
</tr>
</tbody>
</table>

**Basis:** Vessel volumes and pump rates from 24590-WTP-MRR-PENG-16-001, Rev. 0. Temperature is assumed to be ambient.

3.17.4.2 EMF Evaporator (EMF-SEP-00001) Attributes

**Unique ID:** BMR-EMF_TR-2

For simplification, the *EMF Evaporator (EMF-SEP-00001)* shall be modeled as splitter which does not have the physical attributes of the actual vessel associated with it.

**Basis:** N/A

3.17.4.3 EMF Evaporator Bottoms Vessel (EMF-SEP-00001A) Attributes

**Unique ID:** BMR-EMF_TR-14

The EMF Evaporator Bottoms Vessel (EMF-SEP-00001A) shall have the following attributes.

<table>
<thead>
<tr>
<th>Vessel #</th>
<th>Overflow Volume (gal)</th>
<th>Maximum Volume (gal)</th>
<th>Upper Set Volume (gal)</th>
<th>Set Volume (gal)</th>
<th>Minimum Volume (gal)</th>
<th>Flow rate (gpm)</th>
<th>Temperature (C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>EMF-SEP-00001A</td>
<td>N/A</td>
<td>2,000</td>
<td>1,630</td>
<td>1,630</td>
<td>1,500</td>
<td>140</td>
<td>30</td>
</tr>
</tbody>
</table>

**Basis:** Vessel volumes are from 24590-WTP-MRR-PENG-16-001, Rev. 0. The temperature is based on the EMF evaporator operating conditions. The pump rate was increased from 10 gpm to the tank-farm standard of 140 gpm to minimize the time that the vessel is unable to receive concentrated bottoms from the EMF evaporator, so that modeled bottoms transfers from the Evaporator Bottoms Vessel to the Concentrate Receipt Vessels more closely approaches continuous operations.*

3.17.4.4 EMF Evaporator Demister/Condenser (EMF-DMST-00001) Attributes

**Unique ID:** BMR-EMF_TR-3

The *EMF Evaporator Demister/Condenser (EMF-DMST-00001)* shall have the following parametric values.

<table>
<thead>
<tr>
<th>Vessel #</th>
<th>Overflow Volume (gal)</th>
<th>Maximum Volume (gal)</th>
<th>Set Volume (gal)</th>
<th>Minimum Volume (gal)</th>
<th>Flow rate (gpm)</th>
<th>Temperature (C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>EMF-DMST-00001</td>
<td>N/A</td>
<td>1,300</td>
<td>350</td>
<td>50</td>
<td>66</td>
<td>30 (outlet)</td>
</tr>
</tbody>
</table>

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**Basis:** The EMF-DMST-00001 attributes are based on, and identical to those for the TLP-DMST-00001.

### 3.17.4.5 EMF Concentrate Storage Vessel (EMF-VSL-00001A/B/C) Attributes

**Unique ID:** BMR-EMF_TR-15

The *EMF Concentrate Storage Vessel (EMF-VSL-00001A/B/C)* shall have the following parametric values.

<table>
<thead>
<tr>
<th>Vessel #</th>
<th>Overflow Volume (gal)</th>
<th>Maximum Volume (gal)</th>
<th>Upper Set Volume (gal)</th>
<th>Set Volume (gal)</th>
<th>Minimum Volume (gal)</th>
<th>Flow rate (gpm)</th>
<th>Temperature (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>EMF-VSL-00001A/B/C</td>
<td>N/A</td>
<td>9,000</td>
<td>8,280</td>
<td>8,280</td>
<td>1,080</td>
<td>140</td>
<td>25</td>
</tr>
</tbody>
</table>

**Basis:** Vessel volumes and pump rates from 24590-WTP-MRR-PENG-16-001, Rev. 0. Temperature is assumed to be ambient.

### 3.17.4.6 EMF SBS Condensate Receipt Vessel (EMF-VSL-00002A/B) Flush Receipt

**Unique ID:** BMR-EMF_TR-16

The EMF SBS Condensate Receipt Vessels (EMF-VSL-00002A and EMF-VSL-00002B) shall receive 1,300 gallons of the 1,500 gallon AP-106 to LCP line flush if it has been < 72 hours between transfers from AP-106 to LCP-VSL-00001_2, or if it has been > 72 hours between transfers from AP-106 to LCP-VSL-00001_2, EMF-VSL-00002A/B shall receive 2,000 gallons of the 2,200 gallon AP-106 to LCP-VSL-00001_2 line flush.

**Basis:** 31269-22-SDD-003, Rev. B, System Design Description for the Lag Storage Tank and Diversion System.

### 3.17.4.7 EMF SBS Condensate Receipt Vessel (EMF-VSL-00002A/B) Caustic

**Unique ID:** BMR-EMF_TR-4

5.0M NaOH shall be added to the *EMF SBS Condensate Receipt Vessels (EMF-VSL-00002A and EMF-VSL-00002B)* for pH adjustment.

**Basis:** 24590-WTP-MRR-PENG-16-001, Rev. 0.

### 3.17.4.8 EMF SBS Condensate Receipt Vessel (EMF-VSL-00002A/B) Target pH

**Unique ID:** BMR-EMF_TR-5

The target pH endpoint for the *EMF SBS Condensate Receipt Vessel (EMF-VSL-00002A and EMF-VSL-00002B)* shall be 11.0.

**Basis:** Per 24590-WTP-MRR-PENG-16-001, Rev.0, DFLAW 100% Recycle Using 2013 Glass Model, the target pH for EMF-VSL-00002A/B is 10-12.
3.17.4.9 EMF SBS Condensate Receipt Vessels (EMF-VSL-00002A/B) Reactions

**Unique ID:** BMR-EMF_TR-6

The **EMF SBS Condensate Receipt Vessels (EMF-VSL-00002A and EMF-VSL-00002B)** reactions are as follows:

- **RXN-NH4-NEUTRALIZATION** Conversion = 1.0
- **NEUT-REACTION** Conversion = 1.0

**Basis:** The reactions listed are the neutralization reactions that are impacted by the addition of caustic in EMF-VSL-00002A/B.

3.17.4.10 EMF Evaporator (EMF-SEP-00001) Feed Rate

**Unique ID:** BMR-EMF_TR-9

The feed rate for the **EMF Evaporator (EMF-SEP-00001)** is 15 gpm.

**Basis:** Per 24590-WTP-MRR-PENG-16-001, Rev. 0, the evaporator feed pump is 15 gpm.

3.17.4.11 EMF Evaporator (EMF-SEP-00001) Water Boil-off

**Unique ID:** BMR-EMF_TR-18

The **EMF Maximum Boil-off Rate** is 15 gpm.

**Basis:** The maximum boil-off rate must be < = the evaporator feed rate.

3.17.4.12 EMF Evaporator (EMF-SEP-00001) Concentrate Target Endpoint

**Unique ID:** BMR-EMF_TR-8

The **EMF Evaporator (EMF-SEP-00001)** target endpoint is a concentrate SpG limit of 1.2, a Cl- concentration limit of 2 wt%, or a 137-Cs concentration limit of 1.9E-04 Ci/liter, whichever is reached first.

**Basis:** The endpoint criteria are per 24590-WTP-MRR-PENG-001, Rev. 0.

3.17.4.13 EMF Evaporator (EMF-SEP-00001) Dynamic Decontamination Factors

**Unique ID:** BMR-EMF_TR-7

The partition factors from the "EVAP-SEP" tab of SVF-1778, Rev. 8 shall be applied to the EMF Evaporator (EMF-SEP-00001) based on equation 6 in *RPP-RPT-52097, Recommendation for Updating Evaporator Partition Coefficients*, as follows:

\[ WVR = \frac{(\rho_B - \rho_F)}{(\rho_B - 1)} \]

Where:

\[ \rho_B \quad = \quad \text{Evaporator set point (bottoms SpG)} \]
\[ \rho_F = \text{Specific gravity of evaporator feed} \]

\[
SF_i(Kp_i) = \begin{cases} 
WVR, & \text{if } 3 - H \\
WVR, & \text{if } H_2O \\
0.100, & \text{if } H^+ \\
0.067, & \text{if } C_2O_4^{2-} \\
0.00099, & \text{if } OH(\text{Bound}) \\
0, & \text{if } Kp_i = 0 \\
\frac{1}{1 + \frac{Kp_i}{18600} \left(1 - \frac{WVR}{WVR}\right)}, & \text{if } Kp_i > 0
\end{cases}
\]

Where:

\( SF_i \) = split factor for component \( i \); the split factor is the mass or activity of component \( i \) in the process condensate to the mass or activity of \( i \) in the feed

\( WVR \) = waste volume reduction factor

\( Kp_i \) = partition coefficient for component \( i \) (SVF-1778).

18,600 = a numerical factor accounting for the 27% volume increase and for the ratio of the volume of condensate as a vapor to the volume of condensate as a liquid evaluated at 60 torr and 52°C. (RPP-RPT-52097)

**Basis:** The partition factors from the "EVAP-SEP" tab of SVF-1778, Rev. 8 are applied to the EMF Evaporator (EMF-SEP-00001) based on equation 6 in RPP-RPT-52097, Recommendation for Updating Evaporator Partition Coefficients.

### 3.17.4.14 EMF Evaporator Demister (EMF-DMST-00001) Water Addition

**Unique ID:** BMR-EMF_TR-10

The EMF Evaporator Demister (EMF-DMST-00001) water addition shall be 0.96 gpm of water.
**Basis:** The water addition rate is assumed to be the same as that for the TLP Evaporator.

### 3.17.4.15 EMF Evaporator Demister (EMF-DMST-00001) Air Addition

**Unique ID:** BMR-EMF_TR-11

The *EMF Evaporator Demister (EMF-DMST-00001)* air addition shall be at a flow rate of 5 ft³/min (@ 70 °F and 14.7 psi).

**Basis:** The air addition rate is assumed to be the same as that for the TLP Evaporator.

### 3.17.4.16 EMF Evaporator Demister (EMF-DMST-00001) Outlet Conditions

**Unique ID:** BMR-EMF_TR-12

The condenser outlet conditions of the *EMF Evaporator Demister (EMF-DMST-00001)* shall be 30 C and 810 Torr [(1079.91 millibars)].

**Basis:** The EMF Evaporator Demister outlet conditions are assumed to be the same as the TLP Evaporator Demister outlet conditions.

### 3.17.4.17 EMF Evaporator Demister/Condenser (EMF-DMST-00001) Split Factors

**Unique ID:** BMR-EMF_TR-13

The split factors from the tab "EMF-DMST-00001" in SVF-1778, Rev. 8 shall be applied to the *EMF Evaporator Demister (EMF-DMST-00001)*.

**Basis:** SVF-1778, Rev. 8, in the EMF-DMST-00001 worksheet.

### 3.17.4.18 EMF Concentrate Storage Vessel (EMF-VSL-00001A/B/C) Sample Hold Duration

**Unique ID:** BMR-EMF_TR-17

1. When sampling from the EMF Concentrate Storage Vessels (EMF-VSL-00001A/B/C) between the time 0700 and 1100, the sample hold time shall be 13 hours.
2. When sampling from the EMF Concentrate Storage Vessels (EMF-VSL-00001A/B/C) at any other time of day (i.e., not from 0700 to 1100), the sample hold time shall be 25 hours.

**Basis:** The hold times are per 24590-WTP-MRR-PENG-16-001, Rev. 0. When a sample is received too late in the day to complete analysis, the hold time is increased to allow completion of the analysis the next day.

### 3.17.4.19 EMF SBS Condensate Receipt Vessel (EMF-VSL-00002A/B) Start Transferring

**Unique ID:** BMR-EMF_TR-19

The EMF SBS Condensate Receipt Vessels (EMF-VSL-00002A and EMF-VSL-00002B) shall start transferring to the EMF Evaporator (EMF-SEP-00001) when their volume reaches 3,600 gal.

**Basis:** Enabling Assumption that allows at least 600 gallons of feed above the minimum vessel volume to accumulate prior to starting the feed to the EMF Evaporator.
3.18 WASTE TREATMENT AND IMMOBILIZATION PLANT HIGH-LEVEL WASTE VITRIFICATION FACILITY

The HLW Vitrification Facility converts the liquid high-level waste from the Tank Farms into molten glass. HLW Vitrification (HLW) in the HSM consists of the WTP HLW melter feed process and the HLW melter process. The basis for operation of the HLW melter feed process is to ensure adequate feed is provided at all times for all HLW melters in operation. The HLW melter operation, including all associated equipment and vessels, is modeled as a single melter train, having the total capacity of both HLW melters (each with its own associated equipment) that will be installed in the WTP.

In the HLW melter feed process, pretreated HLW slurry is delivered from the PT facility (HLP-VSL-00028, the HLW Feed Blending Vessel) into the HLW Melter Feed Preparation Vessels, HFP-VSL-00001_5 where it is sampled (the sampling of the HLW feed batch is not part of the HSM at this time) to determine the composition of glass formers required to achieve the minimum waste loading as specified by the WTP Contract.

HFP-VSL-00001_5 receives the HLW slurry and mixes the waste with glass formers delivered from the Glass Former Feed Hoppers, GFR-VSL-000025_31. This mixture is transferred to the HLW Melter Feed Vessels, HFP-VSL-00002_6. The feed to the HLW melter consists of a blended waste slurry (solids from ultrafiltration, strontium/transuranic elements precipitate, and cesium concentrate) mixed with glass formers. All volumes of material are continuously mechanically mixed to prevent the settling of solids.

The HLW Melter Feed Vessels provide continuous feed of HLW slurry to the HLW Melters (HMP-MLTR-00001_2 to meet the glass production rate. User-defined reference data sets the melter’s throughput rate in MTG/d. The rate at which the melter operates varies throughout the mission and is also specified by the user-defined reference data. The ramp rate is identified by the HSM requirements. The HSM compares the rate of glass production to the user-defined reference data every eight simulation hours. If the calculated value and set value do not match, the HSM adjusts the melter feed rate to maintain the desired production rate.

When feed enters the melter, the HSM applies a split to the liquid and gas components. The liquid split values apply to the liquid components that come into the melter. After the splits are applied, the reactions, as defined by the HSM requirements, are completed in the order given. The decomposition reactions are completed before the oxide reactions. Air is added to the melter to supply the O2 needed for the reactions.

Molten glass discharges from the melter when the glass level is above the set volume and is collected in the HLW Canister Accumulation Vessel, IHLW-CANISTERS. The number of canisters are tracked based on the mass accumulated in the HLW Canister Accumulation Vessel and dividing by the assumed glass density and canister volume. The HLW Canister Decontamination begins after the canister has been filled, its lid welded on, and any adhering glass has been removed from the canister surface. Canister decontamination waste effluents are
recycled to the Acidic Waste Vessel, RLD-VSL-00007, in the WTP PT facility Storage of the canisters is not modeled, but replacement of the melter is modeled.

### 3.18.1 System Requirements

#### 3.18.1.1 HLW Melter Feed Process

**Unique ID:** BMR-HLW_SR-1

The *HFP* shall prepare the *pretreated HLW slurry* to feed into *HMP*.

**Basis:** N/A

#### 3.18.1.2 HLW Melter Process (HMP)

**Unique ID:** BMR-HLW_SR-2

The *HMP* shall convert *HLW* into *IHLW glass* and route it to storage.

**Basis:** N/A

### 3.18.2 Functional Requirements

#### 3.18.2.1 HLW Melter Feed Receipt

**Unique ID:** BMR-HLW_FR-1

The *HFP* system shall have the capability of receiving *pretreated HLW slurry*.

**Basis:** N/A

#### 3.18.2.2 HLW Melter Feed Sampling

**Unique ID:** BMR-HLW_FR-10

The *HFP* shall have the capability to sample the *pretreated HLW slurry*.

**Basis:** N/A

#### 3.18.2.3 HLW Melter Feed Process

**Unique ID:** BMR-HLW_FR-2

The *HFP* shall have the capability to add glass formers to the *pretreated HLW slurry*.

**Basis:** N/A

#### 3.18.2.4 HLW Melter Feed Mixing

**Unique ID:** BMR-HLW_FR-9

The *HFP* shall have the capability to continuously agitate the mixture of *glass former* and *pretreated HLW slurry*.

**Basis:** N/A
3.18.2.5  HFP to HMP

Unique ID: BMR-HLW_FR-11

The HMP shall have the capability to receive the mixture of glass formers and pretreated HLW slurry from HFP.

Basis: N/A

3.18.2.6  HLW Melter Process

Unique ID: BMR-HLW_FR-3

The HMP shall have the capability to convert the mixture of glass formers and pretreated HLW slurry into molten glass.

Basis: N/A

3.18.2.7  HLW Glass Composition

Unique ID: BMR-HLW_FR-4

The HMP shall have the capability to produce IHLW glass product to meet the specifications in the WTP Contract Section C.8.

Basis: N/A

3.18.2.8  HLW Glass Packaging

Unique ID: BMR-HLW_FR-5

The HMP shall have the capability to pour glass melt into IHLW canisters.

Basis: N/A

3.18.2.9  HLW Glass Packaging Decontamination

Unique ID: BMR-HLW_FR-13

The HMP shall have the capability to decontaminate the IHLW canisters.

Basis: N/A

3.18.2.10  HLW Melter Offgas Stream

Unique ID: BMR-HLW_FR-7

The HMP shall have the capability to send melter offgas to the HOP.

Basis: N/A

3.18.2.11  HLW Melter Replacement

Unique ID: BMR-HLW_FR-8

The HMP shall have the capability to replace a melter, when it has become defective or reached the end of its useful life.

Basis: N/A
3.18.3 Model Requirements

3.18.3.1 HLW Melter Feed Preparation Vessel (HFP-VSL-00001_5)

Unique ID: BMR-HLW_MR-27

The HLW Melter Feed Preparation Vessel shall consist of one vessel identified as HFP-VSL-00001_5, which represents the combined capacity of the two HLW Melter Feed Preparation Vessels (HFP-VSL-00001 and HFP-VSL-00005).

Basis: The HLW melter system consists of two Melter Feed Preparation Vessels, HFP-VSL-00001 and HFP-VSL-00005. BARD Section 2.4.2.

3.18.3.2 HLW Glass Former Feed Hopper (GFR-TK-00025_31)

Unique ID: BMR-HLW_MR-31

HLW Glass Former Feed Hopper shall consist of one vessel identified as GFR-TK-00025_31, which represents the combined capacity of the two HLW Glass Former Feed Hoppers (GFR-VSL-00025 and GFR-VSL-00031).

Basis: The HLW glass former mixers (GFR-TK-00025/00031) receive blended glass formers from the HLW blending hopper (GFR-TK-00021) via the HLW transporter (GFR-VSL-00008). BARD 4.1.3.1.

3.18.3.3 HLW Melter Feed Glass Formulation Calculations

Unique ID: BMR-HLW_MR-30

Based on the HLP-VSL-00028 - HLW Feed Blending Vessel composition, the amount of glass formers to be added (as contained in Glass Former Mineral Addition model requirement) shall be calculated using the selected HLW Glass Model, subject to applicable property and composition constraints. Note that the glass models are part of the software and the actual mathematical model is tested separately.

Basis: Once HLP-VSL-00028 has been filled, the blended contents are held for sampling to determine the composition of the vessel prior to transfer to HLW vitrification. BARD Section 2.4.2.

3.18.3.4 HLW Feed Receipt from HLP

Unique ID: BMR-HLW_MR-28

HFP-VSL-00001_5 shall receive pretreated HLW slurry from HLP-VSL-00028.

Basis: The contents HLP-VSL-00028 are then discharged to the HLW feed preparation vessels (HFP-VSL-00001/00005) as discrete batches. BARD Section 2.4.2.

3.18.3.5 HLW Feed Preparation Vessel (HFP-VSL-00001_5) Fill Trigger

Unique ID: BMR-HLW_MR-29

HFP-VSL-00001_5 shall be capable of receiving batches, when the current volume is at the Lower Set Volume.
Basis: The set point to enable batch transfer is equal to the heel volume (24590-HLW-M6C-HFP-00001, HFP-VSL-00001, 00002, 00005, and 00006 Vessel Sizing Calculation). BARD 4.1.3.2.

3.18.3.6 HLW Melter Feed Preparation Vessel (HFP-VSL-00001_5) Batch Volume

Unique ID: BMR-HLW_MR-35

HFP-VSL-00001_5 shall stop receiving pretreated HLW slurry from HLP-VSL-00028, when the volume combined with the glass formers reaches the Batch Set Volume.

Basis: The MFPV will not process partial batch volumes during normal operating conditions. BARD Section 4.1.3.2.

3.18.3.7 HLW Melter Feed Preparation Vessel (HFP-VSL-00001_5) Glass Former Addition

Unique ID: BMR-HLW_MR-33

HFP-VSL-00001_5 shall receive blended glass formers from GFR-TK-00025_31 after HFP-VSL-00001_5 has received from HLP-VSL-00028.

Basis: Glass formers are added only after the waste concentrate has been added to the MFPV. BARD Section 4.1.3.1.

3.18.3.8 HLW Feed Preparation Vessel (HFP-VSL-00001_5) Glass Receipt Proportional Volume

Unique ID: BMR-HLW_MR-43

The glass formers shall be transferred to HFP-VSL-00001_5 in proportion with the volume fed to HFP-VSL-00001_5 from HLP-VSL-00028, such that the volume of glass formers and the volume of HLW feed is equal to the batch size. The batch size is the difference between the Lower Set Point Volume of HFP-VSL-00001_5 and the Upper Set Point Volume of HFP-VSL-00001_5.

Basis: Constituent volumes for each batch of glass former chemicals are determined by sample analysis of the MFPV contents. The constituents are pneumatically conveyed to GFR-TK-00025/00031, where they are weighed. Weighing ensures proper amounts are added to the MFPVs, thus contributing to waste composition compliance ... batch transfers are of volumes required for a batch volume. BARD Sections 4.1.3.1 and 4.1.3.2.

3.18.3.9 HLW Melter Feed Preparation Vessel (HFP-VSL-00001_5) Filled Volume

Unique ID: BMR-HLW_MR-34

HFP-VSL-00001_5 shall stop receiving glass formers when the volume reaches the Upper Set Volume.

Basis: HFP-VSL-00001/00005 receive HLW waste concentrate from the PT feed blend vessel HLP-VSL-00028. Batch transfers are of volumes required for a batch volume. BARD Section 4.1.3.2.
3.18.3.10  **HLW Melter Feed Preparation Vessel (HFP-VSL-00001_5) No Simultaneous Transfers**

**Unique ID:** BMR-HLW_MR-38

_HFP-VSL-00001_5_ shall not receive while transferring to _HFP-VSL-00002_6.

**Basis:** The MFPVs, HFP-VSL-00001/00005, are the center of the HLW melter feed systems because the concentrate and glass former streams are mixed there, and it is the waste compliance hold point. BARD Section 4.1.3. Adding material to the MFPVs would compromise the analytical results associated with a sampled batch.

3.18.3.11  **HLW Melter Feed Preparation Vessel (HFP-VSL-00001_5) Transfer Complete**

**Unique ID:** BMR-HLW_MR-44

The _HFP-VSL-00001_5 - HLW Melter Feed Process System Vessels_ shall complete transfers to _HFP-VSL-00002_6 - HLW Melter Feed Process System Vessels, when its volume is at the Lower Set Volume.

**Basis:** The setpoint for receipt of feed from the MFPV during continual operations is equal to the heel volume plus the instrument uncertainty volume. BARD Section 4.1.3.3.

3.18.3.12  **HLW Melter Feed Preparation Vessel (HFP-VSL-00001_5) Routing**

**Unique ID:** BMR-HLW_MR-37

After _HFP-VSL-00001_5 has received _glass formers_ from _GFR-VSL-00022_23_ it shall discharge to the _HFP-VSL-00002_6 - HLW Melter Feed Process System Vessels_ at the vessels pump rate.

**Basis:** The MFPVs mix the glass formers from the HLW glass former feed mixers with the HLW concentrate from the HLW feed blend vessels. After adequate mixing of glass formers and feed water, the waste batch is again sampled and analyzed for waste compliance. Each vessel has two mechanical pumps to transfer waste to the associated HLW MFV, with a side stream diverted to an autosampler. BARD Section 4.1.2.

3.18.3.13  **HLW Melter Feed Vessel (HFP-VSL-00002_6)**

**Unique ID:** BMR-HLW_MR-36

The HLW Melter Feed Vessel shall consist of one vessel identified as _HFP-VSL-00002_6, which represents the combined capacity of the two HLW Melter Feed Vessels (HFP-VSL-00002 and HFP-VSL-00006).

**Basis:** The HLW MFVs (HFP-VSL-00002/00006) supply continual feed to the associated HLW melter for each batch of feed prepared. BARD Section 4.1.3.3.

3.18.3.14  **HLW Melter Feed Vessel (HFP-VSL-00002_6) Receipt Source**

**Unique ID:** BMR-HLW_MR-45

The _HFP-VSL-00002_6 - HLW Melter Feed Process System Vessels_ shall receive feed from the _HFP-VSL-00001_5.
**Basis:** Section BARD Section 4.1.3.3 describes the *HFP-VSL-00002_6 - HLW Melter Feed Process System Vessels* operation.

### 3.18.3.15 HLW Melter Feed Vessel (LFP-VSL.00002_6) Receipt Trigger

**Unique ID:** BMR-HLW_MR-53

The *HFP-VSL-00002_6 - HLW Melter Feed Process System Vessels* shall be able to fill when the volume is below the lower set volume.

**Basis:** This model requirement is in Section 4.8.17 HLW Feed Preparation Process (HFP) System in 24590-WTP-MDD-PR-01-002, WTP MDD.

### 3.18.3.16 HLW Melter Feed Vessel (HFP-VSL-00002_6) Simultaneous Transfers

**Unique ID:** BMR-HLW_MR-54

The *HFP-VSL-00002_6 - HLW Melter Feed Process System Vessels* shall discharge continuously to the *HMP-MLTR-00001_2 - HLW Melter* while receiving from HFP-VSL-00001_5 - HLW Melter Feed Process System Vessels.

**Basis:** This model requirement is in Section 4.8.17 HLW Feed Preparation Process (HFP) System in 24590-WTP-MDD-PR-01-002, WTP MDD.

### 3.18.3.17 HLW Melter Feed Vessel (LFP-VSL.00002_6) Complete Filling

**Unique ID:** BMR-HLW_MR-58

The *HFP-VSL-00002_6 - HLW Melter Feed Process System Vessels* shall fill to between the set volume and the upper set volume.

**Basis:** This model requirement is in Section 4.8.17 HLW Feed Preparation Process (HFP) System in 24590-WTP-MDD-PR-01-002, WTP MDD.

### 3.18.3.18 HLW Melter Feed Vessel (HFP-VSL-00002_6) Transfer Complete

**Unique ID:** BMR-HLW_MR-55

The *HFP-VSL-00002_6 - HLW Melter Feed Process System Vessels* shall not transfer below the minimum volume.

**Basis:** This model requirement is found in Section 4.8.17 HLW Feed Preparation Process (HFP) System in 24590-WTP-MDD-PR-01-002, WTP MDD Rev. 13.

### 3.18.3.19 HLW Melter Feed Vessel (LFP-VSL-00002_6) Discharge Rate

**Unique ID:** BMR-HLW_MR-57

The *HFP-VSL-00002_6 - HLW Melter Feed Process System Vessels* shall discharge at the *HLW Melter Variable Rate*.

**Basis:** This model requirement is found in Section 4.8.17 HLW Feed Preparation Process (HFP) System in 24590-WTP-MDD-PR-01-002, WTP MDD Rev. 13.
3.18.3.20  
**HLW Melter (HMP-MLTR-00001_2)**

**Unique ID:** BMR-HLW_MR-39

The HLW Melters shall consist of one melter identified as HMP-MLTR-00001_2, which represents the combined throughput capacity of two HLW Melters (HMP-MLTR-00001 and HMP-MLTR-00002).

**Basis:** There are two Melters, HLW-MLTR-00001/2. BARD Figure 4.2-1.

3.18.3.21  
**HLW Melter Receipt Source**

**Unique ID:** BMR-HLW_MR-40

HMP-MLTR-00001_2 shall receive from HFP-VSL-00002_6.

**Basis:** Feed rate to the melter is determined by the solids content and waste loading of the feed batch. BARD Section 4.1.3.3.

3.18.3.22  
**HLW Melter Vapor-Melt Split**

**Unique ID:** BMR-HLW_MR-46

The amount of contaminants carried into the melter offgas from HMP-MLTR-00001_2 shall be calculated from split factors, after HFP-VSL-00002_6 has transferred to HMP-MLTR-00001_2.

**Basis:** The waste and glass forming additives enter through the top of the melter as a slurry. The slurry quickly dries and forms a cold cap on the molten glass pool. Heat decomposes the cold cap into elemental oxides (and other minor constituents) that dissolve into the glass pool and exit as glass product along with gases (with evaporated water) that exit the melter plenum to the film cooler. In-leakage air eventually enters the melter plenum and exits with the other gases to the film cooler. Dusting caused by drying of the cold cap and splatter also enters the offgas. BARD 4.2.3.3.2.

3.18.3.23  
**HLW Melter Air Input**

**Unique ID:** BMR-HLW_MR-41

Air shall enter HMP-MLTR-00001_2 by bubblers and in-leakage to complete melter reactions.

**Basis:** There are various air streams into the melter and the melter offgas system. These streams include the following: (BARD Section 4.2.2)

- Air in-leakage to the melter caused by operating the melter under vacuum (rate of in-leakage depends on the melter condition and the vacuum applied)
- Air from the operation of the bubblers and other equipment
- Air into the film cooler
- Control air introduced to control melter pressure

3.18.3.24  
**HLW Melter Reactions**

**Unique ID:** BMR-HLW_MR-51

The glass melter reactions shall be applied to the contents of HMP-MLTR-00001_2 after the melter splits have occurred.
Basis: The feed typically forms a cold cap that transitions from a liquid (slurry), to solid, to molten glass. Chemical reactions take place in different regions of this cold cap, including steam generation from boiling of the water component of the slurry feed; burning off of organics, including sugar (added to the waste and glass former chemicals to reduce NOx); oxidation of waste and glass formers; and dissolution of oxidized waste and glass former chemicals to form molten glass. BARD Section 4.2.3.3.3.

3.18.3.25 HLW Spent Melter Collection

Unique ID: BMR-HLW_MR-42

_HMP-MLTR-00001_2 shall send its contents to FAILED-HLW MELTERS vessel at regular intervals as a simplification to simulate melter replacement.

Basis: A design life of minimum 5-years for each melter is documented in 24590-HLW-3PS-AE00-T0001, Rev 3.

3.18.3.26 HLW Melter Offgas to HOP Submerged Bed Scrubber

Unique ID: BMR-HLW_MR-47

_HMP-MLTR-00001_2 shall route the melter offgas to the HOP-SCB-00001_2, after splits and reactions have been applied.

Basis: The melter generates gases that are drawn from the melter into the HLW melter offgas treatment process system (HOP) starting with the Film Cooler HOP-FCLR-00001/2 and then into the Submerged Bed Scrubber HOP-SCB-00001/2. BARD Figure 4.2-1.

3.18.3.27 HLW Melter Glass Discharge

Unique ID: BMR-HLW_MR-48

The _HMP-MLTR-00001_2 shall continuously transfer the molten glass into _IHLW_ containers when the volume reaches above the _HMP-MLTR-00001_2 Set Volume.

Basis: When to start and stop a glass pour is determined based on the glass pool level. When to start and stop a melter glass discharge is determined by using a level detector so that the level of glass in the melter is relatively constant. BARD Section 4.2.3.6.

3.18.3.28 HLW Glass Packaging Counting

Unique ID: BMR-HLW_MR-49

The _IHLW_ glass containers shall be counted as they are transferred out of _HMP-MLTR-00001_2.

Basis: For flowsheet modeling purposes, to provide consistency and avoid confusion between glass densities and canister wall thickness, the WTP models will use 3000 kg HLW glass per canister. BARD Section 4.2.3.6.

3.18.3.29 HLW Canister Decontamination Secondary Waste

Unique ID: BMR-HLW_MR-50

When a _IHLW_ glass canister has been filled, a chemical addition shall be sent to _RLD-VSL-00007_ representing canister decontamination.
**Basis:** The HLW canister decontamination begins after the canister has been filled, its lid welded on, and any adhering glass has been removed from the canister surface. The canister is initially washed with 45 psig plant wash water to remove any loose contamination that may be spread into the C3 decontamination/swabbing cave from the C5 handling cave. The water wash is performed in the canister rinse bogie vessel, HDH-VSL-00001 (mounted on a bogie), which travels from below the handling cave to below the decontamination cave. After the water wash, the canister is placed in one of two canister decontamination vessels (HDH-VSL-00002/00004). The HLW canister is further decontaminated by chemically milling about 0.00039 in. (10 μm) of stainless steel from the canister surface using a heated cerium (IV) nitrate bath, a 6-hr process. Following the cerium nitrate milling process, the canister is rinsed with nitric acid and then with demineralized water.

After drying, the canister is swabbed to verify that its smearable contamination level meets the requirements of IHLW. It is then transferred to the canister storage racks. The decontamination vessel waste solution batches (from the milling, nitric acid rinse, and water rinse) are transferred to the waste neutralization vessel, HDH-VSL-00003.

The wastewater from the canister rinse bogie vessel is also transferred to the waste neutralization vessel. A small amount of hydrogen peroxide is added to the waste neutralization vessel to reduce any remaining cerium nitrate to a non-reactive form. Then the entire contents of the waste neutralization vessel are transferred to the acidic waste vessel, RLD-VSL-00007. BARD Section 4.6.2

### 3.18.3.30 HLW Melter (HMP-MLTR-00001\_2) Idle Mode

**Unique ID:** BMR-HLW_MR-59

The *HMP-MLTR-00001\_2 - HLW Melter* is in idle mode when the following conditions occur:

- *HMP-MLTR-00001\_2 - HLW Melter* has reached its minimum volume, and
- No additional combined HLW feed and glass formers are available,(i.e. that HFP-VSL-00002\_6 - HLW Melter Feed Process System Vessels is at its minimum volume), and
- *HMP-MLTR-00001\_2 - HLW Melter* has stopped discharging molten glass into the IHLW-CANISTERS collection vessel.

**Basis:** This model requirement is found in Section 4.8.17 HLW Feed Preparation Process (LFP) System in 24590-WTP-MDD-PR-01-002, WTP MDD Rev. 13 where it states that "the only time that an HLW MFV will stop pumping to the melter is when there is no feed available from the HLW MFPV and the HLW MFV is at its minimum volume."

### 3.18.4 Technical Requirements

#### 3.18.4.1 HLW Feed Preparation Vessel Parameters

**Unique ID:** BMR-HLW_TR-5

*HFP-VSL-00001\_5 shall have the following parametric values.
### 3.18.4.2 HLW Glass Former Mixer Parameters

**Unique ID:** BMR-HLW_TR-7

$GFR-TK-00025_31$ shall have the following parametric values:

<table>
<thead>
<tr>
<th>Vessel Number</th>
<th>Max/Set Volume (gal)</th>
<th>Minimum Volume (gal)</th>
<th>Effluent Rate (to $HFP-VSL-00001_5$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$GFR-TK-00025_31$</td>
<td>2394 gal</td>
<td>0 gal</td>
<td>33.3 gpm</td>
</tr>
</tbody>
</table>

**Basis:** BARD Section 4.1.3.1. $320 \text{ ft}^3 = 2394 \text{ gal}; 267 \text{ ft}^3/\text{hr} = 33.3 \text{ gpm}$

### 3.18.4.3 HLW Glass Property Constraints (Glass Model)

**Unique ID:** BMR-HLW_TR-4

The properties and composition of the glass shall be calculated from any one of the following: the *PNNL 2009* model, the *PNNL 2013* model, or the *PNNL 2016* model. The default model will use the PNNL 2013 glass model.

**Basis:** The 2016 model is complex relative to the 2013 model and does not make a large difference in waste oxide loading.

### 3.18.4.4 HLW Melter Feed Vessel (HFP-VSL-00002_6) Parameters

**Unique ID:** BMR-HLW_TR-6

$HFP-VSL-00002_6$ shall have the following parametric values.

<table>
<thead>
<tr>
<th>Vessel Name</th>
<th>Max Volume (gal)</th>
<th>Upper Set Volume (gal)</th>
<th>Set Volume (gal)</th>
<th>Min Volume (gal)</th>
<th>Effluent Flowrate (to $HMP-MLTR-00001_2$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$HFP-VSL-00002_6$</td>
<td>7,646</td>
<td>7,208</td>
<td>1,625</td>
<td>1,543</td>
<td>Variable</td>
</tr>
</tbody>
</table>

*Where the Batch Volume is the difference between the Upper Set Volume and the Lower Set Volume.*
**Basis:** BARD Section 4.1.3.3.

### 3.18.4.5 HLW Melter Parameters

**Unique ID:** BMR-HLW_TR-9

*HMP-MLTR-00001_2* shall have the following parametric values.

<table>
<thead>
<tr>
<th>Vessel number</th>
<th>Max Volume (gal)</th>
<th>Upper Set Volume (gal)</th>
<th>Set Volume (gal)</th>
<th>Min Volume (gal)</th>
<th>Pump Rate (gpm)</th>
<th>Temperature (glass melt)</th>
<th>Design Capacity*</th>
</tr>
</thead>
<tbody>
<tr>
<td>HMP-MLTR-00001_2</td>
<td>1,217</td>
<td>1,092</td>
<td>1,067</td>
<td>1,067</td>
<td>250</td>
<td>1150°C</td>
<td>6 MT/day</td>
</tr>
</tbody>
</table>

*Design capacity does not include 70% TOE

**Basis:** Upper Set Volume is from BARD Section 4.2.3.2. When to start and stop a glass pour is determined based on the glass pool level. Working depth of the glass pool is at 44 in. The operating band of the pool depth is approximately 1 in. Cycle time between glass pours (start to start) depends on glass production rate and the level in the melter. When to start and stop a melter glass discharge is determined by using a level detector so that the level of glass in the melter is relatively constant. BARD Section 4.2.3.6.

### 3.18.4.6 HLW Glass Melt Reactions

**Unique ID:** BMR-HLW_TR-1

The reaction in the glass melt shall include the following in the order listed, with the extent of reaction as written.

<table>
<thead>
<tr>
<th>Reaction Name</th>
<th>Extent of Reaction</th>
</tr>
</thead>
<tbody>
<tr>
<td>OD-22</td>
<td>1.0</td>
</tr>
<tr>
<td>OD-1</td>
<td>1.0</td>
</tr>
<tr>
<td>CL-NA-REACTION</td>
<td>0.7353</td>
</tr>
<tr>
<td>F-NA-REACTION</td>
<td>0.8065</td>
</tr>
<tr>
<td>HG-TO-GAS-REACTION</td>
<td></td>
</tr>
<tr>
<td>129-I-TO-GAS</td>
<td>0.7692</td>
</tr>
<tr>
<td>Reaction Name</td>
<td>Extent of Reaction</td>
</tr>
<tr>
<td>-------------------------------</td>
<td>--------------------</td>
</tr>
<tr>
<td>NO3-DECOMPOSITION-VARIABLE</td>
<td>Dynamic**</td>
</tr>
<tr>
<td>NO2-DECOMPOSITION-VARIABLE</td>
<td>Dynamic**</td>
</tr>
<tr>
<td>HLW-SO4-DECOMPOSITION</td>
<td>0.5814</td>
</tr>
<tr>
<td>CR-OXIDE</td>
<td>1.0</td>
</tr>
<tr>
<td>CR-OXIDE2</td>
<td>1.0</td>
</tr>
<tr>
<td>CN-DECOMPOSITION</td>
<td>1.0</td>
</tr>
<tr>
<td>CO3-DECOMPOSITION</td>
<td>1.0</td>
</tr>
<tr>
<td>NEUT-REACTION</td>
<td>1.0</td>
</tr>
<tr>
<td>NEUT-REACTION2</td>
<td>1.0</td>
</tr>
<tr>
<td>BOIL-WATER-REACTION</td>
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</tr>
<tr>
<td>BOIL-3-H-REACTION</td>
<td>1.0*</td>
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<tr>
<td>H2O2-DECOMPOSITION</td>
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<tr>
<td>NH3-DECOMPOSITION</td>
<td>1.0</td>
</tr>
<tr>
<td>NH4-DECOMPOSITION</td>
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<tr>
<td>OH-DECOMPOSITION</td>
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<tr>
<td>Reaction Name</td>
<td>Extent of Reaction</td>
</tr>
<tr>
<td>------------------------</td>
<td>--------------------</td>
</tr>
<tr>
<td>OH-DECOMPOSITION2</td>
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<tr>
<td>O-BOUND-TO-GAS</td>
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<td>AL-OXIDE</td>
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<tr>
<td>AL-OXIDE2</td>
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</tr>
<tr>
<td>AL-OXIDE3</td>
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<tr>
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<td>241-AM-OXIDE</td>
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<tr>
<td>AS-OXIDE</td>
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<tr>
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<tr>
<td>137M-BA-OXIDE</td>
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<tr>
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<td>1.0</td>
</tr>
<tr>
<td>BE-OXIDE</td>
<td>1.0</td>
</tr>
<tr>
<td>BI-OXIDE</td>
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<tr>
<td>Reaction Name</td>
<td>Extent of Reaction</td>
</tr>
<tr>
<td>---------------</td>
<td>--------------------</td>
</tr>
<tr>
<td>243-CM-OXIDE</td>
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<tr>
<td>244-CM-OXIDE</td>
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<td>60-CO-OXIDE</td>
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<td>129-I-OXIDE</td>
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<tr>
<td>K-OXIDE</td>
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<tr>
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<tr>
<td>MG-OXIDE</td>
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<tr>
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</tr>
<tr>
<td>MN-OXIDE2</td>
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<td>Reaction Name</td>
<td>Extent of Reaction</td>
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<td>---------------------</td>
<td>--------------------</td>
</tr>
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<td>MN-OXIDE3</td>
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<tr>
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<tr>
<td>NA-OXIDE</td>
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<td>93M-NB-OXIDE</td>
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<td>PR-OXIDE</td>
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<tr>
<td>Reaction Name</td>
<td>Extent of Reaction</td>
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<tr>
<td>---------------</td>
<td>--------------------</td>
</tr>
<tr>
<td>RH-OXIDE</td>
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<tr>
<td>106-RU-OXIDE</td>
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<tr>
<td>RU-OXIDE</td>
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<tr>
<td>S-OXIDE</td>
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<tr>
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<tr>
<td>79-SE-OXIDE</td>
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<tr>
<td>SI-OXIDE</td>
<td>1.0</td>
</tr>
<tr>
<td>151-SM-OXIDE</td>
<td>1.0*</td>
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<tr>
<td>126-SN-OXIDE</td>
<td>1.0*</td>
</tr>
<tr>
<td>90-SR-OXIDE</td>
<td>1.0*</td>
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<td>SR-OXIDE</td>
<td>1.0</td>
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<tr>
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<tr>
<td>99-TC-OXIDE</td>
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<tr>
<td>TE-OXIDE</td>
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</tr>
<tr>
<td>229-TH-OXIDE</td>
<td>1.0*</td>
</tr>
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</tr>
<tr>
<td>TI-OXIDE</td>
<td>1.0</td>
</tr>
<tr>
<td>TL-OXIDE</td>
<td>1.0</td>
</tr>
<tr>
<td>232-U-OXIDE</td>
<td>1.0*</td>
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</table>
### Reaction Name Extent of Reaction

<table>
<thead>
<tr>
<th>Reaction Name</th>
<th>Extent of Reaction</th>
</tr>
</thead>
<tbody>
<tr>
<td>233-U-OXIDE</td>
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<tr>
<td>234-U-OXIDE</td>
<td>1.0*</td>
</tr>
<tr>
<td>235-U-OXIDE</td>
<td>1.0*</td>
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<td>236-U-OXIDE</td>
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<tr>
<td>Y-OXIDE</td>
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</tr>
<tr>
<td>ZN-OXIDE</td>
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<tr>
<td>93-ZR-OXIDE</td>
<td>1.0*</td>
</tr>
<tr>
<td>ZR-OXIDE</td>
<td>1.0</td>
</tr>
</tbody>
</table>

*For radionuclides, the reactions are done by moving the radionuclide to the oxide array and adding the stoichiometrically appropriate amount of bound oxygen for each. Tracking the radionuclides in this way simplifies the decay calculations.

**The reaction coefficients are dynamically calculated.**

**Basis:** Reactions in the melter are discussed in the BARD Section 4.2.3.3.3.

#### 3.18.4.7 HLW Glass Melt NOx Stoichiometry Data

**Unique ID:** BMR-HLW_TR-2

The stoichiometric coefficients shall effect the split of the NO\textsubscript{3}\textsuperscript{-} and NO\textsubscript{2}\textsuperscript{-} decomposition reactions. The stoichiometric coefficients for the NO\textsubscript{3}\textsuperscript{-} and NO\textsubscript{2}\textsuperscript{-} decomposition reactions are listed in the following table. The value of M is based on pH.
Stoichiometric Coefficients for the $\text{NO}_3^-$ and $\text{NO}_2^-$ Decomposition Reactions.

<table>
<thead>
<tr>
<th>Reaction Number</th>
<th>Value</th>
<th>Reaction Number</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>r11</td>
<td>1</td>
<td>r21</td>
<td>1</td>
</tr>
<tr>
<td>r12</td>
<td>$0.03623 \times M$</td>
<td>r22</td>
<td>$0.03623 \times M$</td>
</tr>
<tr>
<td>p11</td>
<td>$0.2546-0.0121 \times (M-1)$</td>
<td>p21</td>
<td>$0.2546-0.0121 \times (M-1)$</td>
</tr>
<tr>
<td>p12</td>
<td>1.4239</td>
<td>p22</td>
<td>1.4239</td>
</tr>
<tr>
<td>p13</td>
<td>0.04277</td>
<td>p23</td>
<td>0.04277</td>
</tr>
<tr>
<td>p14</td>
<td>$0.024154 \times M$</td>
<td>p24</td>
<td>$0.024154 \times M$</td>
</tr>
<tr>
<td>p15</td>
<td>$1.01339+0.0181 \times (M-1)$</td>
<td>p25</td>
<td>$1.01339+0.0181 \times (M-1)$</td>
</tr>
</tbody>
</table>

Basis: Reactions in the melter are discussed in Section 4.2.3.3.3 of the BARD.

3.18.4.8 HLW Glass Melt and SBS pH Correlation

Unique ID: BMR-HLW_TR-3

The "M" variable in the Glass Melt Reactions shall be based on the pH value in HOP-SCB-00001_2 in the HOP system. The "M" value shall be determined from the following table.
Variable “M” Lookup Table.

<table>
<thead>
<tr>
<th>Current pH</th>
<th>M</th>
<th>Current pH</th>
<th>M</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH &lt;= 3.0</td>
<td>1.05</td>
<td>7.0 &lt; pH &lt;= 7.5</td>
<td>0.99999</td>
</tr>
<tr>
<td>3.0 &lt; pH &lt;= 4.0</td>
<td>1.01</td>
<td>7.5 &lt; pH &lt;= 8.0</td>
<td>0.9999</td>
</tr>
<tr>
<td>4.0 &lt; pH &lt;= 5.0</td>
<td>1.005</td>
<td>8.0 &lt; pH &lt;= 9.0</td>
<td>0.999</td>
</tr>
<tr>
<td>5.0 &lt; pH &lt;= 6.0</td>
<td>1.001</td>
<td>9.0 &lt; pH &lt;= 10.0</td>
<td>0.995</td>
</tr>
<tr>
<td>6.0 &lt; pH &lt;= 6.5</td>
<td>1.0001</td>
<td>10.0 &lt; pH &lt;= 11.0</td>
<td>0.99</td>
</tr>
<tr>
<td>6.5 &lt; pH &lt;= 7.0</td>
<td>1.00001</td>
<td>11.0 &lt; pH</td>
<td>0.95</td>
</tr>
</tbody>
</table>

**Basis:** Reactions in the melter and their relationship to SBS pH are discussed in Section 4.2.3.3.3 of the BARD.

### 3.18.4.9 HLW Melter Start Date

**Unique ID:** BMR-HLW_TR-11

*HMP-MLTR-00001_2* shall receive from *HFP-VSL-00002_6* starting 12/31/2033.

**Basis:** AMENDED CONSENT DECREE BETWEEN DEPARTMENT OF ENERGY AND STATE OF WASHINGTON

### IV. WORK TO BE PERFORMED AND SCHEDULE

**A. Waste Treatment Plant (WTP) Construction and Startup.**

1. In accordance with Appendix A to this Decree, DOE shall achieve “Hot Start of Waste Treatment Plant” by December 31, 2033, and achieve “initial plant operations” of the WTP no later than December 31, 2036.

2. “Hot Start of Waste Treatment Plant” means the initiation of simultaneous operation of the Pretreatment (PT) Facility, High-level Waste (HLW) Facility and Low-activity Waste (LAW) Facility ...
3.18.4.10 HLW Melter Ramp Rate

**Unique ID:** BMR-HLW_TR-12

*HMP-MLTR-00001_2* shall have the following ramp rate:

<table>
<thead>
<tr>
<th>Time Transition Occurs</th>
<th>Rate (MT/day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial Startup</td>
<td>3.0</td>
</tr>
<tr>
<td>12 months after Startup</td>
<td>4.0</td>
</tr>
<tr>
<td>33 months after Startup</td>
<td>4.2</td>
</tr>
<tr>
<td>5 years to Balance of Mission</td>
<td>5.25</td>
</tr>
</tbody>
</table>

**Basis:** These rates were verbally selected by WRPS, ORP, and BNI on approximately 10/1/2014. No basis was given on why these rates were chosen or if they are to supercede the contractual hot commissioning requirements. e-mail from C. Harrington (ORP) to L. Thompson, Strategic Plan Assumptions, 10/2/2014. The ramp up rates match those used in ORP-11242, Rev. 6. The ramp dates use an even interval to meet the requirement of starting operation on 12/31/2031 and reaching 70% TOE by 12/31/2034, using the original melters, and 70% TOE with replacement melters by 12/31/2036.

3.18.4.11 HLW Melter Variable Rate

**Unique ID:** BMR-HLW_TR-17

*HMP-MLTR-00001_2* shall have the following rate:

\[
\text{Melter Rate} = \min(\text{Ramp Rate, TOE} \times N_{\text{melters}} \times [0.0080 \times \text{Yield} + 1.40]) \text{ MTG/day}
\]

Where

- Ramp Rate is the HLW melter ramp rate.
- TOE is the Total Operating Efficiency of the process, 0.7.
- \(N_{\text{melters}}\) is the number of melters in the facility, 2.
- Yield is the mass of glass per volume of feed, (grams waste oxides + grams glass formers oxides)/ liters slurry.

Note: The melter rate equation assumes each melter has 7 bubblers.

**Basis:** BARD Section 4.2.3.4.1.

3.18.4.12 HLW Melter Process Splits

**Unique ID:** BMR-HLW_TR-13

*HMP-MLTR-00001_2* shall split components in the melt to the *melter offgas* using the split factors listed SVF-1778 from the tab labeled "HMP-MLTR-00001-2".
3.18.4.13  HLW Melter Air In-Leakage Flowrates

**Unique ID:** BMR-HLW_TR-14

The *air* added to the *HMP-MLTR-00001_2* shall have a flowrate of 711.5 scfm (measured in standard conditions: 20°C and 1 atm).

**Basis:** According to Section 4.2.3.3.1 of the BARD, the WTP flowsheet uses following melter air input values (All scfm flowrates are at 20°C and 1 atm):

- Melter air in-leakage: 160 scfm (dry) - Water vapor in air: 0.015 lb H₂O/lb dry air
- Melter fixed air addition: 32 scfm (bubbler air not included)
- Bubbler air: 10.5 scfm
- Pressure control air: 200 scfm (part of HOP system)

3.18.4.14  HLW Packaging Parameters

**Unique ID:** BMR-HLW_TR-15

The *IHLW* Glass Container shall have the following parameters:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Volume (3/8-inch Canister) 100% fill</td>
<td>313.2 gal (1.1856 M³)</td>
</tr>
<tr>
<td>Volume at 95% fill</td>
<td>297.7 gal (1.1270 M³)</td>
</tr>
<tr>
<td>Glass Mass (95% fill)</td>
<td>3.00 MT</td>
</tr>
<tr>
<td>Average Glass Density - No bubbles</td>
<td>2.66 MT/m³ at 20°C</td>
</tr>
<tr>
<td>Temperature (glass pour)</td>
<td>1150 °C</td>
</tr>
</tbody>
</table>

The canisters are assumed to be filled to 95% capacity.

**Basis:** BARD Section 4.2.3.6.

3.18.4.15  HLW Melter Replacement Interval

**Unique ID:** BMR-HLW_TR-16

*HMP-MLTR-00001_2* shall send 823 gal to *FAILED-HLW MELTERS* vessel every 2.5 years after start-up. The transfer shall be instantaneous and have the same density as the glass in the melter.

**Basis:** A HLW melter disposal every 2.5-years is based on minimum replacement rotation time between the two melter with a minimum 5-year design life for each melter, when one of the two melters reaches the 5-year design life.

Design life of minimum 5-years for each melter is documented in 24590-HLW-3PS-AE00-T0001, Rev 3. The glass volume remaining in each HLW melter at 823-gal is the difference
between total volume of 5366 liter for a HLW corroded melter with maximum glass level of 48.8 inches, and volume of 2250 liters for maximum pour volume when operating at maximum glass level documented in CCN 102476. Corroded melter total glass volume at 5266 liters (minus) maximum pour volume of 2250 liters = 3116 liters or 823 gallons of remaining HLW glass heel at melter disposal time.

The volume of 3116 liters or 823 gallons allows for increased glass pool volume caused by refractory corrosion/dissolution. No source document about replacing HLW melter glass heel with cold melter glass prior to removal from service, and quantifying the volume of HLW glass replaced by cold glass was found. A time averaged annual total operating efficiency is assumed to encompass periodic and intermittent spent melter change down time. The plenum is an integral part of the melter and can’t be removed without major demolition-type activities. No data on the amount of residual source term deposit on the plenum after 5 years of melter operation was found to quantify the source term concentration. It is expected the quantity of source term deposited on plenum is significantly smaller than 823 gallons HLW waste glass TOPSim uses as remaining in the melter at the disposal time.

3.18.5 HLW Figures and Diagrams

3.18.5.1 HLW Melter Flow Diagram

**Unique ID:** BMR-HLW_FIG-1
3.18.5.2 HLW Melter Feed Preparation Detail

Unique ID: BMR-HLW_FIG-2

3.19 WASTE TREATMENT AND IMMOBILIZATION PLANT HIGH-LEVEL WASTE VITRIFICATION MELTER OFFGAS TREATMENT PROCESS

The function of the HLW offgas process system (HOP) is to treat gases generated primarily by the HLW melter and the vessel vent system. Treatment of these gases allows an environmentally compliant release to the atmosphere. The HOP is divided into two sections; the primary offgas treatment system and the secondary offgas treatment system. The HOP has separate systems for decontamination of the offgas from each melter, however the HSM models the systems as a single train.

The melter offgas from HMP-MLTR-00001_2 enters the HLW Submerged Bed Scrubber (SBS), HOP-SCB-00001_2. The SBS functions to remove particulates from the melter offgas and also cools the offgas to a desired temperature using chilled water. In the HSM split factors are applied to the solid, liquid and gas components entering the SBS from the melter. The fractions of components that are split are sent to the Wet Electrostatic Precipitator (WESP), HOP-WESP-00001_2, while the remaining components undergo a series of reactions provided in the HSM requirements. After the reactions have completed, the pH of the SBS solution is calculated and the calculated value is used in the HLW melter to determine the NH3 generation. A second set of reactions take place once the pH is determined and that forces the SBS to a neutral pH. All gas components remaining after the reactions have completed are transferred to the WESP and the liquid and solid components remain in the SBS.

The SBS is designed to remain constant at the set point, volume greater than the set volume is transferred to the HLW SBS Condensate Receiver Vessel, HOP-VSL-00903_4, which also
receives condensate from the HLW WESP and the HLW HEME. HOP-VSL-00903_4 discharges once it fills to its set point back to the SBS, which then triggers a subsequent SBS discharge to the Acidic Waste Vessel, RLD-VSL-00007.

The WESP receives from the SBS and the HSM applies splits to the liquid, solid, and gas components of the stream. The components then undergo a series of reactions listed in the HSM requirements. As the saturated stream from the SBS passes through the WESP, they are divided into a condensable portion and a non-condensable portion. The condensable portion accumulates in the HLW SBS Condensate Receiver Vessel, HOP-VSL-00903_4. The non-condensable entrained solids, liquids, and gases exit the WESP and pass to the HEME at saturation conditions.

Gases that leave HOP-WESP-00001_2 are routed to the High-Efficiency Mist Eliminator (HEME), HOP-HEME-00001_2. In the HSM split factors are applied to the components entering the HEME, and then the reactions listed in the HSM requirements are applied. All gas components remaining after the reactions have completed are discharge at saturation conditions to the HEPA filters, while the liquid condensate is discharged to the HLW SBS Condensate Receiver Vessel, HOP-VSL-00903_4.

The HEPA filtration system, HOP-HEPA-00001-2AB_7-8AB receives offgas from the HOP HEME where the split components accumulate on the HEPA. The accumulation factor for most components is 99.99994% for the HEPA. The components that pass through the HEPA filters go to the activated carbon absorber, HOP-ADBR-00001_2AB, which uses two carbon absorbers in series to remove mercury from the offgas. The splits for the carbon absorber define how much liquid, solid, and gas from the entering stream accumulates within the unit, and the remainder continues on to the Silver Mordenite Absorption Column, HOP-ABS-00002_3. The HSM models the column as accumulating contaminants based on the split factors listed in the HSM requirements.

The treated offgas exits HOP-ABS-00002_3 and routes to the HLW NOx Selective Catalytic Converter, HOP-SCR-00001_2. Its primary purpose is to remove NO and NO2 from the offgas. NH3 gas is added as necessary based on the amount of NO, NO2 and NH3 entering HOP-SCR-00001_2. After the splits and reactions have been applied, the offgas is discharged to the HLW-OFFGAS-STACK.

3.19.1 System Requirements

3.19.1.1 HLW Melter Offgas Process (HOP)

Unique ID: BMR-HOP_SR-1

The HOP shall receive melter offgas from the HMP system and provide treatment in order to meet facility liquid and gaseous effluent discharge limits.

Basis: N/A
3.19.2 Functional Requirements

3.19.2.1 HOP Particulate Removal
Unique ID: BMR-HOP_FR-1
The HOP shall have the capability to remove particulates from the melter offgas.
Basis: N/A

3.19.2.2 HOP Aerosols Removal
Unique ID: BMR-HOP_FR-9
The HOP shall have the capability to remove aerosols from the melter offgas.
Basis: N/A

3.19.2.3 HOP Cooling
Unique ID: BMR-HOP_FR-8
The HOP shall have the capability to cool the melter offgas.
Basis: N/A

3.19.2.4 HOP Condensate Collection
Unique ID: BMR-HOP_FR-2
The HOP shall have the capability to collect condensate that forms as a result of cooling.
Basis: N/A

3.19.2.5 HOP Condensate Routing
Unique ID: BMR-HOP_FR-3
The HOP shall have the capability to send process condensate to RLD.
Basis: N/A

3.19.2.6 HOP Mercury Removal
Unique ID: BMR-HOP_FR-5
The HOP shall have the capability to remove mercury from the melter offgas.
Basis: N/A

3.19.2.7 HOP VOC Oxidation
Unique ID: BMR-HOP_FR-4
The HOP shall have the capability to oxidize volatile organic compounds (VOC) in the melter offgas.
Basis: N/A
3.19.2.8 HOP NOx Removal
Unique ID: BMR-HOP_FR-6
The HOP shall have the capability to remove NOx in the melter offgas by chemical reduction.
Basis: N/A

3.19.2.9 HOP Halide Removal
Unique ID: BMR-HOP_FR-7
The HOP shall have the capability to remove halides and 129I from the melter offgas.
Basis: N/A

3.19.2.10 HOP Air Movement
Unique ID: BMR-HOP_FR-10
The HOP shall have the capability to provide air movement for the melter offgas up through the HLW facility stack and to maintain the process under a vacuum relative to the surroundings.
Basis: N/A

3.19.3 Model Requirements

3.19.3.1 HOP - Submerged Bed Scrubber (HOP-SCB-00001_2)
Unique ID: BMR-HOP_MR-22
The HOP shall include a submerged bed scrubber column identified as HOP-SCB-00001_2, which represents the functionality of both submerged bed scrubber columns associated with the HLW melter offgas.
Basis: The HOP System has two submerged bed scrubbers, HOP-SCB-00001 and HOP-SCB-00002. Section 4.3.2 of the BARD.

3.19.3.2 HOP-VSL-00903_4 - HLW SBS Condensate Receiver Vessels
Unique ID: BMR-HOP_MR-45
The HOP shall include a condensate receiver vessel identified as HOP-VSL-00903_4, which represents the functionality of both condensate receiver vessels.
Basis: The HOP System has 2 SBS condensate receiver vessels, HOP-VSL-00903 and HOP-VSL-00904. Section 4.3.2 of the BARD.

3.19.3.3 HOP - Wet Electrostatic Precipitator (HOP-WESP-00001_2)
Unique ID: BMR-HOP_MR-23
The HOP shall include a Wet Electrostatic Precipitator (WESP) unit identified as HOP-WESP-00001_2, which represents the functionality of both WESP units associated with the HOP.
Basis: The HOP System has two wet electrostatic precipitators, HOP-WESP-00001 and HOP-WESP-00002. Section 4.3.2 of the BARD.
3.19.3.4  HOP - High Efficiency Mist Eliminator (HOP-HHEME-00001_2)

Unique ID: BMR-HOP_MR-24

The HOP shall include a High Efficiency Mist Eliminator (HEME) unit identified as HOP-HHEME-00001_2, which represents the functionality of both of the HEME units associated with the HOP.

Basis: The HOP System includes two High Efficiency Mist Eliminator (HEME) units, HOP-HHEME-00001 and HOP-HHEME-00002. Section 4.3.2 of the BARD.

3.19.3.5  HOP - HEPA Filters (HOP-HEPA-00001-2AB_7-8AB)

Unique ID: BMR-HOP_MR-1

The HOP shall include a HEPA filter unit identified as HOP-HEPA-00001-2AB_7-8AB, which represents the functionality of all of the HEPA filters and preheaters associated with the HLW offgas.

Basis: The HOP System has two HEPA filter units, HOP-HEPA-00001-2AB and HOP-HEPA-00007-8AB. Section 4.3.2 of the BARD.

3.19.3.6  HOP - Carbon Adsorber (HOP-ADBR-00001_2AB)

Unique ID: BMR-HOP_MR-2

The HOP shall include an activated carbon adsorber, identified as HOP-ADBR-00001_2AB, which represents the functionality of both HOP adsorber units.

Basis: The HOP System has two sulfur-impregnated activated carbon adsorbers, HOP-ADBR-00001A/B and HOP-ADBR-00002A/B. Section 4.3.2 of the BARD.

3.19.3.7  HOP - Silver Mordenite Absorption Column (HOP-ABS-00002_3)

Unique ID: BMR-HOP_MR-3

The HOP shall include a silver mordenite absorption column, identified as HOP-ABS-00002_3, which represents the functionality of all of the equipment associated with the HOP silver mordenite units.

Basis: The HOP System has two silver mordenite columns, HOP-ABS-00002 and HOP-ABS-00003. Section 4.3.2 of the BARD.

3.19.3.8  HOP - Selective Catalytic Reducer/Thermal Catalytic Converter (HOP-SCR-00001_2)

Unique ID: BMR-HOP_MR-4

The HOP shall include a unit operation identified as HOP-SCR-00001_2, which represents the functionality of the HOP selective catalytic converter and thermal catalytic oxidizer used for removal of remaining VOC and NOx prior to discharge to the atmosphere.

Basis: The HOP System has two selective catalytic reducers, HOP-SCR-00001 and HOP-SCR-00002. Section 4.3.2 of the BARD.
3.19.3.9 HOP-SCB-00001_2 - SBS Initial Fill

**Unique ID:** BMR-HOP_MR-15

The *HOP-SCB-00001_2 - HLW Submerged Bed Scrubber* shall be initially filled with *Water* to its set point.

**Basis:** Section 4.3.3.2 of the BARD: HLW Submerged Bed Scrubber and Condensate Receiver Vessel.

3.19.3.10 HOP-SCB-00001_2 - SBS Offgas Receipt

**Unique ID:** BMR-HOP_MR-5

The *HOP-SCB-00001_2 - HLW Submerged Bed Scrubber* shall receive *melter offgas* from the *HMP-MLTR-00001_2 - HLW Melter* when the melter is operating.

**Basis:** Section 4.3.3.2 of the BARD: HLW Submerged Bed Scrubber and Condensate Receiver Vessel.

3.19.3.11 HOP-SCB-00001_2 - SBS Contaminant Removal via Splits

**Unique ID:** BMR-HOP_MR-27

The amount of contaminants removed from the incoming offgas stream by the *HOP-SCB-00001_2 - HLW Submerged Bed Scrubber* shall be calculated from the specified split factors, after receiving offgas.

**Basis:** For particulate removal, the expected decontamination factors (DF) are listed in Table 4.3-1 of the BARD. The DF is defined as the offgas mass flow rate entering the unit divided by offgas mass flow rate out of the unit for a particular component.

3.19.3.12 HOP-SCB-00001_2 - SBS Reactions

**Unique ID:** BMR-HOP_MR-14

The *HOP-SCB-00001_2 - SBS General Reactions* shall be applied to the remaining material in the *HLW Submerged Bed Scrubber* following the application of the splits.

**Basis:** Section 4.3.3.2.6 of the BARD: Chemistry â€“ HLW SBS and SBS Condensate Receiver Vessel

3.19.3.13 HOP-SCB-00001_2 - SBS pH Determination

**Unique ID:** BMR-HOP_MR-28

After the reactions have been applied, the pH of the *HOP-SCB-00001_2 - HLW Submerged Bed Scrubber* liquid shall be calculated and provided to the HLW melter reaction calculation to determine the extent of reactions which drive the ammonia generation in the melter.

**Basis:** Section 4.3.3.2.6 of the BARD: Chemistry â€“ HLW SBS and SBS Condensate Receiver Vessel
3.19.3.14 HOP-SCB-00001-2 - SBS Neutralization Reactions

Unique ID: BMR-HOP_MR-16

The HOP-SCB-00001_2 - SBS pH Adjustment Reactions shall be applied after the pH has been determined,

**Basis:** Section 4.3.3.2.6 of the BARD: Chemistry â€“ HLW SBS and SBS Condensate Receiver Vessel

3.19.3.15 HOP-SCB-00001_2 - SBS Offgas Saturation

Unique ID: BMR-HOP_MR-19

Offgas from HOP-SCB-00001_2 - HLW Submerged Bed Scrubber shall be discharged at saturation conditions calculated using the Mole Fraction of Water at Saturation equation at the HOP-SCB-00001_2 - SBS Outlet Conditions. Water shall either evaporate or condense to meet the saturation mole fraction. Tritium shall follow water proportionally.

**Basis:** Section 4.3.3.2.6 of the BARD: Chemistry â€“ HLW SBS and SBS Condensate Receiver Vessel

3.19.3.16 HOP-SCB-00001_2 - SBS Offgas Routing

Unique ID: BMR-HOP_MR-18

The HOP-SCB-00001_2 - HLW Submerged Bed Scrubber offgas shall discharge to the HOP-WESP-00001_2 - HLW Wet Electrostatic Precipitator following the application of the reactions.

**Basis:** Section 4.3.3.2.6 of the BARD: Chemistry â€“ HLW SBS and SBS Condensate Receiver Vessel

3.19.3.17 HOP-SCB-00001_2 - SBS Operating Volume

Unique ID: BMR-HOP_MR-31

The HOP-SCB-00001_2 - HLW Submerged Bed Scrubber shall maintain a constant volume at the set volume.

**Basis:** Section 4.3.3.2 of the BARD: HLW Submerged Bed Scrubber and Condensate Receiver Vessel.

3.19.3.18 HOP-SCB-00001_2 - SBS Condensate Routing

Unique ID: BMR-HOP_MR-29

1. The contents above the set volume shall discharge to the HOP-VSL-00903_4 - HLW SBS Condensate Receiver Vessels when condensate accumulated in HOP-SCB-00001_2 - HLW Submerged Bed Scrubber is above the set volume,

2. HOP-SCB-00001_2 - HLW Submerged Bed Scrubber shall discharge the volume above the set volume to RLD-VSL-00007 - Acidic Waste Vessel when the HOP-SCB-00001_2 - HLW Submerged Bed Scrubber receives a transfer from HOP-VSL-00903_4 - HLW SBS Condensate Receiver Vessels.
Basis: Section 4.3.3.2 of the BARD: HLW Submerged Bed Scrubber and Condensate Receiver Vessel.

3.19.3.19 HOP-VSL-00903_4 - SBS Condensate Receiver Vessels Fill

Unique ID: BMR-HOP_MR-17

The HOP-VSL-00903_4 - HLW SBS Condensate Receiver Vessels shall be capable of being filled when the volume is less than the upper-set volume.

Basis: N/A

3.19.3.20 HOP-VSL-00903_4 - HLW SBS Condensate Receiver Vessels Routing

Unique ID: BMR-HOP_MR-30

The HOP-VSL-00903_4 - HLW SBS Condensate Receiver Vessels shall discharge to HOP-SCB-00001_2 - HLW Submerged Bed Scrubber.

Basis: Section 4.3.3.2 of the BARD: HLW Submerged Bed Scrubber and Condensate Receiver Vessel.

3.19.3.21 HOP-VSL-00903_4 - SBS Condensate Receiver Vessels Discharge Trigger

Unique ID: BMR-HOP_MR-20

The HOP-VSL-00903_4 - HLW SBS Condensate Receiver Vessels shall trigger a discharge after filling to the set volume but shall not exceed the upper set volume.

Basis: Section 4.3.3.2 of the BARD: HLW Submerged Bed Scrubber and Condensate Receiver Vessel.

3.19.3.22 HOP-VSL-00903_4 - HLW SBS Condensate Receiver Vessels Discharge

Unique ID: BMR-HOP_MR-21

The HOP-VSL-00903_4 - HLW SBS Condensate Receiver Vessels shall not discharge below the minimum volume.

Basis: Section 4.3.3.2 of the BARD: HLW Submerged Bed Scrubber and Condensate Receiver Vessel.

3.19.3.23 HOP-WESP-00001_2 - WESP Contaminant Removal via Splits

Unique ID: BMR-HOP_MR-32

The amount of contaminants removed from the offgas by the HOP-WESP-00001_2 - HLW Wet Electrostatic Precipitator shall be calculated from the specified split factors, after receiving offgas.

Basis: The expected decontamination factors (DF) are listed in Table 4.3-1 of the BARD.

3.19.3.24 HOP-WESP-00001_2 - WESP Reactions

Unique ID: BMR-HOP_MR-43

The HOP WESP Reactions and Extents shall be applied to the remaining material in HOP-WESP-00001_2 following the application of the splits.
**Basis:** Section 4.3.3.3.5 of the BARD: Chemistry â€“ WESP

### 3.19.3.25 HOP-WESP-00001_2 - WESP Offgas Saturation

**Unique ID:** BMR-HOP_MR-41

Offgas from *HOP-WESP-00001_2 - HLW Wet Electrostatic Precipitator* shall be discharged at saturation conditions calculated using the *Mole Fraction of Water at Saturation* equation at the *HOP-WESP-00001_2 - WESP Outlet Conditions*. Water shall either evaporate or condense to meet the saturation mole fraction. Tritium shall follow water proportionally.

**Basis:** Section 4.3.3.3 of the BARD: Wet Electrostatic Precipitator

### 3.19.3.26 HOP-WESP-00001_2 - WESP Condensate Discharge

**Unique ID:** BMR-HOP_MR-34

The *HOP-WESP-00001_2 - HLW Wet Electrostatic Precipitator* shall discharge liquids to the *HOP-VSL-00903_4 - HLW SBS Condensate Receiver Vessels* after the reactions have been applied.

**Basis:** Section 4.3.3.3 of the BARD: Wet Electrostatic Precipitator

### 3.19.3.27 HOP-WESP-00001_2 - WESP Offgas Routing

**Unique ID:** BMR-HOP_MR-36

The *HOP-WESP-00001_2 - HLW Wet Electrostatic Precipitator* offgas shall discharge to the *HOP-HEME-00001_2 - HLW High Efficiency Mist Eliminator* after the reactions have been applied.

**Basis:** Section 4.3.3.6 of the BARD: High Efficiency Mist Eliminator

### 3.19.3.28 HOP-WESP-00001_2 - WESP Air Addition

**Unique ID:** BMR-HOP_MR-38

Air shall be added to the *HOP-WESP-00001_2 - HLW Wet Electrostatic Precipitator* at the *HOP-WESP-00001_2 - WESP Air Flowrate* when the HLW melter is operating.

**Basis:** Section 4.3.3.3 of the BARD: Wet Electrostatic Precipitator

### 3.19.3.29 HOP-WESP-00001_2 - WESP Water Addition

**Unique ID:** BMR-HOP_MR-39

Water shall be added to the *HOP-WESP-00001_2 - HLW Wet Electrostatic Precipitator* at the *HOP-WESP-00001_2 - WESP Water Flowrate* when the HLW melter is operating.

**Basis:** Section 4.3.3.3 of the BARD: Wet Electrostatic Precipitator

### 3.19.3.30 HOP-HEME-00001_2 - HEME Contaminant Removal via Splits

**Unique ID:** BMR-HOP_MR-33

The amount of contaminants removed from the offgas by the *HOP-HEME-00001_2 - HLW High Efficiency Mist Eliminator* shall be calculated from the specified split factors, after receiving offgas.
**Basis:** The expected decontamination factors (DF) are listed in Table 4.3-1 of the BARD.

### 3.19.3.31 HOP-HEME-00001_2 - HEME Reactions

**Unique ID:** BMR-HOP_MR-44

The *HOP-HEME-00001_2 - HEME Reactions and Extents* shall be applied to the remaining material in *HOP-HEME-00001_2* following the application of the splits.

**Basis:** Section 4.3.3.6 of the BARD: High Efficiency Mist Eliminator

### 3.19.3.32 HOP-HEME-00001_2 - HEME Offgas Saturation

**Unique ID:** BMR-HOP_MR-42

Offgas from *HOP-HEME-00001_2 - HLW High Efficiency Mist Eliminator* shall be discharged at saturation conditions calculated using the *Mole Fraction of Water at Saturation* equation at the *HOP-HEME-00001_2 - HEME Outlet Conditions*. Water shall either evaporate or condense to meet the saturation mole fraction. Tritium shall follow water proportionally.

**Basis:** Section 4.3.3.6 of the BARD: High Efficiency Mist Eliminator

### 3.19.3.33 HOP-HEME-00001_2 - HEME Offgas Routing

**Unique ID:** BMR-HOP_MR-37

The *HOP-HEME-00001_2 - HLW High Efficiency Mist Eliminator* offgas shall discharge to the *HOP-HEPA-00001-2AB_7-8AB - HLW High Efficiency Particulate Air Filter* after the reactions have been applied.

**Basis:** Section 4.3.3.6 of the BARD: High Efficiency Mist Eliminator

### 3.19.3.34 HOP-HEME-00001_2 - HEME Condensate Routing

**Unique ID:** BMR-HOP_MR-35

The *HOP-HEME-00001_2 - HLW High Efficiency Mist Eliminator* shall discharge liquid condensate to the *HOP-VSL-00903_4 - HLW SBS Condensate Receiver Vessels* after the reactions have been applied.

**Basis:** Section 4.3.3.6 of the BARD: High Efficiency Mist Eliminator

### 3.19.3.35 HOP-HEME-00001_2 - HEME Water Addition

**Unique ID:** BMR-HOP_MR-40

Water shall be added to the *HOP-HEME-00001_2 - HLW High Efficiency Mist Eliminator* at the *HOP-HEME-00001_2 - HEME Water Addition Rate* when the melter is operating.

**Basis:** Section 4.3.3.6 of the BARD: High Efficiency Mist Eliminator

### 3.19.3.36 HOP-HEPA-00001-2AB_7-8AB - HEPA Contaminant Accumulation

**Unique ID:** BMR-HOP_MR-6

The amount of contaminants captured and accumulated on the *HOP-HEPA-00001-2AB_7-8AB - HLW High Efficiency Particulate Air Filter* shall be calculated from the specified split factors, after receiving offgas.
**Basis:** DFs for the HEPAs are in Table 4.3-2 of the BARD.

3.19.3.37 **HOP-HEPA-00001-2AB_7-8AB - HEPA Offgas Routing**

**Unique ID:** BMR-HOP_MR-7

The *HOP-HEPA-00001-2AB_7-8AB - HLW High Efficiency Particulate Air Filter* shall discharge to the *HOP-ADBR-00001_2AB - HLW Carbon Adsorber*, after the splits have been applied.

**Basis:** Section 4.3.3.10 of the BARD: Activated Carbon Adsorbers

3.19.3.38 **HOP-ADBR-00001_2AB - HLW Carbon Adsorber Contaminant Accumulation**

**Unique ID:** BMR-HOP_MR-8

The *HOP-ADBR-00001_2AB - HLW Carbon Adsorber* shall accumulate contaminants based on the specific split factors, after receiving offgas.

**Basis:** The expected DFs for each component in the offgas are given in Table 4.3-2 of the BARD.

3.19.3.39 **HOP-ADBR-00001_2AB - HLW Carbon Adsorber Routing**

**Unique ID:** BMR-HOP_MR-9

The *HOP-ADBR-00001_2AB - HLW Carbon Adsorber* shall discharge to the *HOP-ABS-00002_3 - HLW Silver Mordenite Absorber Column*, after the splits have been applied.

**Basis:** Section 4.3.3.12 of the BARD: Silver Mordenite Column

3.19.3.40 **HOP-ABS-00002_3 - HLW Silver Mordenite Absorber Contaminant Accumulation**

**Unique ID:** BMR-HOP_MR-10

The *HOP-ABS-00002_3 - HLW Silver Mordenite Absorber Column* shall accumulate contaminates based on the split factors, after receiving offgas.

**Basis:** The expected DFs for each component are listed in Table 4.3-2 of the BARD.

3.19.3.41 **HOP-ABS-00002_3 - HLW Silver Mordenite Absorber Offgas Routing**

**Unique ID:** BMR-HOP_MR-25

The *HOP-ABS-00002_3 - HLW Silver Mordenite Absorber Column* shall discharge to the *HOP-SCR-00001_2 - NOx Selective Catalytic Converter*, after the splits have been applied.

**Basis:** Section 4.3.3.2.6 of the BARD: Chemistry â€“ HLW SBS and SBS Condensate Receiver Vessel
3.19.3.42 HOP-SCR-00001_2 - NOx Selective Catalytic Converter Split Application

Unique ID: BMR-HOP_MR-26

The *HOP-SCR-00001_2 - NOx Selective Catalytic Converter* shall apply the specified splits, after receiving offgas. Note - that there are no modeled contaminants which accumulate based on the split factors.

**Basis:** The expected DFs for each component are in Table 4.3-2 of the BARD.

3.19.3.43 HOP-SCR-00001_2 - NOx Selective Catalytic Converter Reactions

Unique ID: BMR-HOP_MR-11

The *HOP-SCR-00001_2 - NOx Selective Catalytic Converter Reactions and Extents* shall be applied to the remaining material in *HOP-SCR-00001_2* following the application of the splits.

**Basis:** Section 4.3.3.16.5 of the BARD: Chemistry â€“ Selective Catalytic Reducer

3.19.3.44 HOP-SCR-00001_2 - NOx Selective Catalytic Converter Ammonia Addition

Unique ID: BMR-HOP_MR-12

Pure ammonia gas (NH₃) shall be added to the *HOP-SCR-00001_2 - NOx Selective Catalytic Converter* as necessary to satisfy the stoichiometric requirements of the *HOP-SCR-00001_2 - NOx Selective Catalytic Converter Reactions and Extents* and to meet the required amount of *HOP-SCR-00001_2 - Excess Ammonia*.

**Basis:** Section 4.3.3.16.5 of the BARD: Chemistry â€“ Selective Catalytic Reducer

3.19.3.45 HOP-SCR-00001_2 - NOx Selective Catalytic Converter Routing

Unique ID: BMR-HOP_MR-13

The *HOP-SCR-00001_2 - NOx Selective Catalytic Converter* shall discharge to the HLW-OFFGAS-STACK, after the reaction have been applied.

**Basis:** Section 4.3.3.17 of the BARD: Stack Extraction Fan

3.19.4 Technical Requirements

3.19.4.1 HOP-SCB-00001_2 - Submerged Bed Scrubber Vessel Parameters

Unique ID: BMR-HOP_TR-3

The modeled *HOP-SCB-00001_2 - HLW Submerged Bed Scrubber* shall have the following parametric values.

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<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>HOP-SCB-00001-2</td>
<td>3,329</td>
<td>3,329</td>
<td>3,329</td>
<td>0</td>
<td>80</td>
<td>60</td>
<td>0.891</td>
</tr>
</tbody>
</table>

**Basis:** Appendix B of the BARD: Batch Volume and Setpoint Tables
3.19.4.2  **HOP-VSL-00903_4 - HLW SBS Condensate Receiver Vessel Parameters**

**Unique ID:** BMR-HOP_TR-12

The modeled *HOP-VSL-00903_4 - HLW SBS Condensate Receiver Vessels* shall have the following parametric values.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><em>HOP-VSL-00903_4</em></td>
<td>7,898</td>
<td>5,808</td>
<td>4,808</td>
<td>1,758</td>
<td>80</td>
<td>50</td>
<td>1</td>
</tr>
</tbody>
</table>

**Basis:** Appendix B of the BARD: Batch Volume and Setpoint Tables

3.19.4.3  **HOP-SCB-00001_2 - SBS Split Factors**

**Unique ID:** BMR-HOP_TR-4

The *HOP-SCB-00001_2 - HLW Submerged Bed Scrubber* shall use the split factors listed in SVF-1778 from the tab labeled "HOP-SCB-00001-2 ".

**Basis:** For particulate removal, the expected decontamination factors (DF) are listed in Table 4.3-1 of the BARD.

3.19.4.4  **HOP-SCB-00001_2 - SBS General Reaction**

**Unique ID:** BMR-HOP_TR-21

The *HOP-SCB-00001_2 - HLW Submerged Bed Scrubber* general reactions and extents are as follows:

<table>
<thead>
<tr>
<th>Reaction Order</th>
<th>Reaction Name</th>
<th>Reaction</th>
<th>Extent</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>HG-gas-to-liquid</td>
<td>1.0 Hg+2(g) → 1.0 Hg+2(l)</td>
<td>Equation Below</td>
</tr>
<tr>
<td>2</td>
<td>RXN-LAW-SBS-BO4</td>
<td>2.0 B+3(s) + 1.5 O2(g) + 3.0 H2O(l) → 2.0 H+(l) + 2.0 B+3(l) + 4.0 O(BOUND)(l) + 2.0 H2O(l)</td>
<td>1.0</td>
</tr>
<tr>
<td>3</td>
<td>HLW-HCL-SCRUBBER-REACTION</td>
<td>1.0 HCl(g) → 1.0 H+(l) + 1.0 Cl-(l)</td>
<td>0.7561</td>
</tr>
<tr>
<td>4</td>
<td>HF-SCRUBBER-REACTION</td>
<td>1.0 HF(g) → 1.0 H+(l) + 1.0 F-(l)</td>
<td>0.9825</td>
</tr>
<tr>
<td></td>
<td>Reaction Type</td>
<td>Equation</td>
<td>K</td>
</tr>
<tr>
<td>---</td>
<td>-------------------------------------</td>
<td>--------------------------------------------------------------------------</td>
<td>-----</td>
</tr>
<tr>
<td>5</td>
<td>HLW-NO2-SCRUBBER-REACTION</td>
<td>$3.0 \text{ NO}_2(g) + 1.0 \text{ H}_2\text{O}(l) \rightarrow 2.0 \text{ H}^+(l) + 2.0 \text{ NO}_3^-(l) + 1.0 \text{ NO}(g)$</td>
<td>0.002</td>
</tr>
<tr>
<td>6</td>
<td>HLW-NO-SCRUBBER-REACTION</td>
<td>$4.0 \text{ NO}(g) + 2.0 \text{ H}_2\text{O}(l) + 3.0 \text{ O}_2(g) \rightarrow 4.0 \text{ H}^+(l) + 4.0 \text{ NO}_3^-(l)$</td>
<td>0.0548</td>
</tr>
<tr>
<td>7</td>
<td>HLW-SO2-SCRUBBER-REACTION</td>
<td>$2.0 \text{ SO}_2(g) + 2.0 \text{ H}_2\text{O}(l) + 1.0 \text{ O}_2(g) \rightarrow 4.0 \text{ H}^+(l) + 2.0 \text{ SO}_4^2^-(l)$</td>
<td>0.8534</td>
</tr>
<tr>
<td>8</td>
<td>HLW-I-SCRUBBER-RXN</td>
<td>$1.0 \text{ 129-I}(g) \rightarrow 1.0 \text{ 129-I}(l)$</td>
<td>0.6875</td>
</tr>
<tr>
<td>9</td>
<td>HLW-CL-SCRUBBER-REACTION</td>
<td>$1.0 \text{ Na}^+(s) + 1.0 \text{ Cl}^-(s) \rightarrow 1.0 \text{ Na}^+(l) + 1.0 \text{ Cl}^-(l)$</td>
<td>1.0</td>
</tr>
<tr>
<td>10</td>
<td>HLW-F-SCRUBBER-REACTION</td>
<td>$1.0 \text{ Na}^+(s) + 1.0 \text{ F}^-(s) \rightarrow 1.0 \text{ Na}^+(l) + 1.0 \text{ F}^-(l)$</td>
<td>1.0</td>
</tr>
<tr>
<td>11</td>
<td>HLW-NA-SCRUBBER-RXN</td>
<td>$4.0 \text{ Na}^+(s) + 1.0 \text{ O}_2(g) + 2.0 \text{ H}_2\text{O}(l) \rightarrow 4.0 \text{ Na}^+(l) + 4.0 \text{ OH}^-(l)$</td>
<td>0.9</td>
</tr>
<tr>
<td>12</td>
<td>HLW-K-SCRUBBER-RXN</td>
<td>$4.0 \text{ K}^+(s) + 1.0 \text{ O}_2(g) + 2.0 \text{ H}_2\text{O}(l) \rightarrow 4.0 \text{ K}^+(l) + 4.0 \text{ OH}^-(l)$</td>
<td>0.95</td>
</tr>
<tr>
<td>13</td>
<td>HLW-CA-SCRUBBER-RXN</td>
<td>$2.0 \text{ Ca}^{2+}(s) + 1.0 \text{ O}_2(g) + 2.0 \text{ H}_2\text{O}(l) \rightarrow 2.0 \text{ Ca}^{2+}(l) + 4.0 \text{ OH}^-(l)$</td>
<td>0.75</td>
</tr>
<tr>
<td>14</td>
<td>HLW-SR-SCRUBBER-RXN</td>
<td>$2.0 \text{ Sr}^{2+}(s) + 1.0 \text{ O}_2(g) + 2.0 \text{ H}_2\text{O}(l) \rightarrow 2.0 \text{ Sr}^{2+}(l) + 4.0 \text{ OH}^-(l)$</td>
<td>0.65</td>
</tr>
<tr>
<td>15</td>
<td>HLW-SR90-SCRUBBER-RXN</td>
<td>$2.0 \text{ 90-Sr}(s) + 1.0 \text{ O}_2(g) + 2.0 \text{ H}_2\text{O}(l) \rightarrow 2.0 \text{ 90-Sr}(l) + 4.0 \text{ OH}^-(l)$</td>
<td>0.65</td>
</tr>
<tr>
<td>16</td>
<td>HLW-LI-SCRUBBER-RXN</td>
<td>$4.0 \text{ Li}^+(s) + 1.0 \text{ O}_2(g) + 2.0 \text{ H}_2\text{O}(l) \rightarrow 4.0 \text{ Li}^+(l) + 4.0 \text{ OH}^-(l)$</td>
<td>0.95</td>
</tr>
<tr>
<td>17</td>
<td>HLW-NH3-SCRUBBER-RXN</td>
<td>$1.0 \text{ NH}_3(g) \rightarrow 1.0 \text{ NH}_3(l)$</td>
<td>0.9</td>
</tr>
<tr>
<td>18</td>
<td>HLW-NH3-REACTION</td>
<td>$1.0 \text{ NH}_3(l) + 1.0 \text{ H}_2\text{O}(l) \rightarrow 1.0 \text{ NH}_4^+(l) + 1.0 \text{ OH}^-(l)$</td>
<td>Equation Below</td>
</tr>
</tbody>
</table>
The extent of reactions shall be equal to the conversion factor or until one of the reactants has been depleted.


Conversion factor of the mercury reaction is dependent upon the mercury to chloride ratio in the HLW melter feed, for example,

\[
CF = 0.833 \text{ if } Hg^+2 (l, s) / Cl^- (l, s) \leq 0.1 \\
= 0.559 \text{ if } 0.1 < Hg^+2 (l, s) / Cl^- (l, s) \leq 0.5 \\
= 0.286 \text{ if } Hg^+2 (l, s) / Cl^- (l, s) > 0.5
\]

The conversion factor for the NH3/NH4+ reaction is calculated using the equilibrium constant as:

\[
[Total] = 0.9 \times \frac{\text{moles of NH}_3 \text{ (g)}}{\text{volume above setpoint in liters}} \\
[NH3]-End = 5.682e-3 \times [Total] \\
NH4-CF = \frac{([NH3]-Begin - [NH3]-End)}{[NH3]-Begin}
\]

**Basis:** Section 4.3.3.2.6 of the BARD: Chemistry â€“ HLW SBS and SBS Condensate Receiver Vessel

### 3.19.4.5 HOP-SCB-00001_2 - SBS pH Adjustment Reactions

**Unique ID:** BMR-HOP_TR-10

The *HOP-SCB-00001_2 - HLW Submerged Bed Scrubber* pH Adjustment reactions are as follows:

If the pH$<7$ then apply the following reactions:

<table>
<thead>
<tr>
<th>Reaction Name</th>
<th>Reaction</th>
<th>Conversion</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO2-SCRUBBER-REACTION</td>
<td>$1.0 \text{ CO}_2(g) + 1.0 \text{ H}_2\text{O}(l) \rightarrow 2.0 \text{ H}^+(l) + 1.0 \text{ CO}_3^-2(l)$</td>
<td>0.001</td>
</tr>
<tr>
<td>RXN-WTP-H-OH-NEUT</td>
<td>$H^+ (l) + OH^- (l) \rightarrow H_2O (l)$</td>
<td>1.0</td>
</tr>
<tr>
<td>EVAPORATE-H2O or CONDENSE-H2O</td>
<td>$H_2O (l) \rightarrow H_2O (g)$ or $H_2O (g) \rightarrow H_2O (l)$</td>
<td>Based on Saturation calculation</td>
</tr>
<tr>
<td>EVAPORATE-3-H or CONDENSE-3-H</td>
<td>$1.0 3-H(l) \rightarrow 1.0 3-H(g)$ or $1.0 3-H(g) \rightarrow 1.0 3-H(l)$</td>
<td>Follows water</td>
</tr>
</tbody>
</table>
1. \[ 1.0 \text{NO}_3^-(l) + 10.0 \text{H}^+(l) \rightarrow 1.0 \text{NH}_4^+(l) + 3.0 \text{H}_2\text{O}(l) \]

until \text{H}^+ or \text{NO}_3^- is consumed

2. \[ 1.0 \text{NO}_2^-(l) + 8.0 \text{H}^+(l) \rightarrow 1.0 \text{NH}_4^+(l) + 2.0 \text{H}_2\text{O}(l) \]

until \text{H}^+ or \text{NO}_2^- is consumed

If the pH > 7 then apply the following reaction

<table>
<thead>
<tr>
<th>Reaction Name</th>
<th>Reaction</th>
<th>Conversion</th>
</tr>
</thead>
<tbody>
<tr>
<td>RXN-WTP-NH4</td>
<td>[ 1.0 \text{NH}_4^+(l) + 2.0 \text{H}_2\text{O}(l) \rightarrow 8.0 \text{H}^+(l) + 1.0 \text{NO}_2^-(l) ]</td>
<td>until the pH = 7.0 or NH}_4^+ is consumed</td>
</tr>
<tr>
<td>RXN-WTP-H-OH-NEUT</td>
<td>[ \text{H}^+(l) + \text{OH}^-(l) \rightarrow \text{H}_2\text{O}(l) ]</td>
<td>1.0</td>
</tr>
</tbody>
</table>

**Basis:** Section 4.3.3.2.6 of the BARD: Chemistry â€“ HLW SBS and SBS Condensate Receiver Vessel

### 3.19.4.6 HOP-SCB-00001_2 - SBS Outlet Conditions

**Unique ID:** BMR-HOP_TR-18

The *HOP-SCB-00001_2 - HLW Submerged Bed Scrubber* outlet conditions shall be 50°C and 0.891 atmospheres.

**Basis:** Section 4.3.3.2.6 of the BARD: Chemistry â€“ HLW SBS and SBS Condensate Receiver Vessel

### 3.19.4.7 HOP-WESP-00001_2 - WESP Split Factors

**Unique ID:** BMR-HOP_TR-13

The *HOP-WESP-00001_2 - HLW Wet Electrostatic Precipitator* shall use the split factors listed in SVF-1778 from the tab labeled "HOP-WESP-00001-2 ".

**Basis:** The expected decontamination factors (DF) are listed in Table 4.3-1 of the BARD.

### 3.19.4.8 HOP-WESP-00001_2 - WESP Reactions and Extents

**Unique ID:** BMR-HOP_TR-1

The *HOP-WESP-00001_2 - HLW Wet Electrostatic Precipitator* shall contain the following reactions with extents:

**High-Level Waste Wet Electrostatic Precipitator Reactions and Extents**
<table>
<thead>
<tr>
<th>Reaction Name</th>
<th>Reaction</th>
<th>Conversion (fraction)</th>
</tr>
</thead>
<tbody>
<tr>
<td>HLW-HCl-SCRUBBER-REACTION</td>
<td>1.0 HCl(g) → 1.0 H+(l) + 1.0 Cl-(l)</td>
<td>0.8947</td>
</tr>
<tr>
<td>HLW-HF-SCRUBBER-REACTION</td>
<td>1.0 HF(g) → 1.0 H+(l) + 1.0 F-(l)</td>
<td>0.5</td>
</tr>
<tr>
<td>HLW-I-SCRUBBER-RXN</td>
<td>1.0 I2(g) → 1.0 I2(l)</td>
<td>0.4188</td>
</tr>
<tr>
<td>HLW-SO2-SCRUBBER-REACTION</td>
<td>2.0 SO2(g) + 2.0 H2O(l) + 1.0 O2(g) → 4.0 H+(l) + 2.0 SO4-2(l)</td>
<td>0.1667</td>
</tr>
<tr>
<td>HLW-NO-SCRUBBER-REACTION</td>
<td>2.0 NO(g) + 1.0 O2(g) + 2.0 H2O(l) → 4.0 H+(l) + 2.0 NO3-(l)</td>
<td>0.01</td>
</tr>
<tr>
<td>RXN-LAW-SBS-BO4</td>
<td>2.0 B+3(s) + 1.5 O2(g) + 3.0 H2O(l) → 2.0 H+(l) + 2.0 B+3(l) + 4.0 O(BOUND)(l) + 2.0 H2O(l)</td>
<td>1</td>
</tr>
<tr>
<td>H-OH-NEUT-REACTION</td>
<td>1.0 H+(l) + 1.0 OH-(l) → 1.0 H2O(l)</td>
<td>1</td>
</tr>
<tr>
<td>EVAPORATE-H2O or CONDENSE-H2O</td>
<td>H2O (l) → H2O (g) or H2O (g) → H2O (l)</td>
<td>Based on Saturation calculation</td>
</tr>
<tr>
<td>EVAPORATE-3-H or CONDENSE-3-H</td>
<td>1.0 3-H(l) → 1.0 3-H(g) or 1.0 3-H(g) → 1.0 3-H(l)</td>
<td>Follows water</td>
</tr>
</tbody>
</table>

Note: The extent of reactions shall be equal to the conversion factor or until one of the reactants has been depleted. Extent-of-reactions are based on values from 24590-WTP-MDD-PR-01-002, Dynamic (G2) Model Design Document, Rev. 13, Bechtel National, Inc., Richland, Washington.

**Basis:** Section 4.3.3.3.5 of the BARD: Chemistry â€“ WESP

**3.19.4.9 HOP-WESP-00001_2 - WESP Water Flowrate**

**Unique ID:** BMR-HOP_TR-11

The *HOP-WESP-00001_2 - HLW Wet Electrostatic Precipitator* water addition rate shall be 0.14 gpm per metric ton of IHLW glass produced per day. Note - This is based on the 24590-WTP-MDD-PR-01-002, Rev. 13, (pg. 126) which states a rate of 0.42 gpm per 3 MTG/day = 0.14 gpm/MTG/day.

**Basis:** According to Section 4.3.3.3.4 of the BARD: Services â€“ WESP, DIW id used to wash solids from the tube walls and for misting with a combined flow of 0.47 gpm.
3.19.4.10  HOP-WESP-00001_2 - WESP Air Flowrate

Unique ID: BMR-HOP_TR-16

The **HOP-WESP-00001_2** - HLW Wet Electrostatic Precipitator Air addition rate shall be 263 cfm at 35 C and 1 atm.

**Basis:** The requirement is based on 24590-WTP-MDD-PR-01-002, Rev. 13, (pg. 126) and Table B-19 which states a rate of 131.5 cfm (at 95 F and 14.7 psi) per WESP unit = 131.5 * 2 = 263 cfm.

3.19.4.11  HOP-WESP-00001_2 - WESP Outlet Conditions

Unique ID: BMR-HOP_TR-19

The **HOP-WESP-00001_2** - HLW Wet Electrostatic Precipitator outlet conditions shall be 54.444°C and 0.932 atmosphere.

**Basis:** According to Section 4.3.3.3 of the BARD: Wet Electrostatic Precipitator, the WESP will cause a 1.0 in. WG pressure drop and a slight increase of the offgas temperature.

3.19.4.12  HOP-HEME-00001_2 - HEME Split Factors

Unique ID: BMR-HOP_TR-14

The **HOP-HEME-00001_2** - HLW High Efficiency Mist Eliminator shall use the split factors listed in SVF-1778 from the tab labeled "HOP-HEME-00001_2 ".

**Basis:** The expected decontamination factors (DF) are listed in Table 4.3-1 of the BARD.

3.19.4.13  HOP-HEME-00001_2 - HEME Reactions and Extents

Unique ID: BMR-HOP_TR-2

The **HOP-HEME-00001_2** - HLW High Efficiency Mist Eliminator reactions with extents are listed below.

### High-Level Waste High-Efficiency Mist Eliminator Reactions and Extents

<table>
<thead>
<tr>
<th>Reaction Name</th>
<th>Reaction</th>
<th>Conversion (fraction)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hg-gas-to-liquid</td>
<td>1.0 Hg+2(g) → 1.0 Hg+2(l)</td>
<td>See below</td>
</tr>
<tr>
<td>HCL-SCRUBBER-REACTION</td>
<td>1.0 HCl(g) → 1.0 H+(l) + 1.0 Cl-(l)</td>
<td>0.8684</td>
</tr>
<tr>
<td>HF-SCRUBBER-REACTION</td>
<td>1.0 HF(g) → 1.0 H+(l) + 1.0 F-(l)</td>
<td>0.8684</td>
</tr>
<tr>
<td>HLW-SO2-SCRUBBER-REACTION</td>
<td>2.0 SO2(g) + 2.0 H2O(l) + 1.0 O2(g) → 4.0 H+(l) + 2.0 SO4-2(l)</td>
<td>0.9845</td>
</tr>
<tr>
<td>RXN-LAW-SBS-BO4</td>
<td>2.0 B+3(s) + 1.5 O2(g) + 3.0 H2O(l) → 2.0 H+(l) + 2.0 B+3(l) + 4.0 O(BOUND)(l) + 2.0 H2O(l)</td>
<td>1</td>
</tr>
</tbody>
</table>
Conversion factor of the mercury reaction is dependent upon the mercury to chloride ratio in the HLW melter feed, for example,

\[
\text{CF} = 0.714 \text{ if } \frac{\text{Hg}^+2 (l, s)}{\text{Cl}^- (l, s)} \leq 0.1 \\
= 0.357 \text{ if } 0.1 < \frac{\text{Hg}^+2 (l, s)}{\text{Cl}^- (l, s)} \leq 0.5 \\
= 0.0 \text{ if } \frac{\text{Hg}^+2 (l, s)}{\text{Cl}^- (l, s)} > 0.5
\]

**Basis:** Sections 4.3.3.2.6 and 4.3.3.6 of the BARD and Figure 4.3-3

### 3.19.4.14 HOP-HEME-00001_2 - HEME Water Addition Rate

**Unique ID:** BMR-HOP_TR-17

The *HOP-HEME-00001_2 - HLW High Efficiency Mist Eliminator* water addition rate shall be 0.05 gpm per metric ton of IHLW glass produced per day. Note - This is based on the 24590-WTP-MDD-PR-01-002, Rev. 13 (pg. 127) which states a rate of 0.15 gpm per 3 MTG/day = 0.05 gpm/MTG/day.

**Basis:** According to Section 4.3.3.6.4 of the BARD: Services â€“ HEME, demineralized water is used for solids removal and continuous misting. A combined flow of 0.0527 gpm is supplied to the unit (24590-HLW-MKC-HOP-00011).

### 3.19.4.15 HOP-HEME-00001_2 - HEME Outlet Conditions

**Unique ID:** BMR-HOP_TR-20

The *HOP-HEME-00001_2 - HLW High Efficiency Mist Eliminator* outlet conditions shall be 47.778°C and 0.912 atmosphere.

**Basis:** According to Section 4.3.3.6 of the BARD: High Efficiency Mist Eliminator, the HEME is expected to have a pressure drop of 7.0 in. WG and water addition may cause a slight temperature drop in the offgas stream.

### 3.19.4.16 HOP-HEPA-00001-2AB_7-8AB - HEPA Split Factors

**Unique ID:** BMR-HOP_TR-15

The *HOP-HEPA-00001-2AB_7-8AB - HLW High Efficiency Particulate Air Filter* shall use the split factors listed in SVF-1778 from the tab labeled "HOP-HEPA-00001-2AB_7-8AB".

**Basis:** DFs for the HEPAs are in Table 4.3-2 of the BARD.
3.19.4.17 HOP-ADBR-00001_2AB - Carbon Adsorber Split Factors

Unique ID: BMR-HOP_TR-5

The HOP-ADBR-00001_2AB - HLW Carbon Adsorber shall use the split factors listed in SVF-1778 from the tab labeled "HOP-ADBR-00001-2AB".

Basis: The expected DFs for each component are in Table 4.3-2 of the BARD.

3.19.4.18 HOP-ABS-00002_3 - Silver Mordenite Absorber Column Split Factors

Unique ID: BMR-HOP_TR-6

The HOP-ABS-00002_3 - HLW Silver Mordenite Absorber Column shall use the split factors listed in SVF-1778 from the tab labeled "HOP-ABS-00002-3".

Basis: The expected DFs for each component are in Table 4.3-2 of the BARD.

3.19.4.19 HOP-SCR-00001_2 - NOx Selective Catalytic Converter Split Factors

Unique ID: BMR-HOP_TR-9

The HOP-SCR-00001_2 - NOx Selective Catalytic Converter shall use the split factors listed in SVF-1778 from the tab labeled "HOP-SCR-00001-2".

Basis: The expected DFs for each component are in Table 4.3-2 of the BARD.

3.19.4.20 HOP-SCR-00001_2 - NOx Selective Catalytic Converter Reactions and Extents

Unique ID: BMR-HOP_TR-7

The following reactions and extents shall apply to the HOP-SCR-00001_2 - NOx Selective Catalytic Converter

Catalytic Oxidizer Reactions and Extents

<table>
<thead>
<tr>
<th>Rx#</th>
<th>Reaction Name</th>
<th>Reaction</th>
<th>Conversion (fraction)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>HLW-NH3-SCRUBBER-RXN</td>
<td>1.0 NH3(l) → 1.0 NH3(g)</td>
<td>1.0</td>
</tr>
<tr>
<td>2</td>
<td>HLW-NOX-NH3-REACTION</td>
<td>4.0 NO(g) + 4.0 NH3(g) + 1.0 O2(g) → 4.0 N2(g) + 6.0 H2O(g)</td>
<td>0.95</td>
</tr>
<tr>
<td>3</td>
<td>HLW-NOX-NO2-NH3-REACTION2</td>
<td>2.0 NO2(g) + 4.0 NH3(g) + 1.0 O2(g) → 3.0 N2(g) + 6.0 H2O(g)</td>
<td>0.95</td>
</tr>
<tr>
<td>4</td>
<td>HLW-NOX-SO2-REACTION</td>
<td>1.0 SO2(g) + 0.5 O2(g) → 1.0 SO3(g)</td>
<td>0.95</td>
</tr>
</tbody>
</table>
The extent of reactions shall be equal to the conversion factor or until one of the reactants has been depleted.


**Basis:** Section 4.3.3.16.5 of the BARD: Chemistry “Selective Catalytic Reducer”

**3.19.4.21 HOP-SCR-00001_2 - NOx Selective Catalytic Converter Excess Ammonia**

**Unique ID:** BMR-HOP_TR-8

After the reactions are applied there shall be 10 ppm excess gaseous ammonia (NH₃) in the HOP-SCR-00001_2 offgas stream.

**Basis:** Section 4.3.3.16.5 of the BARD: Chemistry “Selective Catalytic Reducer”

**3.19.4.22 HOP-SCR-00001_2 - NOx Selective Catalytic Converter Outlet Condition**

**Unique ID:** BMR-HOP_TR-22

The HOP-SCR-00001_2 - NOx Selective Catalytic Converter outlet conditions shall be 400°C and 1 atmosphere.

**Basis:** According to Section 4.3.3.16.3 of the BARD: the NOx Selective Catalytic Converter outlet conditions is estimated at 400°C and is assumed to be 1 atm.

**3.19.5 HOP Figures and Diagrams**

Figures and diagrams associated with the HOP system.
3.19.5.1 Simplified HOP Flow Diagram

Unique ID: BMR-TXT-366

3.19.5.2 HOP-SCB-00001_2 SBS Model Diagram

Unique ID: BMR-TXT-367
3.19.5.3 HOP-WESP-00001_2 Modeling Diagram

Unique ID: BMR-TXT-368

3.19.5.4 HOP-HEME-00001_2 Model Diagram

Unique ID: BMR-TXT-369
3.19.5.5  HOP-HEPA-00001-2AB_7-8AB -HEPA and HOP-ADBR-00001_2AB - Carbon Adsorber Simplified Diagram

Unique ID: BMR-TXT-371

3.19.5.6  HOP-ABS-00002_3 - HLW Silver Mordenite Absorber Column Model Diagram

Unique ID: BMR-TXT-372
3.19.5.7  HOP-SCR-00001_2 NOX Selective Catalytic Converter Model Diagram

Unique ID: BMR-TXT-370

3.20  SUPPLEMENTAL LOW-ACTIVITY WASTE TREATMENT SYSTEM

The supplemental LAW Treatment System is a theoretical system designated to increase pretreated LAW and concentrated pretreated LAW processing to full LAW treatment capacity for the duration of the RPP mission. Therefore, the HSM contains a second LAW vitrification facility, adjacent to the WTP. The second LAW facility is assumed to have the same technical assumptions as the WTP LAW Vitrification Facility.

The second LAW Vitrification Facility converts the excess low-activity waste and concentrated pretreated low-activity waste (that is greater than the net capacity of the WTP LAW Vitrification facility) into molten glass. The second LAW Vitrification (SLAW) in the HSM consists of the WTP SLAW melter feed process and the SLAW melter process. The basis for operation of the SLAW melter feed process is to ensure adequate feed is provided at all times and while there is feed available for all SLAW melters in operation. The SLAW melter operation is modeled as a single melter (including all associated equipment and vessels) having the total capacity of all the SLAW melters and associated equipment and vessels that will be installed in the WTP.

In the SLAW melter feed process, pre-treated LAW feed, concentrated pre-treated LAW and condensate discharge from the second LAW Evaporator is delivered to the SLAW-BUFFER-TANK. The SLAW-BUFFER-TANK contents are then transferred to the SLAW Concentrate Receipt Vessels, SLCP-VSL-00001_2 where it is sampled (the sampling of the LAW feed batch is not part of the HSM at this time) to determine the composition of glass formers required to achieve the minimum waste loading of Na2O as specified by the WTP Contract.
The SLAW Melter Feed Preparation Vessels, SLFP-VSL-00001_3, receives the LAW concentrate from the concentrate receipt vessel and mixes the waste with glass formers and sucrose delivered from the SLAW Glass Former Feed Hoppers, SGFR-VSL-000022_23. This mixture is transferred to the SLAW Melter Feed Vessels, SLFP-VSL-00002_4.

The SLAW Melter Feed Vessels provide continuous feed of LAW slurry to the SLAW Melters (SLMP-MLTR-00001_2 to meet the glass production rate. User-defined reference data sets the melter’s throughput rate in MTG/d. The rate at which the melter operates varies throughout the mission and is also specified by the user-defined reference data. The ramp rate is identified by the HSM requirements. The HSM compares the rate of glass production to the user-defined reference data every eight simulation hours. If the calculated value and set value do not match, the HSM adjusts the melter feed rate to maintain the desired production rate.

When feed enters the melter, the HSM applies a split to the liquid and gas components. The liquid split values apply to the liquid components that come into the melter. After the splits are applied, the reactions, as defined by the HSM requirements, are completed in the order given. The decomposition reactions are completed before the oxide reactions. Air is added to the melter to supply the O2 needed for the reactions.

Molten glass discharges from the melter when the glass level is high and is collected in the SLAW Canister Accumulation Vessel, SLAW-CANISTERS. The number of canisters are tracked based on the mass accumulated in the SLAW Canister Accumulation Vessel and dividing by the assumed glass density and canister volume. Storage and handling of the canisters is not modeled, but replacement of the melter is modeled.

3.20.1 System Requirements

3.20.1.1 SLAW Pretreated LAW Feed Receipt (SLAW-BUFFER)

Unique ID: BMR-SLAW_SR-4

The SLAW-BUFFER shall receive and store excess pretreated LAW from TCP, LAWPS, and recycle from STLP to supply down stream SLAW Treatment processes.

Basis: SLAW Treatment facility is presently assumed to be another vitrification facility with the same technical design, glass chemistry, melters, and similar feed and offgas equipment as the WTP LAW vitrification facility Therefore the parameters for LAW vitrification facility is used as reference source.

3.20.1.2 SLAW Concentrate Receipt Process (SLCP)

Unique ID: BMR-SLAW_SR-2

The SLCP shall receive pretreated LAW and determine composition.

Basis: SLAW Treatment facility is presently assumed to be another vitrification facility with the same technical design, glass chemistry, melters, and similar feed and offgas equipment as the WTP LAW vitrification facility Therefore the parameters for LAW vitrification facility is used as reference source.
3.20.1.3   SLAW Melter Feed Preparation (SLFP)

Unique ID: BMR-SLAW_SR-3

The SLFP shall prepare the pretreated LAW, and glass formers to feed into SLMP.

Basis: SLAW Treatment facility is presently assumed to be another vitrification facility with the same technical design, glass chemistry, melters, and similar feed and offgas equipment as the WTP LAW vitrification facility Therefore the parameters for LAW vitrification facility is used as reference source.

3.20.1.4   SLAW Melter Process (SLMP)

Unique ID: BMR-SLAW_SR-1

The SLMP shall convert pretreated LAW feed and glass formers into S-ILAW glass and route it to storage.

Basis: SLAW Treatment facility is presently assumed to be another vitrification facility with the same technical design, glass chemistry, melters, and similar feed and offgas equipment as the WTP LAW vitrification facility Therefore the parameters for LAW vitrification facility is used as reference source.

3.20.2   Functional Requirements

3.20.2.1   SLAW Treatment Capacity

Unique ID: BMR-SLAW_FR-9

The SLAW Treatment net capacity shall be adequate to not drive the mission duration when combined with LAW Vitrification.

Basis: This functional requirement is from Assumption A1.4 Supplemental Treatment in ORP-11242, System Plan Rev. 8.

3.20.2.2   SLAW Pretreated LAW Feed Receipt

Unique ID: BMR-SLAW_FR-10

The SLAW-BUFFER shall have the capability to receive and store pretreated LAW from TCP and LAWPS, and recycle from STLP.

Basis: SLAW Treatment is based exactly upon LAW Vit and therefore this functional requirement is found in Section 3.1.2 Process Description (LAW Melter Feed Process) in 24590-WTP-RPT-PT-02-005, BARD Rev. 8. The SLAW-BUFFER-TANK is required for TOPSim modeling purposes in collecting the input streams for SLAW Treatment.

3.20.2.3   SLAW Melter Feed Receipt

Unique ID: BMR-SLAW_FR-11

The SLCP system shall have the capability to receive pretreated LAW and STLP recycle from the SLAW-BUFFER-TANK.

Basis: This functional requirement comes from Section 3.1.3.1. LAW Concentrate Receipt Vessel in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.
3.20.2.4  **SLAW Melter Feed Sampling**

**Unique ID:** BMR-SLAW_FR-1

The *SLCP* system shall have the capability to sample the *pretreated LAW*.

**Basis:** This functional requirement is in Section 3.1.3.1 LAW Concentrate Feed Vessel in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

3.20.2.5  **SLAW Melter Feed Preparation**

**Unique ID:** BMR-SLAW_FR-2

The *SLFP* shall have the capability to add *glass formers* to the *pretreated LAW*.

**Basis:** This functional requirement is in Section 3.1.3.3 LAW Melter Feed Preparation Vessel in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

3.20.2.6  **SLFP to SLMP**

**Unique ID:** BMR-SLAW_FR-13

The *SLMP* shall have the capability to receive the slurry and *glass formers* from *SLFP*.

**Basis:** This functional requirement is from Section 3.4.1.1 LMP Feed (General Requirements) in 24590-LAW-3ZD-LMP-00001, LMP System Design Description.

3.20.2.7  **SLFP Feed Receipt**

**Unique ID:** BMR-SLAW_FR-12

The *SLFP* shall have the capability to receive *pretreated LAW* from *SLCP*.

**Basis:** This functional requirement is in Section 3.1.3.3 LAW Melter Feed Preparation Vessel in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

3.20.2.8  **SLAW Melter Process**

**Unique ID:** BMR-SLAW_FR-3

The *SLMP* shall have the capability to convert *pretreated LAW* and *glass formers* into molten *ILAW* glass product.

**Basis:** This functional requirement is from Section 4.1 Configuration Information (System Description) in 24590-LAW-3ZD-LMP-00001, LMP System Design Description.

3.20.2.9  **SLAW Glass Packaging**

**Unique ID:** BMR-SLAW_FR-4

The *SLMP* shall have the capability to pour *S-ILAW* glass into *S-ILAW* glass containers.

**Basis:** This functional requirement is in Section 4.8.15 LAW Melter Process (LMP) System in 24590-WTP-MDD-PR-01-002, WTP MDD.

3.20.2.10  **SLAW Melter Offgas Stream**

**Unique ID:** BMR-SLAW_FR-6

The *SLMP* shall have the capability to capture and route *melter offgas* to the *SLOP*. 
**Basis:** This functional requirement comes from Section 3.5.2.1 Confinement of Offgas in 24590-LAW-3ZD-LMP-00001, LMP System Design Description.

### 3.20.2.11 SLAW Melter Replacement

**Unique ID:** BMR-SLAW_FR-7

The SLMP shall have the capability to replace a melter, when it has become defective or reached the end of its useful life.

**Basis:** This functional requirement comes from Section 3.15.4.21 Design for Replacement after End of Life or Failure in 24590-LAW-3ZD-LMP-00001, LMP System Design Description.

### 3.20.3 Model Requirements

#### 3.20.3.1 SLAW Pretreated LAW Storage Tank (SLAW-BUFFER-TANK) Identification

**Unique ID:** BMR-SLAW_MR-1

The SLAW Treatment system shall include one SLAW Pretreated LAW Storage tank identified as SLAW-BUFFER-TANK.

**Basis:** SLAW Treatment is based exactly upon LAW Vit and therefore this functional requirement is found in Section 3.1.2 Process Description (LAW Melter Feed Process) in 24590-WTP-RPT-PT-02-005, BARD Rev. 8. The SLAW-BUFFER-TANK is required for TOPSim modeling purposes in collecting the input streams for SLAW Treatment.

#### 3.20.3.2 SLAW Concentrate Receipt Vessel (SLCP-VSL-00001_2) Identification

**Unique ID:** BMR-SLAW_MR-2

The SLAW Treatment system shall include one SLAW Concentrate Receipt vessel identified as SLCP-VSL-00001_2, and modeled to represent combined throughput capacity and functionality of the two SLAW Concentrate Receipt vessels(SLCP-VSL-00001 and SLCP-VSL-00002).

**Basis:** This model requirement is in Section 3.1.3.1 LAW Concentrate Receipt Vessel in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

#### 3.20.3.3 SLAW Glass Former Feed Hopper (SGFR-VSL-00022_23) Identification

**Unique ID:** BMR-SLAW_MR-3

The SLAW Treatment system shall include one SLAW Glass Former Feed Hopper identified as SGFR-TK-00022_23, which represents the combined capacity of the two SLAW Glass Former Feed Hoppers (SGFR-VSL-00022 and SGFR-VSL-00023).

**Basis:** This model requirement is in Section 3.1.3.2 Glass Former Mixers in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

#### 3.20.3.4 SLAW Melter Feed Preparation Vessel (SLFP-VSL-00001_3) Identification

**Unique ID:** BMR-SLAW_MR-4

SLAW Melter Feed Preparation Vessel shall consist of one vessel identified as SLAW Melter Feed Preparation Vessel (SLFP-VSL-00001_3), which represents the combined throughput
capacity of the two SLAW Melter Feed Preparation Vessels (SLFP-VSL-00001 and SLFP-VSL-
00003).

**Basis:** This model requirement is in Section 3.1.3.3 LAW Melter Feed Preparation Vessel in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

### 3.20.3.5 SLAW Melter Feed Vessel (SLFP-VSL-00002_4) Identification

**Unique ID:** BMR-SLAW_MR-5

The SLAW Melter Feed Vessels shall consist of one vessel identified as SLFP-VSL-00002_4, which represents the combined throughput capacity of two SLAW Melter Feed Vessels (SLFP-VSL-00002 and SLFP-VSL-00004).

**Basis:** This model requirement is in Section 3.1.3.4 LAW Melter Feed Vessel in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

### 3.20.3.6 SLAW Melter (SLMP-MLTR-00001_2) Identification

**Unique ID:** BMR-SLAW_MR-43

The SLAW Melter shall consist of one melter identified as SLMP-MLTR-00001_2, which represents the combined throughput capacity of two SLAW Melters (SLMP-MLTR-00001 and SLMP-MLTR-00002).

**Basis:** This model requirement is in Section 3.2.2 System Description (LAW Melter Process) in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

### 3.20.3.7 SLAW Glass Packaging Identification

**Unique ID:** BMR-SLAW_MR-6

The mass of S-ILAW glass shall be accumulated in the SLAW-Canister Accumulation Vessel, identified in TOPSim as SLAW-CANISTERS.

**Basis:** This model requirement is in Section 4.8.15 LAW Melter Process (LMP) System in 24590-WTP-MDD-PR-01-002, WTP MDD.

### 3.20.3.8 SLAW Pretreated LAW Storage Tank (SLAW-BUFFER-TANK) Feed Receipt

**Unique ID:** BMR-SLAW_MR-8

The **SLAW Pretreated LAW Storage Tank (SLAW-BUFFER-TANK)** shall receive from the following sources:

1. Concentrated *pretreated LAW* from the *Treated LAW Concentrate Storage Vessel (TCP-VSL-00001)*.
2. Concentrated recycle from the *SLAW Concentrate Storage Vessel (STCP-VSL-00001)*.

**Basis:** SLAW Treatment is based exactly upon LAW Vit and therefore this model requirement is in Section 4.8.13 LAW Concentrate Receipt Process (LCP System in 24590-WTP-MDD-PR-01-002, WTP MDD.)
3.20.3.9 SLAW Pretreated LAW Storage Tank (SLAW-BUFFER-TANK) One Sources at a Time

**Unique ID:** BMR-SLAW_MR-9

*SLAW Pretreated LAW Storage Tank (SLAW-BUFFER-TANK)* shall receive from one source at a time.

**Basis:** This is based on engineering judgement and model simplification.

3.20.3.10 SLAW Pretreated LAW Storage Tank (SLAW-BUFFER-TANK) Receipt Trigger

**Unique ID:** BMR-SLAW_MR-10

*The SLAW Pretreated LAW Storage Tank (SLAW-BUFFER-TANK)* shall be available to receive waste when the volume is below the upper set volume, and feed from *TCP-VSL-00001, STCP-VSL-00001*, or *TLS-VSL-00001/2/3* is available.

**Basis:** This is based on engineering judgement and model simplification.

3.20.3.11 SLAW Pretreated LAW Storage Tank (SLAW-BUFFER-TANK) Receipt Source Priority

**Unique ID:** BMR-SLAW_MR-44

The order of priority for *SLAW Pretreated LAW Storage Tank (SLAW-BUFFER-TANK)* waste sources shall be:

1) *SLAW Concentrate Storage Vessel (STCP-VSL-00001)*,
2) *Treated LAW Concentrate Storage Vessel (TCP-VSL-00001)*,
3) *LAWPS Treated LAW Storage Vessels (TLS-VSL-00001/2/3)*.

**Basis:** This requirement is based on engineering judgement in order to prevent recycles from backing up the system.

3.20.3.12 SLAW Pretreated LAW Storage Tank (SLAW-BUFFER-TANK) Complete Filling

**Unique ID:** BMR-SLAW_MR-11

*The SLAW Pretreated LAW Storage Tank (SLAW-BUFFER-TANK)* shall complete filling when the SLAW-BUFFER-TANK reaches its upper set volume.

**Basis:** Upper set volume is maximum allowable volume for all tanks in the model. Based on engineering judgement.

3.20.3.13 SLAW Pretreated LAW Storage Tank (SLAW-BUFFER-TANK) Routing

**Unique ID:** BMR-SLAW_MR-12

*The SLAW Pretreated LAW Storage Tank (SLAW-BUFFER-TANK)* shall transfer to the *SLAW Concentrate Receipt Vessel (SLCP-VSL-00001_2)*.

**Basis:** This model requirement is contained in Section 10.2.2 Second Low-Activity Waste Vitrification Facility in RPP-55485, TOPSim Model Design Document.
3.20.3.14 SLAW Pretreated LAW Storage Tank (SLAW-BUFFER-TANK) Transfer Complete

Unique ID: BMR-SLAW_MR-13

Discharge of the SLAW Pretreated LAW Storage Tank (SLAW-BUFFER-TANK) shall be complete when the minimum volume is reached.

Basis: This is based on engineering judgement and simplification in modeling for the SLAW Pretreated LAW Storage Tank (SLAW-BUFFER-TANK).

3.20.3.15 SLAW Concentrate Receipt Vessel (SLCP-VSL-00001_2) Receipt Trigger

Unique ID: BMR-SLAW_MR-14

The SLAW Concentrate Receipt Vessel (SLCP-VSL-00001_2) shall be available to receive a new pretreated LAW feed batch from SLAW-BUFFER-TANK when its remaining feed above the minimum volume plus the formulated glass formers amount in SGFR-TK-00022_23 do not make a full vessel batch volume of feed for the SLAW MELTER Feed Preparation Vessel (SLFP-VSL-00001_3). At that point the SLAW Concentrate Receipt Vessel (SLCP-VSL-00001_2) shall switch to filling mode.

Basis: SLAW Treatment is based exactly upon LAW Vit and therefore this model requirement is in Section 3.1.3.1 LAW Concentrate Receipt Vessel in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

The basis for operation of the LAW melter feed system is to ensure adequate feed is provided at all times for all LAW melters in operation at any one time. The feed system contains standardized equipment sized to hold the same batch capacity under similar process conditions. Therefore the LCP batch volume is such that its addition and the addition of glass formers from GFR-TK-000022_23 provides a full batch volume for LFP-VSL-00001_3.

3.20.3.16 SLAW Concentrate Receipt Vessel (SLCP-VSL-00001_2) Operation

Unique ID: BMR-SLAW_MR-15

The following operational constraints shall apply to the SLAW Concentrate Receipt Vessel (SLCP-VSL-00001_2):

1. SLCP-VSL-00001_2 shall not simultaneously fill and discharge
2. SLCP-VSL-00001_2 shall not discharge when the volume of SLCP-VSL-00001_2 is at or below the lower set volume.
3. SLCP-VSL-00001_2 shall not discharge when the remaining pretreated LAW in SLCP-VSL-00001_2 above the minimum volume plus the glass formers amount required for formulation is not sufficient to fill a full vessel batch volume of formulated feed in SLFP-VSL-00001_3, e.g. partial transfers are prohibited.

Basis: This model requirement is in Section 3.1.3.1 LAW Concentrate Receipt Vessel in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.
3.20.3.17  SLAW Concentrate Receipt Vessel (SLCP-VSL-00001_2) Complete Filling

Unique ID: BMR-SLAW_MR-16

The SLAW Concentrate Receipt Vessel (SLCP-VSL-00001_2) shall complete filling when the volume is at the upper set volume.

Basis: This model requirement is in Section 3.1.3.1 LAW Concentrate Receipt Vessel in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

3.20.3.18  SLAW Melter Feed Sampling

Unique ID: BMR-SLAW_MR-17

The amount of glass formers shall be calculated from the glass models, using the composition of the pretreated LAW to be transferred to SLCP-VSL-00001_2.

Basis: This model requirement comes from Section 3.1.3.2 Glass Former Mixers in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

3.20.3.19  SLAW Glass Formulation Calculations

Unique ID: BMR-SLAW_MR-20

Based on the SLCP-VSL-00001_2 composition, the amount of glass formers to be added (as contained in the Glass Former Mineral Addition model requirement) shall be calculated using the SLAW Selected Glass Model, subject to applicable property and composition constraints. Note that the glass models are part of the software and the actual mathematical model were tested separately.

Basis: This model requirement is in Section 3.1.3.5.2 Waste Loading and Glass Formulation in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

3.20.3.20  SLAW Glass Former Feed Hopper (SGFR-TK-00022_23) Feed Receipt

Unique ID: BMR-SLAW_MR-46

After the glass former composition has been calculated from the SLAW Selected Glass Model, the glass formers shall be added to SGFR-TK-00022_23.

Basis: This model requirement is in Section 3.1.3.2.2 Operating Logic - Glass Former Mixers in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

3.20.3.21  SLAW Sugar Receipt

Unique ID: BMR-SLAW_MR-49

After the glass formers have been added to SGFR-TK-00022_23, sugar shall be added to SGFR-TK-00022_23. See NOTE in Basis.

Basis: This model requirement is found in Section 4.8.13 LAW Concentrate Receipt Process (LCP) System in 24590-WTP-MDD-PR-01-002, WTP MDD.

NOTE: For modeling purposes however, the sugar is added at the same time along with the glass formers into the melter feed preparation vessel.
3.20.3.22 SLAW Concentrate Receipt Vessel (SLCP-VSL-00001_2) Batch Size Determination

**Unique ID:** BMR-SLAW_MR-45

After the SLCP-VSL-00001_2 sampling and formulated glass formers amount is defined, the SLFP Batch Size shall be determined. The batch size is defined according to the combined volumes of: a) SLCP-VSL-00001_2 filled to its upper set point, and b) formulated glass formers amount that generates a discrete melt feed chemical composition of known waste loading. This Batch Size determines the number of transfers that can be made to SLFP-VSL-00001_3 to fill SLFP-VSL-00001_3 to its upper set volume.

**Basis:** This model requirement is found in Section 3.1.3.3 of 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

3.20.3.23 SLAW Concentrate Receipt Vessel (SLCP-VSL-00001_2) Discharge

**Unique ID:** BMR-SLAW_MR-18

After the SLFP Batch Size has been determined, the SLCP-VSL-00001_2 shall discharge to SLAW Melter Feed Preparation Vessel (SLFP-VSL-00001_3).

**Basis:** This model requirement is found in Section 3.1.3.3 of 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

3.20.3.24 SLAW Concentrate Receipt Vessel (SLCP-VSL-00001_2) Transfer Complete

**Unique ID:** BMR-SLAW_MR-19

SLCP-VSL-00001_2 shall stop transferring to SLFP-VSL-00001_3 when the volume of SLCP-VSL-00001_2 is below the Set Volume.

**Basis:** This model requirement is in Section 3.1.3.3 LAW Melter Feed Preparation Vessel in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

3.20.3.25 SLAW Melter Feed Preparation Vessel (SLFP-VSL-00001_3) Receipt Source

**Unique ID:** BMR-SLAW_MR-21

The SLAW Melter Feed Preparation vessel (SLFP-VSL-00001_3) shall receive from the following sources:

1. LAW feed from SLAW Concentrate Receipt Vessel (SLCP-VSL-00001_2),
2. Blended glass formers from SLAW Glass Former Feed Hopper (SGFR-VSL-00022_23).

**Basis:** This model requirement is in Section 3.1.3.3 LAW Melter Feed Preparation Vessel in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

3.20.3.26 SLAW Melter Feed Preparation Vessel (SLFP-VSL-00001_3) Operation

**Unique ID:** BMR-SLAW_MR-22

The following operational constraints shall apply to the SLAW Melter Feed Preparation Vessel (SLFP-VSL-00001_3):
1. *SLFP-VSL-00001_* shall not simultaneously fill and discharge,
2. *SLFP-VSL-00001_* shall not discharge when the volume of *SLFP-VSL-00001_* is at or below the minimum volume,
3. *SLFP-VSL-00001_* shall receive LAW feed from *SLCP-VSL-00001*, after the glass former composition has been calculated and the SLFP Batch Size is determined; and then subsequently *SLFP-VSL-00001_* shall receive from *SGFR-TK-00022*.
4. Each transfer of combined volumes from *SLCP-VSL-00001* and *SGFR-TK-00022* shall fill *SLFP-VSL-00001_* to its upper set volume; i.e. partial transfers are prohibited.

**Basis:** This model requirement is in Section 3.1.3.3 LAW Melter Feed Preparation Vessel in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

### 3.20.3.27 SLAW Melter Feed Preparation Vessel (SLFP-VSL-00001) Complete Filling

**Unique ID:** BMR-SLAW_MR-23

The *SLAW Melter Feed Preparation Vessel (SLFP-VSL-00001) shall complete filling when the volume is at the upper set volume.*

**Basis:** This model requirement is in Section 3.1.3.3 LAW Melter Feed Preparation Vessel in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

### 3.20.3.28 SLAW Melter Feed Preparation Vessel (SLFP-VSL-00001) Transfer Complete

**Unique ID:** BMR-SLAW_MR-25

The *SLAW Melter Feed Preparation Vessel (SLFP-VSL-00001) shall stop transferring when it has reached its minimum volume.*

**Basis:** This model requirement is in Section 3.1.3.3.2 Operating Logic - LAW Melter Feed Preparation Vessel in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

### 3.20.3.29 SLAW Melter Feed Preparation Vessel (SLFP-VSL-00001) Routing

**Unique ID:** BMR-SLAW_MR-24

After filling is complete, the *SLAW Melter Feed Preparation Vessel (SLFP-VSL-00001) shall transfer to the SLAW Melter Feed Vessel (SLFP-VSL-00002).*

**Basis:** This model requirement is in Section 3.1.3.3.2 Operating Logic - LAW Melter Feed Preparation Vessel in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

### 3.20.3.30 SLAW Melter Feed Vessel (SLFP-VSL-00002) Receipt Source

**Unique ID:** BMR-SLAW_MR-26

The *SLAW Melter Feed Vessel (SLFP-VSL-00002) shall receive feed from the SLAW Melter Feed Preparation Vessel (SLFP-VSL-00001).*

**Basis:** This model requirement is in Section 4.8.14 LAW Feed Preparation Process (LFP) System in 24590-WTP-MDD-PR-01-002, WTP MDD.
3.20.3.31 SLAW Melter Feed Vessel (SLFP-VSL-00002_4) Receipt Trigger

Unique ID: BMR-SLAW_MR-27

SLFP-VSL-00002_4 shall be able to fill when the current volume is below the Set Volume.

Basis: This model requirement is in Section 4.8.14 LAW Feed Preparation Process (LFP) System in 24590-WTP-MDD-PR-01-002, WTP MDD.

3.20.3.32 SLAW Melter Feed Vessel (SLFP-VSL-00002_4) Simultaneous Transfers

Unique ID: BMR-SLAW_MR-28

SLFP-VSL-00002_4 shall discharge continuously to SLMP-MLTR-00001_2 while receiving from SLFP-VSL-00001_3.

Basis: This model requirement is in Section 4.8.14 LAW Feed Preparation Process (LFP) System in 24590-WTP-MDD-PR-01-002, WTP MDD.

3.20.3.33 SLAW Melter Feed Vessel (SLFP-VSL-00002_4) Discharge Rate

Unique ID: BMR-SLAW_MR-29

SLFP-VSL-00002_4 shall discharge continuously to SLAW Melter (SLMP-MLTR-00001_2) at SLAW Melter Variable Rate.

Basis: This model requirement is found in Section 4.8.14 LAW Feed Preparation Process (LFP) System in 24590-WTP-MDD-PR-01-002, WTP MDD Rev. 13.

3.20.3.34 SLAW Melter Feed Vessel (SLFP-VSL-00002_4) Complete Filling

Unique ID: BMR-SLAW_MR-50

The SLFP-VSL-00002_4 - SLAW Melter Feed Vessel shall fill to between the set volume and the upper set volume.

Basis: This model requirement is in Section 4.8.14 LAW Feed Preparation Process (LFP) System in 24590-WTP-MDD-PR-01-002, WTP MDD.

3.20.3.35 SLAW Melter Feed Vessel (SLFP-VSL-00002_4) Transfer Complete

Unique ID: BMR-SLAW_MR-30

The SLAW Melter Feed Vessel (SLFP-VSL-00002_4) shall complete transferring when it has reached its minimum volume.

Basis: This model requirement is found in Section 4.8.14 LAW Feed Preparation Process (LFP) System in 24590-WTP-MDD-PR-01-002, WTP MDD Rev. 13.

3.20.3.36 SLAW Melter (SLMP-MLTR-00001_2) Receipt

Unique ID: BMR-SLAW_MR-31

The SLMP-MLTR-00001_2 shall receive from SLFP-VSL-00002_4 when the volume of SLFP-VSL-00002_4 is above the Lower Set Volume.

Basis: This model requirement is found in Section 4.8.14 LAW Feed Preparation Process (LFP) System in 24590-WTP-MDD-PR-01-002, WTP MDD.
3.20.3.37  SLAW Melter (SLMP-MLTR-00001_2) Simultaneous Transfer and Receive  
Unique ID: BMR-SLAW_MR-32  
The SLAW Melter (SLMP-MLTR-00001_2) shall be capable of simultaneously transferring and receiving.  
Basis: Simultaneous transfer and receipts are in place to prevent the LAW melter from becoming idle. The only time that a LAW Melter Feed Preparation Vessel will stop pumping to the melter is when there is no feed available from the LAW Melter Feed Prep Vessel and that vessel is at its minimum volume. This Requirement can be found in Section 4.8.14 of 24590-WTP-MDD-PR-01-002, WTP MDD Rev. 13.

3.20.3.38  SLAW Melter Vessel (SLMP-MLTR-00001_2) Production Rate  
Unique ID: BMR-SLAW_MR-34  
The SLAW Melter (SLMP-MLTR-00001_2) shall operate at the calculated SLAW Melter Variable Rate for each glass batch as a function of glass forming oxides, solids concentration, water concentration, melt power, and SLAW Melter Ramp Rate.  
Basis: This model requirement is found in Section 4.8.15 LAW Melter Process (LMP) System in 24590-WTP-MDD-PR-01-002, WTP MDD Rev. 13.

3.20.3.39  SLAW Melter (SLMP-MLTR-00001_2) Vapor-Melt Split  
Unique ID: BMR-SLAW_MR-35  
The amount of contaminants carried into the melter offgas from SLAW Melter (SLMP-MLTR-00001_2) shall be calculated from split factors, after SLFP-VSL-00002_4 has transferred to SLMP-MLTR-00001_2.  
Basis: This model requirement is in Section 4.8.15 LAW Melter Process (LMP) System in 24590-WTP-MDD-PR-01-002, WTP MDD.

3.20.3.40  SLAW Melter (SLMP-MLTR-00001_2) Air Addition  
Unique ID: BMR-SLAW_MR-36  
The SLAW Melter (SLMP-MLTR-00001_2) shall include air addition at continuous SLAW Melter Air Flowrates. The air stream is made up of air inleakage, bubbler air, purge air, control air and cooling air. The air provides the source of oxygen for the melter reactions.  
Basis: This model requirement is in Section 4.8.15 LAW Melter Process (LMP) System in 24590-WTP-MDD-PR-01-002, WTP MDD.

3.20.3.41  SLAW Melter (SLMP-MLTR-00001_2) Reactions  
Unique ID: BMR-SLAW_MR-37  
The SLAW Glass Melt Reactions shall be applied to the contents of SLMP-MLTR-00001_2 after the melter splits have occurred.  
Basis: This model requirement is in Section 4.8.15 LAW Melter Process (LMP) System in 24590-WTP-MDD-PR-01-002, WTP MDD.
3.20.3.42 SLAW Melter (SLMP-MLTR-00001_2) Offgas Discharge

Unique ID: BMR-SLAW_MR-38

SLMP-MLTR-00001_2 shall route the melter offgas to the *SLAW Melter Submerged Bed Scrubber (SLOP-SCB-00001_2)* after the split factors and reactions have been applied.

**Basis:** This model requirement is in Section 4.8.15 LAW Melter Process (LMP) System in 24590-WTP-MDD-PR-01-002, WTP MDD.

3.20.3.43 SLAW Melter (SLMP-MLTR-00001_2) Molten Glass Discharge

Unique ID: BMR-SLAW_MR-48

After the reactions have been applied, the SLMP-MLTR-00001_2 shall discharge molten glass continuously, above the Upper Set Volume to the SLAW-CANISTER Accumulation Vessel.

**Basis:** This model requirement is in Section 4.8.15 LAW Melter Process (LMP) System in 24590-WTP-MDD-PR-01-002, WTP MDD.

3.20.3.44 SLAW Melter (SLMP-MLTR-00001_2) Idle Mode

Unique ID: BMR-SLAW_MR-40

The *SLAW Melter (SLMP-MLTR-00001_2)* is in idle mode when the following conditions occur:

- *SLMP-MLTR-00001_2* has reached its minimum volume, and
- No additional combined SLAW feed and glass formers are available,(i.e. SLFP-VSL-00002_4 is at its minimum volume), and
- *SLMP-MLTR-00001_2* has stopped discharging molten glass into the SLAW-CANISTER Accumulation Vessel.

**Basis:** This model requirement is found in Section 4.8.14 LAW Feed Preparation Process (LFP) System in 24590-WTP-MDD-PR-01-002, WTP MDD Rev. 13 where it states that "the only time that an LAW MFV will stop pumping to the melter is when there is no feed available from the LAW MFPV and the LAW MFV is at its minimum volume."

3.20.3.45 SLAW Canister Accumulation Vessel (SLAW-CANISTERS) Receipt

Unique ID: BMR-SLAW_MR-41

The SLAW-CANISTER Accumulation Vessel shall receive molten glass for Supplemental Immobilized LAW (S-ILAW) glass packaging.

**Basis:** This model requirement is found in Section 4.8.15 LAW Melter Process (LMP) System in 24590-WTP-MDD-PR-01-002, WTP MDD Rev. 13.

3.20.3.46 SLAW Canister Accumulation Vessel (SLAW-CANISTERS) Accounting

Unique ID: BMR-SLAW_MR-42

The SLAW-CANISTERS shall track produced S-ILAW glass packaging numbers based on the mass accumulated in SLAW-CANISTER Accumulation Vessel and dividing by assumed glass density and container volume.
Basis: This model requirement is found in Section 4.8.15 LAW Melter Process (LMP) System in 24590-WTP-MDD-PR-01-002, WTP MDD Rev. 13.

3.20.3.47 SLAW Spent Melter Collection

Unique ID: BMR-SLAW_MR-7

SLMP-MLTR-00001_2 shall send its contents to FAILED-SLAW-MELTERS at regular intervals as a simplification to simulate melter replacement.

Basis: The melters have a design life of 5 years, which is found in Section 4.1 Configuration Information in 24590-LAW-3ZD-LMP-00001, LMP System Design Description. Engineering judgement was utilized to simulate the melter design life in TOPSim.

3.20.4 Technical Requirements

3.20.4.1 SLAW-BUFFER-TANK - SLAW Pretreated LAW Storage Tank Parameters

Unique ID: BMR-SLAW_TR-12

The modeled SLAW-BUFFER-TANK - SLAW Pretreated LAW Storage Tank shall have the following tank parameters.

<table>
<thead>
<tr>
<th>Vessel Number</th>
<th>Maximum Volume (gal)</th>
<th>Upper Set Volume (gal)</th>
<th>Set Volume (gal)</th>
<th>Minimum Volume (gal)</th>
<th>Flow Rate - Maximum (gpm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SLAW-BUFFER-TANK</td>
<td>50,000</td>
<td>50,000</td>
<td>25,000</td>
<td>0</td>
<td>50</td>
</tr>
</tbody>
</table>


3.20.4.2 SLCP-VSL-00001_2 - SLAW Concentrate Receipt Vessel Parameters

Unique ID: BMR-SLAW_TR-13

SLCP-VSL-00001_2 - SLAW Concentrate Receipt Vessel shall have the following parametric values.

<table>
<thead>
<tr>
<th>Vessel Number</th>
<th>Maximum Volume</th>
<th>Upper Set Volume</th>
<th>Set Volume</th>
<th>Minimum Volume</th>
<th>Effluent Rate (to MFPV)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SLCP-VSL-00001_2</td>
<td>14877 gal</td>
<td>12855 gal</td>
<td>10855 gal</td>
<td>3740 gal</td>
<td>88 gpm</td>
</tr>
</tbody>
</table>
SLCP Batch Volume = Upper Set Volume - Minimum Volume
The Set Volume is a dynamically calculated lower set point to ensure that partial batch transfer to SLFP-VSL-00001_3 will not occur.

**Basis:** SLAW Treatment facility is presently assumed to be another vitrification facility with the same technical design, glass chemistry, melters, and similar feed and offgas equipment as the WTP LAW vitrification facility Therefore the parameters for LAW vitrification facility is used as reference source. These parameters are found in Appendix B of 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

### 3.20.4.3 SGFR-TK-00022_23 - SLAW Glass Former Mixer Parameters

**Unique ID:** BMR-SLAW_TR-14

**SGFR-TK-00022_23 - SLAW Glass Former Mixer** shall have the following tank parameters.

<table>
<thead>
<tr>
<th>Vessel Number</th>
<th>Maximum Volume (gal)</th>
<th>Upper Set Volume (gal)</th>
<th>Hopper Batch Volume (gal)</th>
<th>Minimum Volume (gal)</th>
<th>Flow Rate - Maximum (gpm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SGFR-TK-00022_23</td>
<td>3,516</td>
<td>3,516</td>
<td>3,516</td>
<td>0</td>
<td>49</td>
</tr>
</tbody>
</table>


Maximum Volume is defined as Overflow Volume in source document.
Upper Set Volume is defined as Filled Volume (Batch + Heel) in source document.
Minimum Volume is defined as Heel Volume in source document.

**Basis:** SLAW Treatment facility is presently assumed to be another vitrification facility with the same technical design, glass chemistry, melters, and similar feed and offgas equipment as the WTP LAW vitrification facility Therefore the parameters for LAW vitrification facility is used as reference source. Therefore this technical requirement is in Section 3.1.3.2.1 Design Data - Glass Former Mixers in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

### 3.20.4.4 SLFP-VSL-00001_3 - SLAW Melter Feed Preparation Vessel Parameters

**Unique ID:** BMR-SLAW_TR-15

The modeled **SLFP-VSL-00001_3 - SLAW Melter Feed Preparation Vessel** shall have the following parameters.
<table>
<thead>
<tr>
<th>Vessel Number</th>
<th>Maximum Volume (gal)</th>
<th>Upper Set Volume (gal)</th>
<th>Set Volume (gal)</th>
<th>Minimum Volume (gal)</th>
<th>Flow Rate - Maximum (gpm)</th>
<th>Temperature (°F)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SLFP-VSL-00001_3</td>
<td>7,489</td>
<td>5,132</td>
<td>5,132</td>
<td>1,732</td>
<td>50</td>
<td>140</td>
</tr>
</tbody>
</table>


Maximum Volume is defined as Overflow Volume in source document.
Upper Set Volume is defined as Filled Volume (Batch + Heel) in source document.
Minimum Volume is defined as Heel Volume in source document.

**Basis:** SLAW Treatment facility is presently assumed to be another vitrification facility with the same technical design, glass chemistry, melters, and similar feed and offgas equipment as the WTP LAW vitrification facility. Therefore the parameters for LAW vitrification facility is used as reference source. These parameters are found in Appendix B of 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

### 3.20.4.5 SLFP-VSL-00002_4 - SLAW Melter Feed Vessel Parameters

**Unique ID:** BMR-SLAW_TR-16

The modeled *SLFP-VSL-00002_4 - SLAW Melter Feed Vessel* shall have the following tank parameters.

<table>
<thead>
<tr>
<th>Vessel Number</th>
<th>Maximum Volume (gal)</th>
<th>Upper Set Volume (gal)</th>
<th>Set Volume (gal)</th>
<th>Minimum Volume (gal)</th>
<th>Temperature (°F)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SLFP-VSL-00002_4</td>
<td>5,786</td>
<td>4,377</td>
<td>1,119</td>
<td>977</td>
<td>140</td>
</tr>
</tbody>
</table>

Maximum Volume is defined as Overflow Volume in source document.
Upper Set Volume is defined as Filled Volume (Batch + Heel) in source document.
Minimum Volume is defined as Heel Volume in source document.

**Basis:** SLAW Treatment facility is presently assumed to be another vitrification facility with the same technical design, glass chemistry, melters, and similar feed and offgas equipment as the WTP LAW vitrification facility. Therefore the parameters for LAW vitrification facility is used...
as reference source. These parameters are found in Table B-1 of 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

3.20.4.6 SLMP-MLTR-00001_2 - SLAW Melter Parameters

Unique ID: BMR-SLAW_TR-17

The modeled SLMP-MLTR-00001_2 - SLAW Melter shall have the following tank parameters.

<table>
<thead>
<tr>
<th>Vessel Number</th>
<th>Maximum Volume (gal)</th>
<th>Upper Set Volume (gal)</th>
<th>Minimum Volume (gal)</th>
<th>Flow Rate - Maximum (gpm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SLMP-MLTR-00001_2</td>
<td>2,318</td>
<td>2,016</td>
<td>1,875</td>
<td>N/A</td>
</tr>
</tbody>
</table>

SLMP-MLTR-00001_2 Melter Batch Volume = Upper Set Volume - Minimum Volume - Cold Cap

Maximum Volume is defined as Overflow Volume in source document.
Upper Set Volume is defined as Filled Volume (Batch + Heel) in source document.
Minimum Volume is defined as Heel Volume in source document.

Basis: SLAW Treatment facility is presently assumed to be another vitrification facility with the same technical design, glass chemistry, melters, and similar feed and offgas equipment as the WTP LAW vitrification facility. Therefore the parameters for LAW vitrification facility is used as reference source. These parameters are found in Appendix B of 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

3.20.4.7 SLAW-CANISTERS Parameters

Unique ID: BMR-SLAW_TR-11

The S-ILAW Glass Container shall have the following parameters:

<p>| | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Volume</td>
<td>626</td>
<td>gal</td>
<td></td>
</tr>
<tr>
<td>Glass Mass</td>
<td>5.51</td>
<td>MT</td>
<td></td>
</tr>
<tr>
<td>Average Glass Density</td>
<td>2.58</td>
<td>MT/m³ at 20°C</td>
<td></td>
</tr>
<tr>
<td>Temperature (glass pour)</td>
<td>1150</td>
<td>°C</td>
<td></td>
</tr>
<tr>
<td>Glass Flow Rate</td>
<td>165</td>
<td>gal/hr</td>
<td></td>
</tr>
<tr>
<td>Glass Pour Time</td>
<td>0.853</td>
<td>hr</td>
<td></td>
</tr>
</tbody>
</table>

Each S-ILAW glass container shall be filled to 90% of the total volume, 564 gal (2.135 m³).

Basis: This technical requirement is in Section 3.2.3.6 LAW Container in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.
3.20.4.8 SLAW Treatment Start Date

Unique ID: BMR-SLAW_TR-20

SLAW-BUFFER-TANK shall receive the first pretreated LAW feed starting 12/31/2034.

Basis: This technical requirement is found in the system description of the Baseline Case in ORP-11242, System Plan Rev. 8.

3.20.4.9 SLAW Concentrate Receipt Batch Composition

Unique ID: BMR-SLAW_TR-21

The SLCP Batch Volume, shall have the composition of TCP-VSL-00001, STCP-VSL-00001, inter-facility flush water, feed from the Interim LAW Feed Tank, and the heel below the Set Volume in SLCP-VSL-00001_2.

Basis: This technical requirement is in Section 3.1.3.1 LAW Concentrate Receipt Vessel in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

3.20.4.10 SLAW Melter Treatment Capacity

Unique ID: BMR-SLAW_TR-19

SLMP-MLTR-00001_3 - SLAW Melter shall have a total operating efficiency at full capacity of 70%, which reduces the treatment capacity to 42 MT/day. The melter design capacity is 15 MT/day/melter.

Basis: SLAW Treatment facility is presently assumed to be another vitrification facility with the same technical design, glass chemistry, melters, and similar feed and offgas equipment as the WTP LAW vitrification facility. This technical requirement is found in the "Glass Production" section for the Baseline Case in ORP-11242, System Plan Rev. 8.

3.20.4.11 SLAW Selected Glass Model

Unique ID: BMR-SLAW_TR-6

The glass former composition shall be calculated using one of the following: the DOE 2004 model or BARD Rev. 6 model, PNNL 2013 model or the PNNL 2016 model. The default model will use the PNNL 2013 model.

Basis: The default model is called out in Section 2.2.2 Glass Formulation Models in ORP-11242, System Plan Rev. 8.

3.20.4.12 SLAW Melter Ramp Rate

Unique ID: BMR-SLAW_TR-1

SLAW shall have a ramp rate schedule of:
### Ramp Rates and Dates of Progression

<table>
<thead>
<tr>
<th>Start date of rate</th>
<th>End date of rate</th>
<th>Rate of vitrification (MTG/day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>12/31/2034</td>
<td>End of Mission</td>
<td>42.0</td>
</tr>
</tbody>
</table>

*Rate of Vitrification is defined as vitrification design rate multiplied by total operating efficiency (TOE). The TOE is assumed 70 percent. The vitrification design rate for each melter is 15 MTG/day, and 60 MTG/day equivalent to 4 melters design production rate.

\[
\text{MTG} = \text{metric tons of glass.}
\]

**Basis:** SLAW Treatment facility is presently assumed to be another vitrification facility with the same technical design, glass chemistry, melters, and similar feed and offgas equipment as the WTP LAW vitrification facility. This technical requirement is found in the "Glass Production" section for the Baseline Case in ORP-11242, System Plan Rev. 8.

#### 3.20.4.13 SLAW Melter Variable Rate

**Unique ID:** BMR-SLAW_TR-7

SLMP-MLTR-00001_2 shall have the following rate:

\[
\text{Melter Rate} = \min(\text{Ramp Rate, TOE} \times N_{\text{melters}} \times M_{\text{Rate}}, \text{TOE} \times \text{melters} \times F_{\text{day}}) \text{ MTG/day}
\]

Where:

- Ramp Rate is the SLAW melter ramp rate specified in BMR-TR-428.
- TOE is the Total Operating Efficiency of the process, 0.7.
- \(N_{\text{melters}}\) is the number of melters in the SLAW Treatment facility, 4.

\[
M_{\text{Rate}} = -7.6 \times 10^{-2}X^2 + 0.031X + 0.0156,
\]

where \(X\) is the mass of glass per liter of feed slurry (grams waste oxides + grams frit oxides)/liters slurry.

\[
F_{\text{day}} = \frac{60.4F_g(1 - w)\rho}{(1 - w)S_f + 3171.95w}
\]
Where: $P_A$ is the available power for converting feed to glass, 998.2 kW for each LAW melter. 

$w$ is the weight fraction of free water in the melter feed vessel ($\text{free water mass}/(\text{waste mass} + \text{frit mass})$).

$r_f$ is the mass of glass per mass of feed solids ($(\text{waste oxide mass} + \text{frit oxide mass})/(\text{waste mass} + \text{frit mass} – \text{free water mass})$).

$S_E$ is the specific energy per kg feed solids, 1,915 kJ/kg.

**Basis:** This technical requirement is in 24590-WTP-MCR-PE-13-0024, LAW Melt Rate.

### 3.20.4.14 SLAW Glass Melt Reactions

**Unique ID:** BMR-SLAW_TR-2

The reactions in the glass melt shall include the following in the order listed, with the extent of reaction as written.

<table>
<thead>
<tr>
<th>Reaction Name</th>
<th>Extent of Reaction</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>OD-22</strong></td>
<td>1.0</td>
</tr>
<tr>
<td><strong>OD-1</strong></td>
<td>1.0</td>
</tr>
<tr>
<td><strong>OD-3</strong></td>
<td>1.0</td>
</tr>
<tr>
<td><strong>CL-NA-REACTION</strong></td>
<td>0.5025</td>
</tr>
<tr>
<td><strong>F-NA-REACTION</strong></td>
<td>0.5319</td>
</tr>
<tr>
<td><strong>NO3-DECOMPOSITION-VARIABLE</strong></td>
<td>Dynamic*</td>
</tr>
<tr>
<td><strong>NO2-DECOMPOSITION-VARIABLE</strong></td>
<td>Dynamic*</td>
</tr>
<tr>
<td><strong>129-I-TO-GAS</strong></td>
<td>0.4167</td>
</tr>
<tr>
<td><strong>SO4-DECOMPOSITION</strong></td>
<td>Dynamic **</td>
</tr>
<tr>
<td><strong>CR-OXIDE</strong></td>
<td>1.0</td>
</tr>
<tr>
<td>Reaction Name</td>
<td>Extent of Reaction</td>
</tr>
<tr>
<td>-----------------------------</td>
<td>--------------------</td>
</tr>
<tr>
<td>CR-OXIDE2</td>
<td>1.0</td>
</tr>
<tr>
<td>SUGAR-DECOMPOSITION</td>
<td>1.0</td>
</tr>
<tr>
<td>CN-DECOMPOSITION</td>
<td>1.0</td>
</tr>
<tr>
<td>CO3-DECOMPOSITION</td>
<td>1.0</td>
</tr>
<tr>
<td>BOIL-WATER-REACTION</td>
<td>1.0</td>
</tr>
<tr>
<td>BOIL-3-H-REACTION</td>
<td>1.0</td>
</tr>
<tr>
<td>H2O2-DECOMPOSITION</td>
<td>1.0</td>
</tr>
<tr>
<td>NH3-DECOMPOSITION</td>
<td>1.0</td>
</tr>
<tr>
<td>NH4-DECOMPOSITION</td>
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<tr>
<td>O-BOUND-TO-GAS</td>
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</tr>
<tr>
<td>OH-DECOMPOSITION</td>
<td>1.0</td>
</tr>
<tr>
<td>OH-DECOMPOSITION2</td>
<td>1.0</td>
</tr>
<tr>
<td>227-AC-OXIDE</td>
<td>1.0</td>
</tr>
<tr>
<td>AG-OXIDE</td>
<td>1.0</td>
</tr>
<tr>
<td>AL-OXIDE</td>
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</tr>
<tr>
<td>AL-OXIDE2</td>
<td>1.0</td>
</tr>
<tr>
<td>AL-OXIDE3</td>
<td>1.0</td>
</tr>
<tr>
<td>Reaction Name</td>
<td>Extent of Reaction</td>
</tr>
<tr>
<td>-------------------</td>
<td>--------------------</td>
</tr>
<tr>
<td>243-AM-OXIDE</td>
<td>1.0</td>
</tr>
<tr>
<td>241-AM-OXIDE</td>
<td>1.0</td>
</tr>
<tr>
<td>AS-OXIDE</td>
<td>1.0</td>
</tr>
<tr>
<td>B-OXIDE</td>
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<tr>
<td>137M-BA-OXIDE</td>
<td>1.0</td>
</tr>
<tr>
<td>BA-OXIDE</td>
<td>1.0</td>
</tr>
<tr>
<td>BE-OXIDE</td>
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<td>233-U-OXIDE</td>
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<td>U-OXIDE</td>
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<td>ZR-OXIDE</td>
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<tr>
<td>HG-TO-GAS-REACTION</td>
<td>1.0</td>
</tr>
</tbody>
</table>

*The reaction coefficients are dynamic.

**The conversion factor to calculate extent of reaction is dynamic.

**Basis:** Reactions are found in Section 4.8.15 LAW Melter Process (LMP) System in 24590-WTP-MDD-PR-01-002, WTP MDD.

3.20.4.15 **SLAW Glass Melt NOx Stoichiometry Data**

**Unique ID:** BMR-SLAW_TR-3

The stoichiometric coefficients shall effect the split of the NO$_3^-$ and NO$_2^-$ decomposition reactions. The stoichiometric coefficients for the NO$_3^-$ and NO$_2^-$ decomposition reactions are listed in the following table. The value of M can be found in Technical Requirement SLAW Glass Melt and SBS pH Correlation.
### Stoichiometric Coefficients for the NO₃⁻ and NO₂⁻ Decomposition Reactions.

<table>
<thead>
<tr>
<th>Reaction Number</th>
<th>Value</th>
<th>Reaction Number</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>r11</td>
<td>1</td>
<td>r21</td>
<td>1</td>
</tr>
<tr>
<td>r12</td>
<td>0.03623 × M</td>
<td>r22</td>
<td>0.03623 × M</td>
</tr>
<tr>
<td>p11</td>
<td>0.2546-0.0121 × (M-1)</td>
<td>p21</td>
<td>0.2546-0.0121 × (M-1)</td>
</tr>
<tr>
<td>p12</td>
<td>0.4239</td>
<td>p22</td>
<td>0.4239</td>
</tr>
<tr>
<td>p13</td>
<td>0.04277</td>
<td>p23</td>
<td>0.04277</td>
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<tr>
<td>p14</td>
<td>0.024154 × M</td>
<td>p24</td>
<td>0.024154 × M</td>
</tr>
<tr>
<td>p15</td>
<td>1.01339+0.0181 × (M-1)</td>
<td>p25</td>
<td>0.5134+0.0181 × (M-1)</td>
</tr>
</tbody>
</table>

Where the reactions are found in:

**NO₃-DECOMPOSITION-VARIABLE and NO₂-DECOMPOSITION-VARIABLE.**

**Basis:** This technical requirement is found in Section 4.8.15 LAW Melter Process (LMP) System in 24590-WTP-MDD-PR-01-002, WTP MDD.
3.20.4.16 SLAW Glass Melt and SBS pH Correlation

Unique ID: BMR-SLAW_TR-4

The "M" variable in the Glass Melt Reactions shall be based on the pH value in SLOP-SCB-00001_2 in the SLOP system. The "M" value shall be determined from the following table.

**Variable “M” Lookup Table.**

<table>
<thead>
<tr>
<th>Current pH</th>
<th>M</th>
<th>Current pH</th>
<th>M</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH &lt;= 3.0</td>
<td>1.05</td>
<td>7.0 &lt; pH &lt;= 7.5</td>
<td>0.99999</td>
</tr>
<tr>
<td>3.0 &lt; pH &lt;= 4.0</td>
<td>1.01</td>
<td>7.5 &lt; pH &lt;= 8.0</td>
<td>0.9999</td>
</tr>
<tr>
<td>4.0 &lt; pH &lt;= 5.0</td>
<td>1.005</td>
<td>8.0 &lt; pH &lt;= 9.0</td>
<td>0.999</td>
</tr>
<tr>
<td>5.0 &lt; pH &lt;= 6.0</td>
<td>1.001</td>
<td>9.0 &lt; pH &lt;= 10.0</td>
<td>0.995</td>
</tr>
<tr>
<td>6.0 &lt; pH &lt;= 6.5</td>
<td>1.0001</td>
<td>10.0 &lt; pH &lt;= 11.0</td>
<td>0.99</td>
</tr>
<tr>
<td>6.5 &lt; pH &lt;= 7.0</td>
<td>1.00001</td>
<td>11.0 &lt; pH</td>
<td>0.95</td>
</tr>
</tbody>
</table>

**Basis:** This technical requirement is found in Section 4.8.15 LAW Melter Process (LMP) System in 24590-WTP-MDD-PR-01-002, WTP MDD.

3.20.4.17 SLAW Melt SO4 Decomposition Conversion

Unique ID: BMR-SLAW_TR-5

The conversion factor for the SO4-DECOMPOSITION reaction shall be calculated from the following equations:

1. Calculate the equivalent mass of SO$_3$ in the glass (MSO3).
2. Calculate the weight fraction of SO$_3$ (CSO3), if all of the SO$_4^{2-}$ reacted.
   
   \[
   CSO3 = \frac{MSO3}{GlassMass}
   \]

3. Calculate the decontamination factor of SO$_4^{2-}$ (DFSO4) from one of the following conditions:

   - If CSO3 <= 0.002941, then DFSO4 = 8000
   - Else, DFSO4 = 1 / (73.5 * CSO3 - 0.216)

4. Select the decontamination factor of SO$_4^{2-}$ based on the maximum between the DFSO4 from the previous step and the value 2.8.

   - DFSO4 = max(2.8,DFS04)
5. Calculate the conversion of $\text{SO}_4^{2-}$

- conversion = $1.0 / \text{DFSO}_4$

Note: extent of reaction = conversion $\times$ initial mole of $\text{SO}_4$

**Basis:** This technical requirement is found in Section 4.8.15 LAW Melter Process (LMP) System in 24590-WTP-MDD-PR-01-002, WTP MDD.

### 3.20.4.18 SLAW Melter Process Splits

**Unique ID:** BMR-SLAW_TR-8

SLMP-MLTR-00001_2 shall use the split factors listed on the tab "SLMP-MLTR-00001-2" in SVF-1778.

**Basis:** This technical requirement is in Section 4.8.15 LAW Melter Process (LMP) System in 24590-WTP-MDD-PR-01-002, WTP MDD.

### 3.20.4.19 SLAW Melter Air Flowrates

**Unique ID:** BMR-SLAW_TR-9

The air added to the SLAW Melter (SLMP-MLTR-00001_2) shall have a flowrate of 1182.5 cfm per melter (measured at: 25°C and 1 atm).

**Basis:** SLAW Treatment facility is presently assumed to be another vitrification facility with the same technical design, glass chemistry, melters, and similar feed and offgas equipment as the WTP LAW vitrification facility. Therefore the parameters for LAW vitrification facility is used as reference source. This technical requirement is based on Table B-15 of WTP-MDD, 24590-WTP-MDD-PR-01-002, Rev. 13 and listed as 946 cfm measured in standard conditions: 20°C and 1 atm for each melter. However, the air addition make-up for the TOPSim model is at a temperature of 25°C and therefore appropriate adjustments were made to the requirement above.

### 3.20.4.20 SLAW Melter Replacement Interval

**Unique ID:** BMR-SLAW_TR-10

SLMP-MLTR-00001_2 shall send 2,016 gal of S-ILAW glass to FAILED-SLAW MELTERS vessel every 5 years for each SLMP-MLTR-00001_2 after start-up. The transfer shall be instantaneous and have the same density as the glass melt. When the combined throughput capacity and functionality of multiple SLMP-MLTR-00001_2 melters in SLAW Treatment is used, then the melter replacement frequency of every 5 years per one SLMP-MLTR-00001_2 is divided by the total number of operated SLMP-MLTR-00001_2 melters.

**Basis:** The 2,016 gal referred to is the set volume of the melter. This is found in Appendix B-1 and Section 3.2.3.1 General (LAW Melter Process) of 24590-WTP-RPT-PT-02-005, BARD Rev. 8.
3.20.4.21  SLAW Glass Former Sugar Calculation

Unique ID: BMR-SLAW_TR-22

The mass of sugar ($C_{12}H_{22}O_{11}$) shall be calculated by the following equations:

\[
\text{Mass of sugar} = \frac{((\text{Moles of NO}_2 + \text{Moles of NO}_3) \times 0.75 - \text{Moles of TOC}) \times \text{MW}_{\text{sugar}}}{12}
\]

Where the moles of NO$_2$, NO$_3$ and TOC (total organic carbon) include both the solid and liquid phases.

NOTE: Moles of TOC (as tracked in TOPSim) = (Moles of TOC) + 2*(Moles of C2O4-2)

Basis: This technical requirement is in Equations 3.2-20 through 22 in Section 3.2.3.4.3 Cold Cap Reactions (System LMP) in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

3.20.5  SLAW Treatment Figures and Diagrams

3.20.5.1  Supplemental Low Activity Waste Treatment Facility Flow Diagram

Unique ID: BMR-SLAW_FIG-1

3.21  SUPPLEMENTAL LOW-ACTIVITY WASTE TREATMENT PRIMARY OFFGAS PROCESS

The function of the second LAW primary offgas process system (SLOP) is to treat gases generated by the SLAW melter system. Treatment of these gases results in meeting air discharge permit limits. Each melter has its own offgas system, but they are modeled as a single train in
The melter offgas from SLMP-MLTR-00001_2 enters the SLAW Submerged Bed Scrubber (SBS), SLOP-SCB-00001_2. The SBS functions to remove particulates from the melter offgas and also cools the offgas to a desired temperature using chilled water. In the HSM split factors are applied to the solid, liquid and gas components entering the SBS from the melter. The fractions of components that are split are sent at saturation conditions to the Wet Electrostatic Precipitator (WESP), SLOP-WESP-00001_2, while the remaining components undergo a series of reactions provided in the HSM requirements. After the reactions have completed, the pH of the SBS solution is calculated and the calculated value is used in the SLAW melter to determine the NH3 generation. A second set of reactions take place once the pH is determined and that forces the SBS to a neutral pH. All gas components remaining after the reactions have completed are transferred to the WESP and the liquid and solid components remain in the SBS.

The SBS is designed to remain constant at the set point, volume greater than the set volume is transferred to the SBS Condensate Vessel, SLOP-VSL-00001_2. The SBS Condensate Vessel discharges once it fills to its set point. The SBS Condensate Vessel discharges back to the SBS, which then triggers a subsequent SBS discharge to the SLAW SBS Condensate Collection Vessel, SRLD-VSL-00005.

The WESP receives from the SBS and the HSM applies splits to the liquid, solid, and gas components of the stream. The split components are transferred to the HEPA filtration system; the remaining components undergo a series of reactions listed in the HSM requirements. After the reactions are complete the remaining material is transferred out of the WESP to the SLAW WESP Condensate Collection Vessel, SRLD-VSL-00004. When SRLD-VSL-00004 reaches its set volume, it transfers to the SLAW SBS Condensate Collection Vessel, SRLD-VSL-00005. The contents of SRLD-VSL-00005 then discharges to the second LAW Evaporator system, STLP.

### 3.21.1 System Requirements

#### 3.21.1.1 SLAW Primary Offgas Process (SLOP)

**Unique ID:** BMR-SLOP_SR-1

The *SLOP* system shall treat *melter offgas* generated by the *SLMP*. Each melter has a separate *SLOP* system.

**Basis:** SLAW Treatment facility is presently assumed to be another vitrification facility with the same technical design, glass chemistry, melters, and similar feed and offgas equipment as the WTP LAW vitrification facility. Therefore the parameters for LAW vitrification facility is used as reference source.
3.21.2 Functional Requirements

3.21.2.1 SLMP To SLOP

Unique ID: BMR-SLOP_FR-1

The SLOP shall have the capability to receive melter offgas from SLMP.

Basis: This functional requirement comes from section 3.3.1 Functions and Requirements of the LOP/LVP System in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

3.21.2.2 SLOP Particle Removal

Unique ID: BMR-SLOP_FR-2

The SLOP shall have the capability to remove large particulates (>1 micron) from the melter offgas.

Basis: This functional requirement comes from section 3.3.1 Functions and Requirements of the LOP/LVP System in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

3.21.2.3 SLOP Aerosols Removal

Unique ID: BMR-SLOP_FR-5

The SLOP shall have the capability to remove aerosols from the melter offgas.

Basis: This functional requirement comes from section 3.3.1 Functions and Requirements of the LOP/LVP System in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

3.21.2.4 SLOP Cooling

Unique ID: BMR-SLOP_FR-3

The SLOP shall have the capability to cool the melter offgas.

Basis: This functional requirement comes from section 3.3.1 Functions and Requirements of the LOP/LVP System in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

3.21.2.5 SLOP Condensate

Unique ID: BMR-SLOP_FR-6

The SLOP shall have the capability to collect condensate generated by melter offgas cooling.

Basis: This functional requirement comes from section 3.3.2 Process Description of the LOP/LVP System in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

3.21.2.6 SLOP Condensate Routing

Unique ID: BMR-SLOP_FR-4

The SLOP shall have the capability to route process condensate to STLP.

Basis: This functional requirement comes from section 3.3.2 Process Description of the LOP/LVP System in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.
3.21.3 Model Requirements

3.21.3.1 SLAW Submerged Bed Scrubber (SLOP-SCB-00001_2)

Unique ID: BMR-SLOP_MR-1

The SLOP system shall include one submerged bed scrubber (SBS) identified as SLOP-SCB-00001_2, which represent combined throughput capacity and functionality of multiple submerged bed scrubbers in SLAW primary offgas treatment process.

Basis: This model requirement comes from section 3.3.1 Submerged Bed Scrubber and Condensate Vessel (Basis) in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

3.21.3.2 SLAW Submerged Bed Scrubber Condensate Vessel (SLOP-VSL-00001_2)

Unique ID: BMR-SLOP_MR-2

The SLOP system shall include one submerged bed scrubber (SBS) condensate vessel identified as SLOP-VSL-00001_2, which represent combined throughput capacity and functionality of two SBS condensate vessels, SLOP-VSL-00001 and SLOP-VSL-00002 in SLAW primary offgas treatment process.

Basis: This model requirement comes from section 3.3.1 Submerged Bed Scrubber and Condensate Vessel (Basis) in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

3.21.3.3 SLAW Wet Electrostatic Precipitator (SLOP-WESP-00001_2)

Unique ID: BMR-SLOP_MR-3

The SLOP system shall include one Wet Electrostatic Precipitator (WESP) identified as SLOP-WESP-00001_2, which represents combined throughput capacity and functionality of two Wet Electrostatic Precipitators, SLOP-WESP-00001 and SLOP-WESP-00002, in SLAW primary offgas treatment process.

Basis: This model requirement comes from section 3.3.2 Wet Electrostatic Precipitator (Basis) in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

3.21.3.4 SLAW SBS Condensate Collection Vessel (SRLD-VSL-00005)

Unique ID: BMR-SLOP_MR-28

The SLOP system shall include one submerged bed scrubber (SBS) condensate collection vessel identified as SRLD-VSL-00005 which receives SLAW SBS condensate.

Basis: The recycles from the Supplemental LAW facility are not defined and it is assumed that an evaporator similar to the treated LAW evaporator will be required. This assumption can be found in Section A1.4 in ORP-11242, System Plan Rev. 8.

3.21.3.5 SLAW WESP Condensate Collection Vessel (SRLD-VSL-00004)

Unique ID: BMR-SLOP_MR-29

The SLOP system shall include one Wet Electrostatic Precipitator (WESP) condensate collection vessel identified as SRLD-VSL-00004 which receives SLAW WESP condensate.
Basis: The recycles from the Supplemental LAW facility are not defined and it is assumed that an evaporator similar to the treated LAW evaporator will be required. This assumption can be found in Section A1.4 in ORP-11242, System Plan Rev. 8.

3.21.3.6 SLAW Submerged Bed Scrubber (SLOP-SCB-00001_2) Start-Up Fill

**Unique ID:** BMR-SLOP_MR-4

The SLAW Submerged Bed Scrubber (SLOP-SCB-00001_2) shall be filled with demineralized water to the upper set volume when the SLOP system starts.

**Basis:** This model requirement comes from section 3.3.3.1.2 Operating Logic - SBS and SBS Condensate Vessel (Basis) in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

3.21.3.7 SLAW Submerged Bed Scrubber (SLOP-SCB-00001_2) Offgas Receipt

**Unique ID:** BMR-SLOP_MR-26

The SLAW Submerged Bed Scrubber (SLOP-SCB-00001_2) shall receive offgas discharge from the SLAW Melter (SLMP-MLTR-00001_2).

**Basis:** This model requirement comes from section 3.3.1 Functions and Requirements (Systems LOP/LVP) in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

3.21.3.8 SLAW Submerged Bed Scrubber (SLOP-SCB-00001_2) Condensate Receipt

**Unique ID:** BMR-SLOP_MR-43

The SLAW Submerged Bed Scrubber (SLOP-SCB-00001_2) shall receive condensate from SLAW SBS Condensate Vessel (SLOP-VSL-00001_2).

**Basis:** This model requirement comes from section 3.3.2 Process Description (Systems LOP/LVP) in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

3.21.3.9 SLAW Submerged Bed Scrubber (SLOP-SCB-00001_2) Simultaneous Receipt and Discharge

**Unique ID:** BMR-SLOP_MR-27

The SLAW Submerged Bed Scrubber (SLOP-SCB-00001_2) shall receive and discharge simultaneously.

**Basis:** This model requirement is stated as such for modeling purposes, due to the task-based design of TOPSim. However, in section 3.3.3.1 Submerged Bed Scrubber and Condensate Vessel (Basis) in 24590-WTP-RPT-PT-02-005, BARD Rev. 8 there is reference to "...thereby maintaining a constant liquid depth in the SBS scrubber section.".
3.21.3.10 SLAW Submerged Bed Scrubber (SLOP-SCB-00001_2) Offgas Components Splits

Unique ID: BMR-SLOP_MR-5

The \textit{SLOP-SCB-00001\_2 - SLAW SBS Split Factors} shall be applied to the solid, liquid and gas components in \textit{SLAW Submerged Bed Scrubber (SLOP-SCB-00001\_2)} after \textit{melter offgas receipt} from the \textit{SLAW Melter (SLMP-MLTR-00001\_2)}.

\textbf{Basis:} This model requirement comes from section 3.3.3.1.1 Design Data - SBS and SBS Condensate Vessel in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

3.21.3.11 SLAW Submerged Bed Scrubber (SLOP-SCB-00001_2) â€“ SBS Reactions

Unique ID: BMR-SLOP_MR-6

The \textit{SLOP-SCB-00001\_2 - SLAW SBS Reactions and Conversions} shall be applied after the split factors application.

\textbf{Basis:} This model requirement comes from section 3.3.3.1.5 Chemistry - SBS in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

3.21.3.12 SLAW Submerged Bed Scrubber (SLOP-SCB-00001_2) pH Determination

Unique ID: BMR-SLOP_MR-7

After the reactions have been applied, the pH of the \textit{SLOP-SCB-00001\_2} liquid shall be calculated and provided to the SLAW melter reaction calculations to determine the extend of reactions which derive the ammonia generation in the melter.

\textbf{Basis:} This model requirement is in section 4.8.16 LAW Offgas Process (LOP) Systems of the WTP MDD, 24590-WTP-MDD-PR-01-002.

3.21.3.13 SLAW Submerged Bed Scrubber (SLOP-SCB-00001_2) â€“ SBS Neutralization Reactions

Unique ID: BMR-SLOP_MR-8

The \textit{SLOP-SCB-00001\_2 - SLAW SBS pH Adjustment Reactions} shall be applied after the pH is determined.

\textbf{Basis:} This model requirement is in section 4.8.16 LAW Offgas Process (LOP) Systems of the WTP MDD, 24590-WTP-MDD-PR-01-002.

3.21.3.14 SLAW Submerged Bed Scrubber (SLOP-SCB-00001_2) â€“ SBS Offgas Saturation

Unique ID: BMR-SLOP_MR-9

The offgas from \textit{SLOP Submerged Bed Scrubber (SLOP-SCB-00001\_2)} shall be discharged at saturation conditions calculated using the \textit{Mole Fraction of Water at Saturation} equation at the \textit{SLOP-SCB-00001\_2 - SLAW SBS Outlet Conditions}. Water shall either evaporate or condense to meet the saturation mole fraction. Tritium shall follow water in proportion.

\textbf{Basis:} This model requirement is in section 4.8.16 LAW Offgas Process (LOP) Systems of the WTP MDD, 24590-WTP-MDD-PR-01-002.
3.21.3.15  SLAW Submerged Bed Scrubber (SLOP-SCB-00001_2) offgas Routing

Unique ID: BMR-SLOP_MR-10

The SLAW Submerged Bed Scrubber (SLOP-SCB-00001_2) offgas shall discharge to the SLAW Wet Electrostatic Precipitator (SLOP-WESP-00001_2) after the reactions application.

Basis: This model requirement comes from section 3.3.3.2 Wet Electrostatic Precipitator (Basis) in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

3.21.3.16  SLAW Submerged Bed Scrubber (SLOP-SCB-00001_2) Operating Volume

Unique ID: BMR-SLOP_MR-11

As condensate is generated in the SLAW Submerged Bed Scrubber (SLOP-SCB-00001_2), a comparable amount shall be transferred out to SLAW SBS Condensate Vessel (SLOP-VSL-00001_2) to maintain a constant volume in the SLAW Submerged Bed Scrubber (SLOP-SCB-00001_2) at the upper set volume.

Basis: This model requirement comes from section 3.3.3.1 Submerged Bed Scrubber and Condensate Vessel (Basis) in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

3.21.3.17  SLAW Submerged Bed Scrubber (SLOP-SCB-00001_2) Condensate Routing

Unique ID: BMR-SLOP_MR-12

The following routing constraints shall apply to SLAW Submerged Bed Scrubber (SLOP-SCB-00001_2):

1. The overflow excess shall be discharged to SLAW SBS Condensate Vessel (SLOP-VSL-00001_2), when accumulated condensate produced by the melter offgas cooling in SLOP-SCB-00001_2 reaches above the upper set volume and the SLAW SBS Condensate Vessel (SLOP-VSL-00001_2) is below the upper set volume.
2. The SLOP-SCB-00001_2 shall discharge the volume above the upper set volume to SLAW SBS Condensate Collection Vessel (SRLD-VSL-00005), when SLAW Submerged Bed Scrubber (SLOP-SCB-00001_2) receives a transfer from SLAW SBS Condensate Vessel (SLOP-VSL-00001_2).
3. The deficit liquid volume shall be supplied by adding demineralized water, when SLAW Submerged Bed Scrubber (SLOP-SCB-00001_2) volume reduces to below the upper set volume.

Basis: This model requirement comes from section 3.3.3.1 Submerged Bed Scrubber and Condensate Vessel (Basis) in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

3.21.3.18  SLAW SBS Condensate Vessel (SLOP-VSL-00001_2) Receipt and Discharge

Unique ID: BMR-SLOP_MR-13

The SLAW SBS Condensate Vessel (SLOP-VSL-00001_2) shall receive and discharge to the SLAW Submerged Bed Scrubber (SLOP-SCB-00001_2).

Basis: This model requirement comes from section 3.3.3.1 Submerged Bed Scrubber and Condensate Vessel (Basis) in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.
3.21.3.19 SLAW SBS Condensate Vessel (SLOP-VSL-00001_2) Receipt Trigger

Unique ID: BMR-SLOP_MR-14

The SLAW SBS Condensate Vessel (SLOP-VSL-00001_2) shall receive condensate when the volume is less than the upper set volume.

Basis: This model requirement comes from section 3.3.3.1 Design Data - SBS and SBS Condensate Vessel (Basis) in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

3.21.3.20 SLAW SBS Condensate Vessel (SLOP-VSL-00001_2) Complete Filling

Unique ID: BMR-SLOP_MR-15

The SLAW SBS Condensate Vessel (SLOP-VSL-00001_2) shall complete filling when SLOP-VSL-00001_2 reaches upper set volume.

Basis: This model requirement comes from section 3.3.3.1 Submerged Bed Scrubber and Condensate Vessel (Basis) in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

3.21.3.21 SLAW SBS Condensate Vessel (SLOP-VSL-00001_2) Discharge Trigger

Unique ID: BMR-SLOP_MR-16

The SLAW SBS Condensate Vessel (SLOP-VSL-00001_2) shall trigger a discharge at the upper set volume.

Basis: This model requirement is in section 4.8.16 LAW Offgas Process (LOP) Systems of the WTP MDD, 24590-WTP-MDD-PR-01-002.

3.21.3.22 SLAW SBS Condensate Vessel (SLOP-VSL-00001_2) Discharge Routing

Unique ID: BMR-SLOP_MR-44

The SLAW SBS Condensate Vessel (SLOP-VSL-00001_2) shall discharge condensate to the SLAW Submerged Bed Scrubber (SLOP-SCB-00001_2).

Basis: This model requirement comes from section 3.3.3.1.2 Operating Logic - SBS and SBS Condensate Vessel in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

3.21.3.23 SLAW SBS Condensate Vessel (SLOP-VSL-00001_2) Transfer Complete

Unique ID: BMR-SLOP_MR-17

Discharge from the SLAW SBS Condensate Vessel (SLOP-VSL-00001_2) shall end when the SLAW SBS Condensate Vessel (SLOP-VSL-00001_2) reaches minimum volume.

Basis: This model requirement comes from section 3.3.3.1.2 Operating Logic - SBS and SBS Condensate Vessel in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.
3.21.3.24 SLAW Wet Electrostatic Precipitator (SLOP-WESP-00001_2) Simultaneous Receipt and Discharge

Unique ID: BMR-SLOP_MR-18

The SLAW Wet Electrostatic Precipitator (SLOP-SCB-00001_2) shall receive and discharge simultaneously.

Basis: This model requirement is stated as such for modeling purposes, due to the task-based design of TOPSim. The recycles from the Supplemental LAW facility are not defined and it is assumed that an evaporator similar to the treated LAW evaporator will be required. This assumption can be found in Section A1.4 in ORP-11242, System Plan Rev. 8.

3.21.3.25 SLAW Wet Electrostatic Precipitator (SLOP-WESP-00001_2) Removal Splits

Unique ID: BMR-SLOP_MR-19

The SLOP-WESP-00001_2 - LAW WESP Split Factors shall be applied to the liquid, solid and gas components as the cooled offgas enters the SLAW Wet Electrostatic Precipitator (SLOP-WESP-00001_2).

Basis: This model requirement is in section 4.8.16 LAW Offgas Process (LOP) Systems of the WTP MDD, 24590-WTP-MDD-PR-01-002.

3.21.3.26 SLAW Wet Electrostatic Precipitator (SLOP-WESP-00001_2) â€“ WESP Reactions

Unique ID: BMR-SLOP_MR-20

The SLOP-WESP-00001_2 - SLAW WESP Reactions and Extents shall be applied after the splits are completed.

Basis: This model requirement is in section 4.8.16 LAW Offgas Process (LOP) Systems of the WTP MDD, 24590-WTP-MDD-PR-01-002.

3.21.3.27 SLAW Wet Electrostatic Precipitator (SLOP-WESP-00001_2) â€“ WESP Offgas Saturation

Unique ID: BMR-SLOP_MR-21

The offgas from SLAW Wet Electrostatic Precipitator (SLOP-WESP-00001_2) shall be discharged at saturation conditions calculated using the Mole Fraction of Water at Saturation equation at the SLOP-WESP-00001_2 - SLAW WESP Outlet Conditions after the SLOP-WESP-00001_2 Reactions and Conversions is applied. Then, water shall either evaporate or condense to meet the saturation mole fraction. Tritium shall follow water in proportion.

Basis: This model requirement is in section 4.8.16 LAW Offgas Process (LOP) Systems of the WTP MDD, 24590-WTP-MDD-PR-01-002.
3.21.3.28  SLAW Wet Electrostatic Precipitator (SLOP-WESP-00001_2) Water Addition

**Unique ID:** BMR-SLOP_MR-23

Demineralized water shall be added to the SLAW Wet Electrostatic Precipitator (SLOP-WESP-00001_2) at SLOP-WESP-00001_2 - SLAW WESP Water Flowrate.

**Basis:** This model requirement comes from section 3.3.3.2.2 Operating Logic - WESP in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

3.21.3.29  SLAW Wet Electrostatic Precipitator (SLOP-WESP-00001_2) Condensate Discharge

**Unique ID:** BMR-SLOP_MR-24

The SLAW Wet Electrostatic Precipitator (SLOP-WESP-00001_2) shall discharge liquid to SLAW WESP Collection Vessel (SRLD-VSL-00004) after the reactions are applied.

**Basis:** The recycles from the Supplemental LAW facility are not defined and it is assumed that an evaporator similar to the treated LAW evaporator will be required.

This assumption can be found in Section A1.4 in ORP-11242, System Plan Rev. 8.

3.21.3.30  SLAW Wet Electrostatic Precipitator (SLOP-WESP-00001_2) Offgas Routing

**Unique ID:** BMR-SLOP_MR-25

The SLAW Wet Electrostatic Precipitator (SLOP-WESP-00001_2) offgas shall discharge to SLVP High Efficiency Particulate Air Filter (SLVP-HEPA-00001AB) after the reactions are applied.

**Basis:** This model requirement comes from section 3.3.3 Vessel Ventilation in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

3.21.3.31  SLAW WESP Condensate Collection Vessel (SRLD-VSL-00004) Receipt Source

**Unique ID:** BMR-SLOP_MR-30

The SLAW WESP Condensate Collection Vessel (SRLD-VSL-00004) shall receive liquids from SLAW Wet Electrostatic Precipitator (SLOP-WESP-00001_2).

**Basis:** This model requirement is in section 4.8.11 Radioactive Liquid Waste Disposal (RLD) System of the WTP MDD, 24590-WTP-MDD-PR-01-002.

3.21.3.32  SLAW WESP Condensate Collection Vessel (SRLD-VSL-00004) Complete Filling

**Unique ID:** BMR-SLOP_MR-32

The SLAW WESP Condensate Collection Vessel (SRLD-VSL-00004) shall complete filling when the volume of SRLD-VSL-00004 is between the set volume and upper set volume.

**Basis:** This model requirement is in section 4.8.11 Radioactive Liquid Waste Disposal (RLD) System of the WTP MDD, 24590-WTP-MDD-PR-01-002. See the related requirement for RLD-VSL-00004 (BMR-RLD_MR-23) for more information.
3.21.3.33 SLAW WESP Condensate Collection Vessel (SRLD-VSL-00004) Discharge to SRLD-VSL-00005

Unique ID: BMR-SLOP_MR-34

When the volume of *SLAW WESP Condensate Collection Vessel (SRLD-VSL-00004)* is at its set volume, it shall then transfer at its maximum pump rate to the *SLAW SBS Condensate Collection Vessel (SRLD-VSL-00005)*.

**Basis:** This model requirement is in section 4.8.11 Radioactive Liquid Waste Disposal (RLD) System of the WTP MDD, 24590-WTP-MDD-PR-01-002.

3.21.3.34 SLAW WESP Condensate Collection Vessel (SRLD-VSL-00004) Transfer Complete

Unique ID: BMR-SLOP_MR-35

Discharge from the *SLAW WESP Condensate Collection Vessel (SRLD-VSL-00004)* shall end when the *SLAW WESP Condensate Collection Vessel (SRLD-VSL-00004)* reaches minimum volume.

**Basis:** This model requirement is in section 4.8.11 Radioactive Liquid Waste Disposal (RLD) System of the WTP MDD, 24590-WTP-MDD-PR-01-002.

3.21.3.35 SLAW SBS Condensate Collection Vessel (SRLD-VSL-00005) Receipt Sources

Unique ID: BMR-SLOP_MR-36

The *SLAW SBS Condensate Collection Vessel (SRLD-VSL-00005)* shall receive from the following sources:

1. Liquid transfer from the *SLAW Submerged Bed Scrubber (SLOP-SCB-00001_2)*.
2. Liquid transfer from *SLAW WESP Condensate Collection Vessel (SRLD-VSL-00004)*.

**Basis:** The recycles from the Supplemental LAW facility are not defined and it is assumed that an evaporator similar to the treated LAW evaporator will be required. This routing was based on engineering judgement for the modeling efforts.

This assumption can be found in Section A1.4 in ORP-11242, System Plan Rev. 8.

3.21.3.36 SLAW SBS Condensate Collection Vessel (SRLD-VSL-00005) Simultaneous Receipt

Unique ID: BMR-SLOP_MR-37

The *SLAW SBS Condensate Collection Vessel (SRLD-VSL-00005)* shall be capable of receiving from both of the sources simultaneously.

**Basis:** SLAW Treatment is based exactly upon LAW Vit and therefore this functional requirement is based on the description in Section 4.8.11 *Radioactive Liquid Waste Disposal (RLD)* System of 24590-WTP-MDD-PR-01-002, WTP MDD Rev. 13.
3.21.3.37  SLAW SBS Condensate Collection Vessel (SRLD-VSL-00005) Complete Filling

**Unique ID:** BMR-SLOP_MR-39

The *SLAW SBS Condensate Collection Vessel (SRLD-VSL-00005)* shall complete filling when the volume is between the set volume and upper set volume.

**Basis:** This model requirement is in section 4.8.11 Radioactive Liquid Waste Disposal (RLD) System of the WTP MDD, 24590-WTP-MDD-PR-01-002. See the related requirement for RLD-VSL-00005 (BMR-RLD_MR-27) for more information.

3.21.3.38  SLAW SBS Condensate Collection Vessel (SRLD-VSL-00005) Discharge Routing

**Unique ID:** BMR-SLOP_MR-41

The *SLAW SBS Condensate Collection Vessel (SRLD-VSL-00005)* shall transfer to one of the two *SLAW SBS Condensate Receipt Vessels (STLP-VSL-00009A and STLP-VSL-00009B)* at its maximum pump rate.

**Basis:** The recycles from the SLAW facility are not defined and it is assumed that an evaporator similar to the treated LAW evaporator will be required.

This assumption can be found in Section A1.4 in ORP-11242, System Plan Rev. 8.

3.21.3.39  SLAW SBS Condensate Collection Vessel (SRLD-VSL-00005) Transfer Complete

**Unique ID:** BMR-SLOP_MR-42

The *SLAW SBS Condensate Collection Vessel (SRLD-VSL-00005)* shall transfer at the maximum pump-rate until the vessel has reached its minimum volume.

**Basis:** This model requirement is in section 4.8.11 Radioactive Liquid Waste Disposal (RLD) System of the WTP MDD, 24590-WTP-MDD-PR-01-002.

3.21.4  Technical Requirements

3.21.4.1  SLOP-SCB-00001_2 - SLAW Submerged Bed Scrubber Parameters

**Unique ID:** BMR-SLOP_TR-14

The modeled *SLOP-SCB-00001_2 - SLAW Submerged Bed Scrubber* shall have the following tank parameters.

Maximum Volume is defined as Overflow Volume in source document.
Upper Set Volume is defined as Filled Volume (Batch + Heel) in source document.
Minimum Volume is defined as Heel Volume in source document.


SLAW Treatment facility is presently assumed to be another vitrification facility with the same technical design, glass chemistry, melters, and similar feed and offgas equipment as the WTP LAW vitrification facility. Therefore the parameters for LAW vitrification facility is used as reference source.

### 3.21.4.2 SLOP-VSL-00001_2 - SLAW SBS Condensate Vessel Parameters

**Unique ID:** BMR-SLOP_TR-15

The modeled *SLOP-VSL-00001_2 - SLAW SBS Condensate Vessel* shall have the following tank parameters.

<table>
<thead>
<tr>
<th>Vessel Number</th>
<th>Maximum Volume (gal)</th>
<th>Upper Set Volume (gal)</th>
<th>Set Volume (gal)</th>
<th>Minimum Volume (gal)</th>
<th>Flow Rate - Maximum (gpm)</th>
<th>Maximum Temperature (°F)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SLOP-VSL-00001_2</td>
<td>6,806</td>
<td>6,651</td>
<td>6,651</td>
<td>451</td>
<td>80</td>
<td>-</td>
</tr>
</tbody>
</table>

Maximum Volume is defined as Overflow Volume in source document.
Upper Set Volume is defined as Filled Volume (Batch + Heel) in source document.
Minimum Volume is defined as Heel Volume in source document.


SLAW Treatment facility is presently assumed to be another vitrification facility with the same technical design, glass chemistry, melters, and similar feed and offgas equipment as the WTP LAW vitrification facility. Therefore the parameters for LAW vitrification facility is used as reference source.

### 3.21.4.3 SRLD-VSL-00004 - SLAW WESP Condensate Collection Vessel Parameters

**Unique ID:** BMR-SLOP_TR-25

The modeled *SLAW WESP Condensate Collection Vessel (SRLD-VSL-00004)* shall have the following vessel parameters.

<table>
<thead>
<tr>
<th>Vessel Number</th>
<th>Maximum Volume (gal)</th>
<th>Upper Set Volume (gal)</th>
<th>Set Volume (gal)</th>
<th>Minimum Volume (gal)</th>
<th>Flow Rate - Maximum (gpm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SRLD-VSL-00004</td>
<td>6,456</td>
<td>5,887</td>
<td>3,387</td>
<td>1,387</td>
<td>75</td>
</tr>
</tbody>
</table>

**Basis:** SLAW Treatment facility is presently assumed to be another vitrification facility with the same technical design, glass chemistry, melters, and similar feed and offgas equipment as the WTP LAW vitrification facility.

Therefore, the vessel parameters are based on *Table E-1 Vessel Parameters* in 24590-WTP-MDD-PR-01-002, *WTP MDD* (also consistent with Table B-1, *Facility Item Datasheet* in 24590-WTP-RPT-PT-02-005, *BARD Rev. 8*). The temperature is based on engineering judgment.

### 3.21.4.4 SRLD-VSL-00005 - SLAW SBS Condensate Collection Vessel Parameters

**Unique ID:** BMR-SLOP_TR-26

The modeled SLAW SBS *Condensate Collection Vessel (SRLD-VSL-00005)* shall have the following vessel parameters.
Basis: SLAW Treatment facility is presently assumed to be another vitrification facility with the same technical design, glass chemistry, melters, and similar feed and offgas equipment as the WTP LAW vitrification facility. Therefore, the vessel parameters are based on Table E-1 Vessel Parameters in 24590-WTP-MDD-PR-01-002, WTP MDD (also consistent with Table B-1, Facility Item Datasheet in 24590-WTP-RPT-PT-02-005, BARD Rev. 8). The temperature is based on engineering judgment.

3.21.4.5 SLOP-SCB-00001_2 - SLAW SBS Split Factors

Unique ID: BMR-SLOP_TR-16

The SLOP-SCB-00001_2 - LAW Submerged Bed Scrubber shall use the split factors listed in SVF-1778 from the tab labeled "SLOP-SCB-00001-2 ".

Basis: This technical requirement for the SBS is listed in SVF-1778, HTWOS Equipment Splits Rev. 8, which in turn is derived from 24590-WTP-MDD-PR-01-002, WTP MDD.

3.21.4.6 SLOP-SCB-00001_2 - SLAW SBS Reactions and Conversions

Unique ID: BMR-SLOP_TR-17

The SLOP-SCB-00001_2 - SLAW Submerged Bed Scrubber general reactions and conversions are as follows:

<table>
<thead>
<tr>
<th>Reaction No</th>
<th>Reaction Name</th>
<th>Reaction</th>
<th>Conversion Factor(Fraction)(^{(a)})</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>HG-Gas-To-liquid</td>
<td>1.0 Hg(^+2)(g) → 1.0 Hg(^+2)(l)</td>
<td>Equation Below(^{(b)})</td>
</tr>
<tr>
<td>2</td>
<td>RXN-LAW-SBS-BO4</td>
<td>2.0 B(^+3)(s) + 1.5 O(^2)(g) + 3.0 H(_2)O(l) → 2.0 H(^+(l)) + 2.0 B(^+3)(l) + 4.0 O(BOUND)(l) + 2.0 H(_2)O(l)</td>
<td>1.0</td>
</tr>
<tr>
<td>3</td>
<td>RXN-LAW-SBS-HCL</td>
<td>1.0 HCl(g) → 1.0 H(^+(l)) + 1.0 Cl(\text{-})(l)</td>
<td>0.8588</td>
</tr>
<tr>
<td>4</td>
<td>RXN-LAW-SBS-HF</td>
<td>1.0 HF(g) → 1.0 H(^+(l)) + 1.0 F(\text{-})(l)</td>
<td>0.8384</td>
</tr>
<tr>
<td>5</td>
<td>RXN-LAW-SBS-NO2</td>
<td>3.0 NO(_2)(g) + 1.0 H(_2)O(l) → 2.0 H(^+(l)) + 2.0 NO(_3)(-l) + 1.0 NO(g)</td>
<td>0.002</td>
</tr>
<tr>
<td>6</td>
<td>RXN-LAW-SBS-NO</td>
<td>4.0 NO(g) + 2.0 H(_2)O(l) + 3.0 O(_2)(g) → 4.0 H(^+(l)) + 4.0 NO(_3)(-l)</td>
<td>0.0548</td>
</tr>
<tr>
<td></td>
<td>Reaction Equation</td>
<td>1.0 P₂O₅(g) + 3.0 H₂O(l) → 6.0 H⁺(l) + 0.5 PO₄³⁻(l) + 1.5 PO₂⁵⁻(s)</td>
<td>0.6</td>
</tr>
<tr>
<td>---</td>
<td>-----------------------------------------------------------------------------------</td>
<td>-----------------------------------------------------------------------------------------------------------------</td>
<td>-----</td>
</tr>
<tr>
<td>8</td>
<td>RXN-LAW-SBS-SO₂</td>
<td>2.0 SO₂(g) + 2.0 H₂O(l) + 1.0 O₂(g) → 4.0 H⁺(l) + 2.0 SO₄²⁻(l)</td>
<td>0.8721</td>
</tr>
<tr>
<td>9</td>
<td>RXN-LAW-SBS-129-I</td>
<td>1.0 129-I(g) → 1.0 129-I(l)</td>
<td>0.798</td>
</tr>
<tr>
<td>10</td>
<td>LAW-CL-SCRUBBER-REACTION</td>
<td>1.0 Na⁺⁺(s) + 1.0 Cl⁻(s) → 1.0 Na⁺⁺(l) + 1.0 Cl⁻(l)</td>
<td>1.0</td>
</tr>
<tr>
<td>11</td>
<td>LAW-F-SCRUBBER-REACTION</td>
<td>1.0 Na⁺⁺(s) + 1.0 F⁻(s) → 1.0 Na⁺⁺(l) + 1.0 F⁻(l)</td>
<td>1.0</td>
</tr>
<tr>
<td>12</td>
<td>RXN-LAW-SBS-MAKE-OH-NA</td>
<td>4.0 Na⁺⁺(s) + 1.0 O₂(g) + 2.0 H₂O(l) → 4.0 Na⁺⁺(l) + 4.0 OH⁻(l)</td>
<td>1.0</td>
</tr>
<tr>
<td>13</td>
<td>RXN-LAW-SBS-MAKE-OH-K</td>
<td>4.0 K⁺⁺(s) + 1.0 O₂(g) + 2.0 H₂O(l) → 4.0 K⁺⁺(l) + 4.0 OH⁻(l)</td>
<td>1.0</td>
</tr>
<tr>
<td>14</td>
<td>RXN-LAW-SBS-MAKE-OH-Ca</td>
<td>2.0 Ca⁺²⁺(s) + 1.0 O₂(g) + 2.0 H₂O(l) → 2.0 Ca⁺²⁺(l) + 4.0 OH⁻(l)</td>
<td>0.3</td>
</tr>
<tr>
<td>15</td>
<td>RXN-LAW-SBS-MAKE-OH-Sr</td>
<td>2.0 Sr⁺²⁺(s) + 1.0 O₂(g) + 2.0 H₂O(l) → 2.0 Sr⁺²⁺(l) + 4.0 OH⁻(l)</td>
<td>0.5</td>
</tr>
<tr>
<td>16</td>
<td>RXN-LAW-SBS-MAKE-OH-90-Sr</td>
<td>2.0 90-Sr(s) + 1.0 O₂(g) + 2.0 H₂O(l) → 2.0 90-Sr(l) + 4.0 OH⁻(l)</td>
<td>0.5</td>
</tr>
<tr>
<td>17</td>
<td>RXN-LAW-SBS-MAKE-OH-Li</td>
<td>4.0 Li⁺⁺(s) + 1.0 O₂(g) + 2.0 H₂O(l) → 4.0 Li⁺⁺(l) + 4.0 OH⁻(l)</td>
<td>1.0</td>
</tr>
<tr>
<td>18</td>
<td>RXN-LAW-SBS-NH3-CONDENSE</td>
<td>1.0 NH₃(g) → 1.0 NH₃(l)</td>
<td>0.90</td>
</tr>
<tr>
<td>19</td>
<td>RXN-LAW-SBS-NH3</td>
<td>1.0 NH₃(l) + 1.0 H₂O(l) → 1.0 NH₄⁺⁺(l) + 1.0 OH⁻(l)</td>
<td>Equation Below (c)</td>
</tr>
<tr>
<td>20</td>
<td>RXN-WTP-H-OH-NEUT</td>
<td>H⁺⁺(l) + OH⁻(l) → H₂O(l)</td>
<td>1.0</td>
</tr>
<tr>
<td>21</td>
<td>EVAPORATE-H₂O or CONDENSE-H₂O</td>
<td>H₂O(l) → H₂O(g) or H₂O(g) → H₂O(l)</td>
<td>Based on Saturation calculation</td>
</tr>
<tr>
<td>22</td>
<td>EVAPORATE-3-H or CONDENSE-3-H</td>
<td>1.0 3-H(l) → 1.0 3-H(g) or 1.0 3-H(g) → 1.0 3-H(l)</td>
<td>Follows water</td>
</tr>
</tbody>
</table>

(a) Conversion Factor for a reaction until one of the reactants has been depleted.

(b) Conversion Factor (CF) of the mercury reaction is dependent upon the mercury to chloride ratio in the SLAW melter feed, for example:
CF = 0.833 if Hg+2 (l, s) / Cl- (l, s) ≤ 0.1
= 0.559 if 0.1 < Hg+2 (l, s) / Cl- (l, s) ≤ 0.5
= 0.286 if Hg+2 (l, s) / Cl- (l, s) > 0.5

(c) Conversion of NH3 to NH4+ shall be calculated based on the following equation:

\[ \text{NH}_4^{CF} = \frac{\text{NH}_3_{\text{begin}} - 0.9 \times 5.682^{-3} \times \text{NH}_3_{\text{gas}}}{\text{NH}_3_{\text{begin}}} \]

Where:
\( \text{NH}_4^{CF} \) = The conversion factor for RXN-LAW-SBS-NH3.
\( \text{NH}_3_{\text{begin}} \) = Moles of NH3 liquid before the reaction.
\( \text{NH}_3_{\text{gas}} \) = Moles of NH3 gas before the reaction.

**Basis:** SLAW Treatment facility is presently assumed to be another vitrification facility with the same technical design, glass chemistry, melters, and similar feed and offgas equipment as the WTP LAW vitrification facility. Therefore, the parameters for LAW vitrification facility are used as reference source and based on values in Section 4.8.16 LAW Offgas Process (LOP) Systems from 24590-WTP-MDD-PR-01-002, Dynamic (G2) Model Design Document, Rev. 13, Bechtel National, Inc., Richland, Washington.

**3.21.4.7 SLOP-SCB-00001_2 - SLAW SBS pH Adjustment Reactions**

**Unique ID:** BMR-SLOP_TR-18

The SLOP-SCB-00001_2 - SLAW Submerged Bed Scrubber pH Adjustment reactions are as follows:

If the pH < 7 then apply the following reactions:

<table>
<thead>
<tr>
<th>Reaction Name</th>
<th>Reaction</th>
<th>Conversion</th>
</tr>
</thead>
<tbody>
<tr>
<td>RXN-WTP-NO3-NEUT</td>
<td>1.0 NO3-(l) + 10.0 H+(l) --&gt; 1.0 NH4+(l) + 3.0 H2O(l)</td>
<td>until H+ or NO3- is consumed</td>
</tr>
<tr>
<td>RXN-WTP-NO2-NEUT</td>
<td>1.0 NO2-(l) + 8.0 H+(l) --&gt; 1.0 NH4+(l) + 2.0 H2O(l)</td>
<td>until H+ or NO2- is consumed</td>
</tr>
<tr>
<td>RXN-WTP-H-OH-NEUT</td>
<td>H+(l) + OH-(l) --&gt; H2O(l)</td>
<td>1.0</td>
</tr>
</tbody>
</table>

If the pH > 7 then apply the following reaction
<table>
<thead>
<tr>
<th>Reaction Name</th>
<th>Reaction</th>
<th>Conversion</th>
</tr>
</thead>
<tbody>
<tr>
<td>RXN-WTP-NH4</td>
<td>1.0 NH4+(l) + 2.0 H2O(l) --&gt; 8.0 H+(l) + 1.0 NO2-(l)</td>
<td>until the pH=7.0 or NH4+ is consumed</td>
</tr>
<tr>
<td>RXN-WTP-H-OH-NEUT</td>
<td>H+ (l) + OH- (l) -&gt; H2O (l)</td>
<td>1.0</td>
</tr>
</tbody>
</table>

**Basis:** SLAW Treatment facility is presently assumed to be another vitrification facility with the same technical design, glass chemistry, melters, and similar feed and offgas equipment as the WTP LAW vitrification facility. Therefore the parameters for LAW vitrification facility is used as reference source and found in Section 4.8.16 LAW Offgas Process (LOP) Systems of 24590-WTP-MDD-PR-01-002, Dynamic (G2) Model Design Document, Rev. 13, Bechtel National, Inc., Richland, Washington

3.21.4.8 SLOP-SCB-00001_2 - SLAW SBS Outlet Conditions

**Unique ID:** BMR-SLOP_TR-19

The SLOP-SCB-00001_2 - SLAW Submerged Bed Scrubber outlet conditions shall be 50°C and 1.0 atmospheres.

**Basis:** This technical requirement comes from section 3.3.3.1.3 Energy Contribution - SBS and SBS Condensate Receipt Vessel in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

3.21.4.9 SLOP-WESP-00001_2 - SLAW WESP Split Factors

**Unique ID:** BMR-SLOP_TR-20

The SLOP-WESP-00001_2 - SLAW Wet Electrostatic Precipitator shall use the split factors listed in SVF-1778 from the tab labeled "SLOP-WESP-00001-2".

**Basis:** This technical requirement for the SBS is listed in SVF-1778, HTWOS Equipment Splits Rev. 8, which in turn is derived from 24590-WTP-MDD-PR-01-002, WTP MDD

3.21.4.10 SLOP-WESP-00001_2 - SLAW WESP Reactions and Conversions

**Unique ID:** BMR-SLOP_TR-21

The SLOP-WESP-00001_2 - SLAW Wet Electrostatic Precipitator general reactions and conversions are as follows:

<table>
<thead>
<tr>
<th>Reaction No</th>
<th>Reaction Name</th>
<th>Reaction</th>
<th>Conversion Factor(Fraction)(a)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>RXN-LAW-SBS-HCL</td>
<td>1.0 HCl(g) → 1.0 H+(l) + 1.0 Cl-(l)</td>
<td>0.2308</td>
</tr>
<tr>
<td>2</td>
<td>RXN-LAW-SBS-HF</td>
<td>1.0 HF(g) → 1.0 H+(l) + 1.0 F-(l)</td>
<td>0.4764</td>
</tr>
</tbody>
</table>
Basis: SLAW Treatment facility is presently assumed to be another vitrification facility with the same technical design, glass chemistry, melters, and similar feed and offgas equipment as the WTP LAW vitrification facility. Therefore the parameters for LAW vitrification facility is used as reference source and are found in Section 3.3.3.2.4 Services - WESP in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

NOTE:RXN-LAW-WESP-NO is incorrect in Dynamic (G2) Model Design Document, Rev. 13. Therefore, only the BARD reference should be used.


3.21.4.11 SLOP-WESP-00001_2 - SLAW WESP Water Flowrate

Unique ID: BMR-SLOP_TR-22

The SLOP-WESP-00001_2 - SLAW Wet Electrostatic Precipitator water addition rate shall be 0.36 gpm for each melter train in the SLOP-WESP-00001_2 - SLAW Wet Electrostatic Precipitator. Therefore, the flow rate shall be multiplied by the total number of melters in SLAW treatment, as well as the ramp-up rate and facility availability.

Basis: This is based on 24590-WTP-RPT-PT-02-005, BARD Rev. 8, Section 3.3.3.2.2 Operating Logic - WESP. Also, according to 24590-WTP-MDD-PR-01-002, WTP MDD Rev. 13, this water rate is based on 15 metric tons of glass per day melter operation and is proportional to the melter production rate if ramp up occurs.

SLAW Treatment facility is presently assumed to be another vitrification facility with the same technical design, glass chemistry, melters, and similar feed and offgas equipment as the WTP LAW vitrification facility. Therefore the parameters for LAW vitrification facility is used as reference source.
3.21.4.12 SLOP-WESP-00001_2 - SLAW WESP Outlet Conditions

**Unique ID:** BMR-SLOP_TR-24

The *SLOP-WESP-00001_2 - LAW Wet Electrostatic Precipitator* outlet conditions shall be 50°C and 1 atmosphere.

**Basis:** This technical requirement comes from section 3.3.3.2.3 Energy Contribution - WESP in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

3.22 SUPPLEMENTAL LOW-ACTIVITY WASTE TREATMENT SECONDARY OFFGAS PROCESS

The function of the second LAW secondary offgas/vessel vent process system (SLVP) is to treat gases generated by the LAW vessel vent system, discharging from the LOP. Treatment of these gases results in meeting air discharge permit limits. The LVP is designed to handle the maximum sustained flow rate from all WTP second LAW melters. This treatment system removes almost all of the remaining particulates, mercury, NOx, and miscellaneous acid gases. The second LAW offgas treatment is assumed to have the same technical assumptions as the WTP LAW offgas treatment system.

The HEPA filtration system, SLVP-HEPA-00001AB receives offgas from the SLAW WESP. Liquid and solid components from the offgas feed are captured according to the splits provided in the HSM requirements. The accumulation factor for most components is 99.99994% for the HEPA. The treated gas is then routed to the SLAW carbon absorber, SLVP-ADBR-00001AB, which uses activated carbon absorbers to remove mercury, halides, and acid gases, including 129I, in the offgas by adsorption. A large percentage of the liquid and solid components entering the LAW carbon absorber are captured, while a few of the gas components are removed. The materials leaving the SLAW carbon absorber are routed to the SLAW Catalytic Oxidizer Reducer, SLVP-SCR-00001_2.

The primary purpose of the SLAW Catalytic Oxidizer Reducer, SLVP-SCR-00001_2, is to remove NO and NO2 from the offgas. NH3 gas is added as necessary based on the amount of NO, NO2 and NH3 entering SLVP-SCR-00001_2. After the reactions have been applied, the SLVP-SCR-00001_2 discharges to the SLAW Caustic Scrubber, SLVP-SCB-00001. Upon arriving, the splits provided in the HSM requirements are applied and then reactions are completed per the HSM requirements. The offgas is discharged at saturation conditions to the second LAW Offgas Stack, SLAW-OFFGAS-STACK. After the offgas reactions, the pH of the Caustic Scrubber liquid contents is adjusted by adding enough 5.0M NaOH or water to meet the target pH, as given in the HSM requirements. Water is continuously added to the caustic scrubber to aid in cooling of the offgases. When the vessel fills to its upper limit with condensate and/or the maximum SpG is reached, the contents are transferred out to the LERF Basins.
3.22.1 System Requirements

3.22.1.1 SLAW Secondary Offgas/Vessel Vent Process (SLVP)

**Unique ID:** BMR-SLVP_SR-1

The SLVP shall receive treated *melter offgas* from the SLOP systems and provide additional treatment in order to meet liquid and gaseous effluent facility discharge limits.

**Basis:** SLAW Treatment facility is presently assumed to be another vitrification facility with the same technical design, glass chemistry, melters, and similar feed and offgas equipment as the WTP LAW vitrification facility. Therefore the parameters for LAW vitrification facility is used as reference source.

3.22.2 Functional Requirements

3.22.2.1 SLVP Receipt from SLOP

**Unique ID:** BMR-SLVP_FR-1

The SLVP shall have the capability to receive offgas from the SLOP system.

**Basis:** This functional requirement is found in Section 2.3 Basic Operational Overview in 24590-LAW-3ZD-LOP-00001, LOP and LVP System Design Description.

3.22.2.2 SLVP Particulate Removal

**Unique ID:** BMR-SLVP_FR-2

The SLVP shall have the capability to remove particulate from the melter offgas.

**Basis:** This functional requirement is found in Section 2.3 Basic Operational Overview in 24590-LAW-3ZD-LOP-00001, LOP and LVP System Design Description.

3.22.2.3 SLVP Chemical Adsorption

**Unique ID:** BMR-SLVP_FR-3

The SLVP shall have the capability to remove mercury, halides and acid gases (including $^{129}$I) in the offgas by adsorption.

**Basis:** This functional requirement is found in Section 2.3 Basic Operational Overview in 24590-LAW-3ZD-LOP-00001, LOP and LVP System Design Description.

3.22.2.4 SLVP NOx, CO and VOC Removal

**Unique ID:** BMR-SLVP_FR-4

The SLVP shall have the capability to remove NO$_x$, CO and VOC by chemical reduction.

**Basis:** This functional requirement is found in Section 2.3 Basic Operational Overview in 24590-LAW-3ZD-LOP-00001, LOP and LVP System Design Description.

3.22.2.5 SLVP Acid Gas Removal

**Unique ID:** BMR-SLVP_FR-5

The SLVP shall have the capability to remove acid gases (e.g. SO$_x$) from the offgas.
**Basis:** This functional requirement is found in Section 2.3 Basic Operational Overview in 24590-LAW-3ZD-LOP-00001, LOP and LVP System Design Description.

### 3.22.2.6 SLVP Cooling

**Unique ID:** BMR-SLVP_FR-6

The SLVP system shall have the capability to cool the treated melter offgas.

**Basis:** This functional requirement is found in Section 2.3 Basic Operational Overview in 24590-LAW-3ZD-LOP-00001, LOP and LVP System Design Description.

### 3.22.2.7 SLVP Condensate Collection

**Unique ID:** BMR-SLVP_FR-7

The SLVP system shall have the capability to collect liquid condensate.

**Basis:** This functional requirement is found in Section 2.3 Basic Operational Overview in 24590-LAW-3ZD-LOP-00001, LOP and LVP System Design Description.

### 3.22.2.8 SLVP Air Movement

**Unique ID:** BMR-SLVP_FR-8

The SLVP system shall have the capability to provide air movement for the melter offgas up through the Second LAW Facility stack and to maintain the process under a vacuum relative to the surroundings.

**Basis:** This functional requirement is found in Section 4.1 Configuration Information (System Description) in 24590-LAW-3ZD-LOP-00001, LOP and LVP System Design Description.

### 3.22.2.9 SLVP Liquid Effluent Routing

**Unique ID:** BMR-SLVP_FR-9

The SLVP system shall have the capability to discharge Liquid effluent to LERF.

**Basis:** This functional requirement is found in Section 2.3 Basic Operational Overview in 24590-LAW-3ZD-LOP-00001, LOP and LVP System Design Description.

### 3.22.2.10 SLVP Gaseous Effluent Routing

**Unique ID:** BMR-SLVP_FR-10

The SLVP system shall have the capability to discharge the treated gaseous effluent out the Second LAW Facility stack.

**Basis:** This functional requirement is found in Section 2.3 Basic Operational Overview in 24590-LAW-3ZD-LOP-00001, LOP and LVP System Design Description.
3.22.3 Model Requirements

3.22.3.1 SLVP HEPA Filters (SLVP-HEPA-00001AB)

Unique ID: BMR-SLVP_MR-1

The SLVP shall include a HEPA filter unit identified as SLVP-HEPA-00001AB, which represents the functionality of all of the HEPA filters and preheaters associated with the Second LAW Offgas.

Basis: For ease in modeling, the main train and the backup train of HEPA filters are modeled as one unit, LVP-HEPA-00001AB, according to Section 4.8.16 LAW Offgas Process (LOP) Systems 24590-WTP-MDD-PR-01-002, WTP MDD.

3.22.3.2 SLVP Carbon Adsorber (SLVP-ADBR-00001AB)

Unique ID: BMR-SLVP_MR-2

The SLVP shall include an activated carbon adsorber, identified as SLVP-ADBR-00001AB, which represents the functionality of both SLVP adsorber units.

Basis: This model requirement can be found in Section 3.3.3.6 Activated Carbon Adsorbers in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

3.22.3.3 SLVP Catalytic Oxidizer Reducer (SLVP-SCR-00001_2)

Unique ID: BMR-SLVP_MR-3

The SLVP shall include a catalytic oxidizer reducer, identified as SLVP-SCR-00001_2, which represents the functionality of the thermal catalytic oxidizer (SLVP-SCO-00001) and the selective catalytic reducer (SLVP-SCR-00001).

Basis: This model requirement's system equipment can be found in Section 3.3.2 Process Description in 24590-WTP-RPT-PT-02-005, BARD Rev. 8, and in more detail in Section 4.1.1.2 in 24590-LAW-3ZD-LOP-00001, LOP and LVP System Design Description.

3.22.3.4 SLVP Caustic Scrubber Column (SLVP-SCB-00001)

Unique ID: BMR-SLVP_MR-4

The SLVP shall include a caustic scrubber column, identified as SLVP-SCB-00001, which represents the functionality of the SLVP caustic scrubber and associated collection vessel.

Basis: This model requirement can be found in Section 3.3.3.11.2 Operating Logic - Caustic Scrubber System in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

3.22.3.5 SLVP-HEPA-00001AB Offgas Receipt

Unique ID: BMR-SLVP_MR-5

The SLVP-HEPA-00001AB - High Efficiency Particulate Air Filter shall receive offgas from the SLOP-WESP-00001-2 - Second LAW Wet Electrostatic Precipitator.

Basis: This functional requirement is found in Section 2.3 Basic Operational Overview in 24590-LAW-3ZD-LOP-00001, LOP and LVP System Design Description.
3.22.3.6  SLVP-HEPA-00001AB - High Efficiency Particulate Air Filter Contaminant Accumulation

Unique ID: BMR-SLVP_MR-6

The amount of contaminants captured and accumulated on the SLVP-HEPA-00001AB - High Efficiency Particulate Air Filter shall be calculated from the specified split factors, after receiving offgas.

Basis: This model requirement is from Section 3.3.3.5.1 Design Data - HEPA Filters in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

3.22.3.7  SLVP-HEPA-00001AB Offgas Discharge Routing

Unique ID: BMR-SLVP_MR-7

The SLVP-HEPA-00001AB - High Efficiency Particulate Air Filter shall discharge to the SLVP-ADBR-00001AB - Carbon Adsorber, after the splits have been applied.

Basis: This functional requirement is found in Section 2.3 Basic Operational Overview in 24590-LAW-3ZD-LOP-00001, LOP and LVP System Design Description.

3.22.3.8  SLVP-ADBR-00001AB - Carbon Adsorber Contaminant Accumulation

Unique ID: BMR-SLVP_MR-8

The SLVP-ADBR-00001AB - Carbon Adsorber shall accumulate contaminants based on the specified split factors, after receiving offgas.

Basis: This model requirement is from Section 3.3.3.6.1 Design Data - Activated Carbon Adsorbers in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

3.22.3.9  SLVP-ADBR-00001AB - Carbon Adsorber Routing

Unique ID: BMR-SLVP_MR-9

The SLVP-ADBR-00001AB - Carbon Adsorber shall discharge to the SLVP-SCR-00001_2 - NOx Selective Catalytic Reducer, after the splits have been applied.

Basis: This functional requirement is found in Section 2.3 Basic Operational Overview in 24590-LAW-3ZD-LOP-00001, LOP and LVP System Design Description.

3.22.3.10  SLVP-SCR-00001_2 - Catalytic Oxidizer Reducer Split Application

Unique ID: BMR-SLVP_MR-10

The SLVP-SCR-00001_2 - NOx Selective Catalytic Reducer shall apply the specified split factors, after receiving offgas. Note - that there are no modeled contaminants which accumulate based on the split factors.

Basis: This model requirement is from Section 4.8.16 LAW Offgas Process (LOP) Systems in 24590-WTP-MDD-PR-01-002, WTP MDD.
3.22.3.11  SLVP-SCR-00001_2 - Catalytic Oxidizer Reducer Reactions

Unique ID: BMR-SLVP_MR-11

The *SLVP-SCR-00001_2 - Catalytic Oxidizer Reducer Reactions and Extents* shall be applied after the splits in the *SLVP-SCR-00001_2 - NOx Selective Catalytic Reducer*.

Basis: This model requirement is from Section 3.3.3.10.1 Design Data - SCO in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

3.22.3.12  SLVP-SCR-00001_2 - Catalytic Oxidizer Reducer Ammonia Addition

Unique ID: BMR-SLVP_MR-12

Pure ammonia gas (NH₃) shall be added to the *SLVP-SCR-00001_2 - NOx Selective Catalytic Reducer* as necessary to satisfy the stoichiometric requirements of the *SLVP-SCB-00001 - Caustic Scrubber Column Reactions and Extents* and to meet the required amount of *excess ammonia*.

Basis: This model requirement is from Section 3.3.3.10.1 Design Data - SCO in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

3.22.3.13  SLVP-SCR-00001_2 - Catalytic Oxidizer Reducer Routing

Unique ID: BMR-SLVP_MR-13

The *SLVP-SCR-00001_2 - NOx Selective Catalytic Reducer* shall discharge to the *SLVP-SCB-00001 - Caustic Scrubber Column*, after the reactions have been applied.

Basis: This functional requirement is found in Section 2.3 Basic Operational Overview in 24590-LAW-3ZD-LOP-00001, LOP and LVP System Design Description.

3.22.3.14  SLVP-SCB-00001 - Caustic Scrubber Column Splits

Unique ID: BMR-SLVP_MR-14

The *SLVP-SCB-00001 - Caustic Scrubber Column* shall remove contaminants based on the specified split factors, after receiving offgas.

Basis: This model requirement is from Section 3.3.3.11.1 Design Data - Caustic Scrubber System in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

3.22.3.15  SLVP-SCB-00001 - Caustic Scrubber Column Reactions

Unique ID: BMR-SLVP_MR-15

The *SLVP-SCB-00001 - Caustic Scrubber Column Reactions and Extents* shall be applied after the splits in the *SLVP-SCB-00001 - Caustic Scrubber Column*.

Basis: This model requirement is from Section 3.3.3.11.5 Chemistry - Caustic Scrubber System in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.
3.22.3.16  **SLVP-SCB-00001 - Caustic Scrubber Column Quench Water**

**Unique ID:** BMR-SLVP_MR-16

*Water* shall be continuously added to the *SLVP-SCB-00001 - Caustic Scrubber Column* at the *SLVP-SCB-00001 - Caustic Scrubber Column Excess Quench Water Rate* when the melter is running. The water addition shall be stopped when the melter is not running.

**Basis:** This model requirement is in Attachment A2 of 24590-WTP-MRQ-PE-14-0019, Direct LAW with Evaporator.

3.22.3.17  **SLVP-SCB-00001 - Caustic Scrubber Column pH Adjustment**

**Unique ID:** BMR-SLVP_MR-17

After the offgas reactions, the pH of the *SLVP-SCB-00001 - Caustic Scrubber Column* content shall be adjusted by adding enough 5.0M *NaOH* or *Water* to meet the *SLVP-SCB-00001 Target pH*, applying the *SLVP-SCB-00001 - pH Adjustment Reactions*.

**Basis:** This model requirement is from Section 4.1.1.2.10 Caustic Scrubber in 24590-LAW-3ZD-LOP-00001, LOP and LVP System Design Description.

3.22.3.18  **SLVP-SCB-00001 - Caustic Scrubber Column Condensate Routing**

**Unique ID:** BMR-SLVP_MR-18

When the *SLVP-SCB-00001 - Discharge Trigger* condition is met, the *SLVP-SCB-00001 - Caustic Scrubber Column* shall discharge the condensate stream to one of the *LERF BASIN-1/2 - LERF Basins*.

**Basis:** This model requirement is in Section 3.3.3.11.2 Operating Logic - Caustic Scrubber System in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

3.22.3.19  **SLVP-SCB-00001 - Caustic Scrubber Column Offgas Routing**

**Unique ID:** BMR-SLVP_MR-19

The *SLVP-SCB-00001 - Caustic Scrubber Column* shall discharge the offgas stream to the *SLAW-OFFGAS-STACK*.

**Basis:** This functional requirement is found in Section 2.3 Basic Operational Overview in 24590-LAW-3ZD-LOP-00001, LOP and LVP System Design Description.

3.22.3.20  **SLVP-SCB-00001 - Caustic Scrubber Column Offgas Saturation**

**Unique ID:** BMR-SLVP_MR-20

Offgas from *SLVP-SCB-00001 - Caustic Scrubber Column* shall be discharged at saturation conditions calculated using the *Mole Fraction of Water at Saturation* equation at the *SLVP-SCB-00001 - Caustic Scrubber Column Outlet Conditions*. Water shall either evaporate or condense to meet the saturation mole fraction. Tritium shall follow water proportionally.

**Basis:** This model requirement is found in Section 4.8.16 LAW Offgas Process (LOP) Systems in 24590-WTP-MDD-PR-01-002, WTP MDD.
3.22.3.21 SLVP-SCB-00001 - Caustic Scrubber Column Discharge Trigger

Unique ID: BMR-SLVP_MR-21

The SLVP-SCB-00001 - Caustic Scrubber Column conditions for discharge are as follows:

1. The SLVP-SCB-00001 - Caustic Scrubber Column Maximum SpG is reached AND the downstream vessel is available.
2. The SLVP-SCB-00001 - Caustic Scrubber Column has filled to the set volume AND the downstream vessel is available.
3. If either the maximum SpG or the set volume has been reached AND the downstream vessel is not available then the SLVP-SCB-00001 - Caustic Scrubber Column is allowed to fill to the upper set volume.

Basis: This model requirement is in Attachment A2 of 24590-WTP-MRQ-PE-14-0019, Direct LAW with Evaporator.

3.22.3.22 SLVP-SCB-00001 - Caustic Scrubber Column Complete Discharge

Unique ID: BMR-SLVP_MR-22

The SLVP-SCB-00001 - Caustic Scrubber Column shall stop discharging when emptied to the minimum volume or the destination tank has reached its upper set volume.

Basis: This model requirement is found in Section 4.8.16 LAW Offgas Process (LOP) Systems in 24590-WTP-MDD-PR-01-002, WTP MDD.

3.22.4 Technical Requirements

3.22.4.1 SLVP-SCB-00001 - Caustic Scrubber Column Vessel Parameters

Unique ID: BMR-SLVP_TR-1

The modeled SLVP-SCB-00001 - Caustic Scrubber Column shall have the following parametric values.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>SLVP-SCB-00001</td>
<td>7,325</td>
<td>6,032</td>
<td>5,032</td>
<td>2,032</td>
<td>200</td>
<td>53.9</td>
<td>1</td>
</tr>
</tbody>
</table>

Note - The modeled SLVP-SCB-00001 includes SLVP-TK-00001 and the volumes are consistent with LVP-TK-00001.

Basis: This model requirement is found in Appendix E in LAW Offgas Process (LOP) Systems in 24590-WTP-MDD-PR-01-002, WTP MDD.
3.22.4.2 SLVP-HEPA-00001AB - High Efficiency Particulate Air Filter Split Factors

**Unique ID:** BMR-SLVP_TR-2

The *SLVP-HEPA-00001AB - High Efficiency Particulate Air Filter* accumulation calculation shall use the split factors listed in SVF-1778 from the tab labeled "SLVP-HEPA-00001AB".

**Basis:** This technical requirement is listed in SVF-1778, HTWOS Equipment Splits Rev. 8, which in turn is derived from 24590-WTP-MDD-PR-01-002, WTP MDD

3.22.4.3 SLVP-ADBR-00001AB - Carbon Adsorber Split Factors

**Unique ID:** BMR-SLVP_TR-3

The *SLVP-ADBR-00001AB - Carbon Adsorber* shall accumulate components using the split factors listed in SVF-1778 from the tab labeled "SLVP-ADBR-00001AB".

**Basis:** This technical requirement is listed in SVF-1778, HTWOS Equipment Splits Rev. 8, which in turn is derived from 24590-WTP-MDD-PR-01-002, WTP MDD

3.22.4.4 SLVP-SCR-00001_2 - Catalytic Oxidizer Reducer Split Factors

**Unique ID:** BMR-SLVP_TR-4

The *SLVP-SCR-00001_2 - NOx Selective Catalytic Reducer* accumulation calculation shall use the split factors listed in SVF-1778 from the tab labeled "SLVP-SCR-00001-2".

**Basis:** This technical requirement is listed in SVF-1778, HTWOS Equipment Splits Rev. 8, which in turn is derived from 24590-WTP-MDD-PR-01-002, WTP MDD

3.22.4.5 SLVP-SCR-00001_2 - Catalytic Oxidizer Reducer Reactions and Extents

**Unique ID:** BMR-SLVP_TR-5

The following reactions and extents shall apply to the *SLVP-SCR-00001_2 - NOx Selective Catalytic Reducer*

### Catalytic Oxidizer Reactions and Extents

<table>
<thead>
<tr>
<th>Rx#</th>
<th>Reaction Name</th>
<th>Reaction</th>
<th>*Conversion (fraction)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>RXN-LAW-CO-NO-NH3</td>
<td>4.0 NO(g) + 4.0 NH₃(g) + 1.0 O₂(g) → 4.0 N₂(g) + 6.0 H₂O(g)</td>
<td>0.98</td>
</tr>
<tr>
<td>2</td>
<td>RXN-LAW-CO-NO₂-NH₃</td>
<td>2.0 NO₂(g) + 4.0 NH₃(g) + 1.0 O₂(g) → 3.0 N₂(g) + 6.0 H₂O(g)</td>
<td>0.98</td>
</tr>
<tr>
<td>3</td>
<td>RXN-LAW-CO-SO₂-SO₃</td>
<td>1.0 SO₂(g) + 0.5 O₂(g) → 1.0 SO₃(g)</td>
<td>0.95</td>
</tr>
</tbody>
</table>
The extent of reactions shall be equal to the conversion factor or until one of the reactants has been depleted.


**Basis:** N/A

### 3.22.4.6 SLVP-SCR-00001_2 - Catalytic Oxidizer Reducer Excess Ammonia

**Unique ID:** BMR-SLVP_TR-6

The SLVP-SCR-00001_2 - NOx Selective Catalytic Reducer excess gaseous ammonia (NH₃) concentration target shall be 78 ppm.

**Basis:** N/A

### 3.22.4.7 SLVP-SCB-00001 - Caustic Scrubber Column Split Factors

**Unique ID:** BMR-SLVP_TR-7

The SLVP-SCB-00001 - Caustic Scrubber Column accumulation calculation shall use the split factors listed in SVF-1778 from the tab labeled "SLVP-SCB-00001".

**Basis:** This technical requirement is listed in SVF-1778, HTWOS Equipment Splits Rev. 8, which in turn is derived from 24590-WTP-MDD-PR-01-002, WTP MDD

### 3.22.4.8 SLVP-SCB-00001 - Caustic Scrubber Column Reactions and Extents

**Unique ID:** BMR-SLVP_TR-8

The following reactions and extents shall be applied to the SLVP-SCB-00001 - Caustic Scrubber Column

#### SLVP Caustic Scrubber Reactions and Extents

<table>
<thead>
<tr>
<th>Rx#</th>
<th>Reaction Name</th>
<th>Reaction</th>
<th><em>Conversion (fraction)</em></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>RXN-LAW-CAUSCRUB-CO2</td>
<td>1.0 CO₂(g) + 1.0 H₂O(l) → 2.0 H⁺(l) + 1.0 CO₃⁻²(l)</td>
<td>0.017</td>
</tr>
<tr>
<td>2</td>
<td>RXN-LAW-CAUSCRUB-NH3-CONDENSE</td>
<td>1.0 NH₃(g) → 1.0 NH₃(l)</td>
<td>0.2857</td>
</tr>
<tr>
<td>3</td>
<td>RXN-LAW-CAUSCRUB-NH3-REACTION</td>
<td>1.0 NH₃(l) + 1.0 H₂O(l) → 1.0 NH₄⁺(l) + 1.0 OH⁻(l)</td>
<td>*Calculated per equation below</td>
</tr>
<tr>
<td>4</td>
<td>RXN-LAW-CAUSCRUB-HCL</td>
<td>1.0 HCl(g) → 1.0 H⁺(l) + 1.0 Cl⁻(l)</td>
<td>0.99</td>
</tr>
<tr>
<td>No.</td>
<td>Reaction</td>
<td>Equation</td>
<td>Conversion Factor</td>
</tr>
<tr>
<td>-----</td>
<td>----------</td>
<td>----------</td>
<td>------------------</td>
</tr>
<tr>
<td>5</td>
<td>RXN-LAW-CAUSCRUB-HF</td>
<td>$1.0 \text{HF(g)} \rightarrow 1.0 \text{H}^+(l) + 1.0 \text{F}^-(l)$</td>
<td>0.9874</td>
</tr>
<tr>
<td>6</td>
<td>RXN-LAW-CAUSCRUB-NO2</td>
<td>$3.0 \text{NO}_2(g) + 1.0 \text{H}_2\text{O}(l) \rightarrow 2.0 \text{H}^+(l) + 2.0 \text{NO}_3^-(l) + 1.0 \text{NO}(g)$</td>
<td>0.2248</td>
</tr>
<tr>
<td>7</td>
<td>RXN-LAW-CAUSCRUB-NO</td>
<td>$4.0 \text{NO}(g) + 2.0 \text{H}_2\text{O}(l) + 3.0 \text{O}_2(g) \rightarrow 4.0 \text{H}^+(l) + 4.0 \text{NO}_3^-(l)$</td>
<td>0.2248</td>
</tr>
<tr>
<td>9</td>
<td>RXN-LAW-SBS-SO2</td>
<td>$2.0 \text{SO}_2(g) + 2.0 \text{H}_2\text{O}(l) + 1.0 \text{O}_2(g) \rightarrow 4.0 \text{H}^+(l) + 2.0 \text{SO}_4^{2-}(l)$</td>
<td>0.97</td>
</tr>
<tr>
<td>10</td>
<td>RXN-LAW-CAUSCRUB-SO3</td>
<td>$1.0 \text{SO}_3(g) + 1.0 \text{H}_2\text{O}(l) \rightarrow 2.0 \text{H}^+(l) + 1.0 \text{SO}_4^{2-}(l)$</td>
<td>0.97</td>
</tr>
<tr>
<td>11</td>
<td>EVAPORATE-H2O or CONDENSE-H2O</td>
<td>$\text{H}_2\text{O}(l) \rightarrow \text{H}_2\text{O}(g)$ or $\text{H}_2\text{O}(g) \rightarrow \text{H}_2\text{O}(l)$</td>
<td>Based on Saturation calculation</td>
</tr>
<tr>
<td>12</td>
<td>EVAPORATE-3-H or CONDENSE-3-H</td>
<td>$1.0 \text{3-H}(l) \rightarrow 1.0 \text{3-H}(g)$ or $1.0 \text{3-H}(g) \rightarrow 1.0 \text{3-H}(l)$</td>
<td>Follows water</td>
</tr>
</tbody>
</table>

*The extent of reactions shall be equal to the conversion factor or until one of the reactants has been depleted.

Note: Unless noted, extent-of-reactions are based on values from 24590-WTP-MRQ-PE-14-00019 Rev 0, Bechtel National, Inc., Richland, Washington.

The extent of reaction for the conversion of NH$_3$ to NH$_4^+$ is calculated based on the equation below.

$$NH_4^+_{CF} = \frac{NH_3_{begin} - 0.9 \times 5.682^{-3} \times NH_3_{gas}}{NH_3_{begin}}$$

Where:
- NH$_4^+_{CF}$ = The conversion factor for RXN-LAW-SBS-NH3.
- NH$_3_{begin}$ = Moles of NH$_3$ liquid before the reaction.
- NH$_3_{gas}$ = Moles of NH$_3$ gas before the reaction.

**Basis:** N/A

### 3.22.4.9 SLVP-SCB-00001 - Caustic Scrubber Column Target pH

**Unique ID:** BMR-SLVP_TR-9

The target pH for the *SLVP-SCB-00001 - Caustic Scrubber Column* shall be 9.0.
**Basis:** This model requirement is found in Section 4.8.16 LAW Offgas Process (LOP) Systems in 24590-WTP-MDD-PR-01-002, WTP MDD.

NOTE: A proposed change to the target pH = 9.75 is provided in Attachment A2 of 24590-WTP-MRQ-PE-14-0019, Direct LAW with Evaporator.

### 3.22.4.10 SLVP-SCB-00001 - Caustic Scrubber Column pH Adjustment Reactions

**Unique ID:** BMR-SLVP_TR-10

The *SLVP-SCB-00001 - Caustic Scrubber Column* pH Adjustment reactions are:

- **RXN-NH4-NEUTRALIZATION** Conversion = 1.0
- **NEUT-REACTION** Conversion = 1.0

**Basis:** The pH adjustment is found in Section 3.3.6.1 Ammonia in Water and Flowsheet Calculations in 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

### 3.22.4.11 SLVP-SCB-00001 - Caustic Scrubber Column Outlet Conditions

**Unique ID:** BMR-SLVP_TR-11

The *SLVP-SCB-00001 - Caustic Scrubber Column* outlet conditions shall be 53.9 °C and 1 atmosphere.

**Basis:** This model requirement is in Attachment A2 of 24590-WTP-MRQ-PE-14-0019, Direct LAW with Evaporator.

### 3.22.4.12 SLVP-SCB-00001 - Caustic Scrubber Column Excess Quench Water Rate

**Unique ID:** BMR-SLVP_TR-12

The *SLVP-SCB-00001 - Caustic Scrubber Column* excess quench water rate shall be 3 gpm as the scrubber is sized for 2 SLAW melters operating. This flowrate is a dynamic variable, scaling as necessary to accommodate the number of SLAW melters in operation.

**Basis:** The value of the quench water is based on 24590-WTP-MRQ-PE-14-0019, Rev 0, *Direct LAW with Evaporator*, 2014, which is 3 gpm for two melter units. Additional clarification is provided in Hanson, R.L., Email - Caustic Scrubber Quench Water.

### 3.22.4.13 SLVP-SCB-00001 - Caustic Scrubber Column Maximum SpG

**Unique ID:** BMR-SLVP_TR-13

The *SLVP-SCB-00001 - Caustic Scrubber Column* maximum SpG is 1.1.

**Basis:** This model requirement is in Attachment A2 of 24590-WTP-MRQ-PE-14-0019, Direct LAW with Evaporator.
3.22.5  SLVP Figures and Diagrams

3.22.5.1  Simplified SLVP Flow Diagram

Unique ID: BMR-SLVP_FIG-5

3.22.5.2  SLVP HEAPA and Carbon Adsorber Logic Diagram

Unique ID: BMR-SLVP_FIG-6
3.22.5.3 SLVP NOX Scrubber Logic Diagram

Unique ID: BMR-SLVP_FIG-7

3.22.5.4 SLVP Caustic Scrubber Logic Diagram

Unique ID: BMR-SLVP_FIG-8

3.23 SUPPLEMENTAL TREATED LOW-ACTIVITY WASTE EVAPORATION PROCESS

The STLP system performs concentration of the SBS condensate generated by the SLOP system. It is assumed that supplemental LAW treatment consists of vitrification, and the STLP system contains the same flowsheet and technical assumptions as the WTP TLP system. The STLP system collects and neutralizes the offgas condensate from the SLOP system SBS. The concentrate is then recycled to the front end of the Supplemental LAW Vitrification Facility and
blended with incoming treated LAW feed. The STLP system is modeled like the TLP system in the WTP.

3.23.1 System Requirements

3.23.1.1 STLP Concentrate Recycles for the Second LAW Vitrification
Unique ID: BMR-STLP_SR-1
The STLP shall receive offgas process condensate from second LAW, then concentrate it and transfer the concentrate to the SLMP.
Basis: N/A

3.23.2 Functional Requirements

3.23.2.1 STLP Feed Receipt from SLOP
Unique ID: BMR-STLP_FR-1
The STLP shall have the capability to receive melter offgas condensate from the SLOP.
Basis: N/A

3.23.2.2 STLP pH Adjustment of Feed
Unique ID: BMR-STLP_FR-2
The STLP shall have the capability to adjust the chemistry of the received offgas process condensate.
Basis: N/A

3.23.2.3 STLP Concentrate Feed
Unique ID: BMR-STLP_FR-3
The STLP shall have the capability to concentrate the received offgas process condensate using evaporation.
Basis: N/A

3.23.2.4 STLP Condense the Offgas
Unique ID: BMR-STLP_FR-4
The STLP shall have the capability to condense the vapor in the evaporator overheads.
Basis: N/A

3.23.2.5 STLP Evaporator Concentrate Transfer to Second LAW Melter
Unique ID: BMR-STLP_FR-5
The STLP shall have the capability to transfer the evaporator concentrate to the SLMP.
Basis: N/A
3.23.2.6 STLP Offgas Routing

**Unique ID:** BMR-STLP_FR-6

The STLP shall have the capability to route the *gaseous effluent* stream from the evaporator overheads to the *second LAW* stack.

**Basis:** N/A

3.23.2.7 STLP Process Condensate Routing

**Unique ID:** BMR-STLP_FR-7

The STLP shall have the capability to route the *process condensate* stream from the evaporator overheads to *LERF*.

**Basis:** N/A

3.23.3 Model Requirements

3.23.3.1 STLP LAW SBS Condensate Receipt Vessels (STLP-VSL-00009A and STLP-VSL-00009B)

**Unique ID:** BMR-STLP-10

The STLP shall include two SLAW SBS Condensate Receipt vessels identified as *STLP-VSL-00009A* and *STLP-VSL-00009B*.

**Basis:** This model requirement is based on *Section 2.12.2 TLP Process Description* of the BARD (24590-WTP-RPT-PT-02-005, BARD Rev. 8) and *Section 4.8.8 Treated LAW Evaporation Process (TLP) System* in 24590-WTP-MDD-PR-01-002, WTP MDD. STLP and TLP use same type of evaporators and similar naming convention.

3.23.3.2 SLAW Evaporator (STLP-SEP-00001)

**Unique ID:** BMR-STLP-11

The STLP shall include an evaporator vessel identified as *STLP-SEP-00001*.

**Basis:** This model requirement is based on *Section 2.12.2 TLP Process Description* of the BARD (24590-WTP-RPT-PT-02-005, BARD Rev. 8) and *Section 4.8.8 Treated LAW Evaporation Process (TLP) System* in 24590-WTP-MDD-PR-01-002, WTP MDD. STLP and TLP use same type of evaporators and similar naming convention.

3.23.3.3 SLAW Evaporator Demister (STLP-DMST-00001)

**Unique ID:** BMR-STLP-12

The STLP shall include a demister/condenser unit identified as *STLP-DMST-00001*, which represents the functionality of a demister, and condenser units (primary, inter and after).

**Basis:** This model requirement is based on *Section 4.8.8 Treated LAW Evaporation Process (TLP) System* in 24590-WTP-MDD-PR-01-002, WTP MDD. Demister/condenser unit for STLP is same as TLP.
3.23.3.4 **SLAW Concentrate Storage Vessel (STCP-VSL-00001) Identification**

**Unique ID:** BMR-STLP-31

The *STLP* system shall contain a SLAW Concentrate Storage Vessel identified as *STCP-VSL-00001*.

**Basis:** SLAW Concentrate Storage Vessel in STLP system follows same naming convention and process as TLP system.

3.23.3.5 **SLAW SBS Condensate Receipt Vessels (STLP-VSL-00009A/B) Feed Source**

**Unique ID:** BMR-STLP-13

The two *STLP-VSL-00009A/B* - *SLAW SBS Condensate Receipt Vessels* shall each receive feed from the *SRLD-VSL-00005 - SBS Condensate Collection Vessel*.

**Basis:** This model requirement is based on the description in Section 4.8.11 *Radioactive Liquid Waste Disposal (RLS) System* in 24590-WTP-MDD-PR-01-002, WTP MDD. STLP and TLP share same process that RLS and SRLS share same process.

3.23.3.6 **SLAW SBS Condensate Receipt Vessels (STLP-VSL-00009A/B) Receipt Trigger**

**Unique ID:** BMR-STLP-14

Each of the *STLP-VSL-00009A/B* - *SLAW SBS Condensate Receipt Vessels* shall be available to receive waste when the volume is less than the set volume.

**Basis:** This model requirement is based on the description in Section 4.8.8 *Treated LAW Evaporation Process (TLP) System* of 24590-WTP-MDD-PR-01-002, WTP MDD. STLP and TLP share same process.

3.23.3.7 **SLAW SBS Condensate Receipt Vessels (STLP-VSL-00009A/B) Alternate Filling**

**Unique ID:** BMR-STLP-15

The *STLP-VSL-00009A/B* - *SLAW SBS Condensate Receipt Vessels* shall fill in an alternating fashion (e.g. as one is filling the other is emptying).

**Basis:** This model requirement is based on the description in Section 4.8.8 *Treated LAW Evaporation Process (TLP) System* of 24590-WTP-MDD-PR-01-002, WTP MDD. STLP and TLP share same process.

3.23.3.8 **STLP-VSL-00009A/B - SLAW SBS Condensate Receipt Vessels Complete Filling with Waste**

**Unique ID:** BMR-STLP-16

Each of the *STLP-VSL-00009A/B* - *SLAW SBS Condensate Receipt Vessels* shall complete filling with waste when the volume is at the set volume.

**Basis:** This model requirement is based on the description in Section 4.8.8 *Treated LAW Evaporation Process (TLP) System* of 24590-WTP-MDD-PR-01-002, WTP MDD.
3.23.3.9  STLP-VSL-00009A/B - SLAW SBS Condensate Receipt Vessels Apply Reactions

Unique ID: BMR-STLP-17

Each time one of the STLP-VSL-00009A/B - SLAW SBS Condensate Receipt Vessels has been filled to the set volume the STLP-VSL-00009A/B Reactions shall be applied.

Basis: This model requirement is based the description in Section 4.8.8 Treated LAW Evaporation Process (TLP) System of 24590-WTP-MDD-PR-01-002, WTP MDD. STLP and TLP share same vessel volume/receipt conditions.

3.23.3.10  STLP-VSL-00009A/B - SLAW SBS Condensate Receipt Vessels pH Adjustment

Unique ID: BMR-STLP-18

After the reactions have been applied in the STLP-VSL-00009A/B - SLAW SBS Condensate Receipt Vessels, then the pH of the vessel shall be adjusted by adding enough STLP-VSL-00009A/B Caustic to meet the target pH not to exceed the upper set volume. After the caustic addition, the STLP-VSL-00009A/B Reactions shall be reapplied.

Basis: This model requirement is based on the description in Section 4.8.8 Treated LAW Evaporation Process (TLP) System of 24590-WTP-MDD-PR-01-002, WTP MDD. STLP and TLP share same process.

3.23.3.11  STLP-VSL-00009A/B - SLAW SBS Condensate Receipt Vessels Routing

Unique ID: BMR-STLP-19

Once the pH has been adjusted, the contents of the STLP-VSL-00009A/B - SLAW SBS Condensate Receipt Vessel shall be transferred to the STLP-SEP-00001 - SLAW Evaporator.

Basis: This model requirement is based on the description in Section 4.8.8 Treated LAW Evaporation Process (TLP) System of 24590-WTP-MDD-PR-01-002, WTP MDD. STLP and TLP share same process.

3.23.3.12 STLP-VSL-00009A/B - SLAW SBS Condensate Receipt Vessels Transfer Complete

Unique ID: BMR-STLP-20

Each of the STLP-VSL-00009A/B - SLAW SBS Condensate Receipt Vessels shall complete transferring when it has reached its minimum volume.

Basis: This model requirement is based on the description in Section 4.8.8 Treated LAW Evaporation Process (TLP) System of 24590-WTP-MDD-PR-01-002, WTP MDD. STLP and TLP share same process.

3.23.3.13 STLP-SEP-00001 - SLAW Evaporator Routing

Unique ID: BMR-STLP-21

The STLP-SEP-00001 - SLAW Evaporator shall send vapors to the STLP-DMST-00001 - SLAW Evaporator Demister and the liquid concentrate to the STCP-VSL-00001 - SLAW Evaporator Concentrate Storage Vessel.
Basis: This model requirement is based the description in Section 4.8.8 Treated LAW Evaporation Process (TLP) System of 24590-WTP-MDD-PR-01-002, WTP MDD. STLP and TLP share same evaporation process.

3.23.3.14 STLP-SEP-00001 - SLAW Evaporator Feed Receipt

Unique ID: BMR-STLP-22

The STLP-SEP-00001 - SLAW Evaporator shall receive feed from the STLP-VSL-00009A/B - SLAW SBS Condensate Receipt Vessels.

Basis: This model requirement is based the description in Section 4.8.8 Treated LAW Evaporation Process (TLP) System of 24590-WTP-MDD-PR-01-002, WTP MDD. STLP and TLP share same process, however SLAW evaporator will not receive from CXP vessels.

3.23.3.15 STLP-SEP-00001 - SLAW Evaporator Water Boil Off

Unique ID: BMR-STLP-23

The rate of water boiled off in the STLP-SEP-00001 - SLAW Evaporator shall not exceed the target STLP-SEP-00001 Maximum Boil-Off Rate.

Basis: This model requirement is based on the description in Section 4.8.8 Treated LAW Evaporation Process (TLP) System of 24590-WTP-MDD-PR-01-002, WTP MDD. STLP and TLP share same process.

3.23.3.16 STLP-SEP-00001 - SLAW Evaporator End Point

Unique ID: BMR-STLP-24

The STLP-SEP-00001 - SLAW Evaporator shall concentrate the feed to the STLP-SEP-00001 Target Concentration Endpoint.

Basis: This model requirement is based the description in Section 4.8.8 Treated LAW Evaporation Process (TLP) System of 24590-WTP-MDD-PR-01-002, WTP MDD. STLP and TLP share same process.

3.23.3.17 STLP-SEP-00001 - SLAW Evaporator Offgas Component Splits

Unique ID: BMR-STLP-25

The predicted components carried into the vapor stream from the STLP-SEP-00001 - SLAW Evaporator shall be calculated based on the method described in RPP-RPT-52097, Evaporator Partition Coefficients (see SLAW Evaporator (STLP-SEP-00001) Dynamic Decontamination Factors).

Basis: The splits for the STLP evaporator follow the recommendations in RPP-RPT-52097, Evaporator Partition Coefficients and are dynamic based on the WVR.

3.23.3.18 STLP-DMST-00001 - SLAW Evaporator Demister Routing

Unique ID: BMR-STLP-26

The STLP-DMST-00001 - SLAW Evaporator Demister vapor shall be routed to the SLAW Offgas Stack and condensate shall be routed to the LERF-BASIN-1/2 - LERF Basins.
Basis: This requirement is based on Section 10.2.1 Supplemental Transuranic Waste Treatment of RPP-55485, Rev.1.

3.23.3.19 STLP-DMST-00001 - SLAW Evaporator Demister Component Split
Unique ID: BMR-STLP-27
The predicted component splits in the STLP-DMST-00001 - SLAW Evaporator Demister offgas and condensate shall be based on the STLP-DMST-00001 Split Factors.
Basis: This model requirement is based the description in Section 4.8.8 Treated LAW Evaporation Process (TLP) System of 24590-WTP-MDD-PR-01-002, WTP MDD. STLP and TLP share same split factors.

3.23.3.20 STLP-DMST-00001 - SLAW Evaporator Demister Water Addition
Unique ID: BMR-STLP-28
The STLP-DMST-00001 - SLAW Evaporator Demister shall include the STLP-DMST-00001 Water Addition when operating, which represents the amount of steam condensate added while using the vacuum eductor system to maintain a vacuum between the evaporator and condensers.
Basis: This model requirement is based the description in Section 4.8.8 Treated LAW Evaporation Process (TLP) System of 24590-WTP-MDD-PR-01-002, WTP MDD.

3.23.3.21 STLP-DMST-00001 - SLAW Evaporator Demister Air Addition
Unique ID: BMR-STLP-29
The STLP-DMST-00001 - SLAW Evaporator Demister shall include the STLP-DMST-00001 Air Addition when operating which represents the control air used to maintain a relatively constant air flow to the vacuum eductor.
Basis: This model requirement is based on the values in Table B-10 Chemical Reagents for TLP/TCP in 24590-WTP-MDD-PR-01-002, WTP MDD. STLP and TLP share same parameters.

3.23.3.22 STLP-DMST-00001 - SLAW Evaporator Demister Offgas Conditions
Unique ID: BMR-STLP-30
Offgas from STLP-DMST-00001 - SLAW Evaporator Demister shall be discharged at the saturation conditions of the condenser outlet conditions, which is calculated by using the Mole Fraction of Water at Saturation equation at the STLP-DMST-00001 Outlet Conditions.
Basis: This model requirement is based the description in Section 2.12.3.15 Condenser Outlet Temperatures of 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

3.23.3.23 STCP-VSL-00001 - SLAW Evaporator Concentrate Storage Vessel Simultaneous Transfer and Receive
Unique ID: BMR-STLP-32
The STCP-VSL-00001 - SLAW Evaporator Concentrate Storage Vessel shall be capable of simultaneously transferring and receiving.
Basis: This model requirement is based on the description in Section 4.8.9 Treated LAW Concentrate Storage Process (TCP) System of 24590-WTP-MDD-PR-01-002, WTP MDD. STLP and TLP share same process.

3.23.3.24 STCP-VSL-00001 - SLAW Evaporator Concentrate Storage Vessel Operating Volume

Unique ID: BMR-STLP-33

The STCP-VSL-00001 - SLAW Evaporator Concentrate Storage Vessel shall operate between the minimum volume and upper set volume.

Basis: This model requirement is based on Section 4.7.2 in Chemical Reagents for TLP/TCP in 24590-WTP-MDD-PR-01-002, WTP MDD. STLP and TLP share same parameters.

3.23.3.25 STCP-VSL-00001 - SLAW Evaporator Concentrate Storage Vessel Solubility Application

Unique ID: BMR-STLP-35

The Solubility Application shall be applied to the STCP-VSL-00001 - SLAW Evaporator Concentrate Storage Vessel at the vessel temperature prior to discharge.

Basis: This model requirement is based the description in Section 4.7.16.3 Applications of 24590-WTP-MDD-PR-01-002, WTP MDD. STLP and TLP share same logic for solubility applications.

3.23.3.26 STCP-VSL-00001 - SLAW Evaporator Concentrate Storage Vessel Discharge

Unique ID: BMR-STLP-36

After solubility has been applied, the STCP-VSL-00001 - SLAW Evaporator Concentrate Storage Vessel shall discharge to the SLAW-BUFFER-TANK at its maximum pump rate when the downstream vessel is available to fill.

Basis: This requirement is based on Section 10.2.2 Second Low-Activity Waste Vitrification Facility of RPP-55485, Rev.1.

3.23.4 Technical Requirements

3.23.4.1 STLP-VSL-00009A and STLP-VSL-00009B Vessel Parameters

Unique ID: BMR-STLP_TR-1

The STLP-VSL-00009A/B - SLAW SBS Condensate Receipt Vessels shall each have the following parametric values.

<table>
<thead>
<tr>
<th>Vessel #</th>
<th>Overflow Volume (gal)</th>
<th>Maximum Volume (gal)</th>
<th>Upper Set Volume (gal)</th>
<th>Set Volume (gal)</th>
<th>Minimum Volume (gal)</th>
<th>Maximum Flow rate (gpm)</th>
<th>Temperature (C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>STLP-VSL-00009A/B</td>
<td>114,064</td>
<td>87,450</td>
<td>87,450</td>
<td>82,450</td>
<td>7,450</td>
<td>50</td>
<td>25</td>
</tr>
</tbody>
</table>

Basis: The vessel parameters are based on the values in Table E-1 (TLP-VSL-00009A/B since STLP shares same parameters with TLP); Vessel Parameters in the 24590-WTP-MDD-PR-01-
002, WTP MDD and the temperature is based on engineering judgment. The maximum pump rate is based on the boil-off rate of the evaporator.

### 3.23.4.2 SLAW Evaporator (STLP-SEP-00001) Parameters

**Unique ID:** BMR-STLP_TR-2

For simplification, the *SLAW Evaporator (STLP-SEP-00001)* shall be modeled as splitter which does not have the physical attributes of the actual vessel associated with it.

**Basis:** This is a modeling simplification. To model the evaporator for flowsheet purposes the actual physical volume is not required.

### 3.23.4.3 SLAW Evaporator Demister (STLP-DMST-00001) Vessel Parameters

**Unique ID:** BMR-STLP_TR-3

The *SLAW Evaporator Demister (STLP-DMST-00001)* shall have the following parametric values.

<table>
<thead>
<tr>
<th>Vessel #</th>
<th>Overflow Volume (gal)</th>
<th>Maximum Volume (gal)</th>
<th>Set Volume (gal)</th>
<th>Minimum Volume (gal)</th>
<th>Flow rate (gpm)</th>
<th>Temperature (C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>STLP-DMST-00001</td>
<td>N/A</td>
<td>1,300</td>
<td>350</td>
<td>50</td>
<td>66</td>
<td>30 (outlet)</td>
</tr>
</tbody>
</table>

**Basis:** The parameters for the STLP demister are based on the values in Table E-1 (TLP-DMST-00001 since STLP shares same parameters with TLP) in 24590-WTP-MDD-PR-01-002, WTP MDD. The temperature is based on the value specified in Section 2.12.3.15 Condenser Outlet Temperatures in the BARD (24590-WTP-RPT-PT-02-005, BARD Rev. 8).

### 3.23.4.4 STCP-VSL-00001 - SLAW Evaporator Concentrate Storage Vessel Parameters

**Unique ID:** BMR-STLP_TR-14

The *STCP-VSL-00001 - SLAW Evaporator Concentrate Storage Vessel* shall have the following parametric values.

<table>
<thead>
<tr>
<th>Vessel #</th>
<th>Overflow Volume (gal)</th>
<th>Maximum Volume (gal)</th>
<th>Upper Set Volume (gal)</th>
<th>Lower Set Volume (gal)</th>
<th>Minimum Volume (gal)</th>
<th>Maximum Flow rate (gpm)</th>
<th>Temperature (C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>STCP-VSL-00001</td>
<td>130,234</td>
<td>103,430</td>
<td>80,000</td>
<td>75,000</td>
<td>7,430</td>
<td>88</td>
<td>31</td>
</tr>
</tbody>
</table>

**Basis:** This requirement is based on the description in Section 4.8.8 Treated LAW Evaporation Process (TLP) System of 24590-WTP-MDD-PR-01-002, WTP MDD (also in Appendix E). STLP and TLP shares same parameters.
3.23.4.5 STLP-VSL-00009A/B - SLAW SBS Condensate Receipt Vessels Caustic

**Unique ID:** BMR-STLP_TR-4

5.0M NaOH shall be added to the STLP-VSL-00009A/B - SLAW SBS Condensate Receipt Vessels for pH adjustment.

**Basis:** This requirement is based on the description in Section 4.8.8 Treated LAW Evaporation Process (TLP) System of 24590-WTP-MDD-PR-01-002, WTP MDD (also in Table B-10). STLP and TLP shares same molarity and pH.

3.23.4.6 STLP-VSL-00009A/B - SLAW SBS Condensate Receipt Vessels Target pH

**Unique ID:** BMR-STLP_TR-5

The target pH endpoint for the STLP-VSL-00009A/B - SLAW SBS Condensate Receipt Vessels shall be 12.0.

**Basis:** This requirement is based on the description in Section 4.8.8 Treated LAW Evaporation Process (TLP) System of 24590-WTP-MDD-PR-01-002, WTP MDD (also in Table B-10). STLP and TLP shares same target pH endpoints.

3.23.4.7 STLP-VSL-00009A/B - SLAW SBS Condensate Receipt Vessels Reactions

**Unique ID:** BMR-STLP_TR-6

The STLP-VSL-00009A/B - SLAW SBS Condensate Receipt Vessels reactions are as follows:

- **RXN-NH4-NEUTRALIZATION** Conversion = 1.0
- **HG-LIQUID-to-SOLID** Conversion = 1.0
- **NEUT-REACTION** Conversion = 1.0

**Basis:** This requirement is based on the description in Section 4.8.8 Treated LAW Evaporation Process (TLP) System of 24590-WTP-MDD-PR-01-002, WTP MDD (also in Table B-10). STLP and TLP shares same conversions.

3.23.4.8 SLAW Evaporator (STLP-SEP-00001) Dynamic Decontamination Factors

**Unique ID:** BMR-STLP_TR-7

The partition factors from the "EVAP-SEP" tab of SVF-1778, Rev. 8 shall be applied to the SLAW Evaporator (STLP-SEP-00001) based on the equation 6 in RPP-RPT-52097, Recommendation for Updating Evaporator Partition Coefficients.

**Basis:** This requirement is based on SVF-1778, HTWOS Equipment Splits Rev. 8 and Equation 6 in RPP-RPT-52097, Evaporator Partition Coefficients.

3.23.4.9 SLAW Evaporator (STLP-SEP-00001) Target Concentration Endpoint

**Unique ID:** BMR-STLP_TR-8

The SLAW Evaporator (STLP-SEP-00001) target concentration endpoint is a SpG of 1.33 or 3.4 wt% solids, whichever threshold is reached first.
Basis: This requirement is based on the description in Section 4.8.8 Treated LAW Evaporation Process (TLP) System of 24590-WTP-MDD-PR-01-002, WTP MDD (also in Table B-10). STLP and TLP shares same target concentration endpoint.

3.23.4.10 SLAW Evaporator (STLP-SEP-00001) Maximum Boil-Off Rate

Unique ID: BMR-STLP_TR-9

The maximum boil-off rate for the SLAW Evaporator (STLP-SEP-00001) is 28 gpm. This is the maximum design rate of 30 gpm minus the 2 gpm used for the evaporator recycle spray.

Basis: This requirement is based on the description in Section 4.8.8 Treated LAW Evaporation Process (TLP) System of 24590-WTP-MDD-PR-01-002, WTP MDD (also in Table B-10). STLP and TLP shares same flowrate.

3.23.4.11 SLAW Evaporator Demister (STLP-DMST-00001) Water Addition

Unique ID: BMR-STLP_TR-10

The SLAW Evaporator Demister (STLP-DMST-00001) water addition shall be 0.96 gpm of water.

Basis: This requirement is based on the description in Section 4.8.8 Treated LAW Evaporation Process (TLP) System of 24590-WTP-MDD-PR-01-002, WTP MDD (also in Table B-10). STLP and TLP shares same flowrate.

3.23.4.12 SLAW Evaporator Demister (STLP-DMST-00001) Air Addition

Unique ID: BMR-STLP_TR-11

The SLAW Evaporator Demister (STLP-DMST-00001) air addition shall be at a flow rate of 5 ft³/min (@ 70 °F and 14.7 psi).

Basis: This requirement is based on the values in Table B-10 Chemical Reagents for TLP/TCP in 24590-WTP-MDD-PR-01-002, WTP MDD. TLP and STLP shares same flowrate.

3.23.4.13 SLAW Evaporator Demister (STLP-DMST-00001) Outlet Conditions

Unique ID: BMR-STLP_TR-12

The condenser outlet conditions of the SLAW Evaporator Demister (STLP-DMST-00001) shall be 30°C and 810 Torr [(1079.91 millibars/1.06579 atm)].

Basis: This requirement is based on the description in Section 2.12.3.15 Condenser Outlet Temperatures of 24590-WTP-RPT-PT-02-005, BARD Rev. 8.

3.23.4.14 SLAW Evaporator Demister (STLP-DMST-00001) Split Factors

Unique ID: BMR-STLP_TR-13

The split factors from the tab "STLP-DMST-00001" in SVF-1778, Rev. 8 shall be applied to the SLAW Evaporator Demister (STLP-DMST-00001).

Basis: This requirement is based on SVF-1778, HTWOS Equipment Splits, Rev. 8.
3.23.5 STLP Figures and Diagrams

3.23.5.1 Simplified STLP

Unique ID: BMR-STLP_DIG-1

3.23.5.2 STLP-VSL-00009A/B Operation

Unique ID: BMR-STLP_DIG-2
3.23.5.3 Second LAW Evaporator and Demister Operation

**Unique ID:** BMR-STLP_DIG-3
3.23.5.4 Second LAW Concentrate (STCP-VSL-00001) Operation

Unique ID: BMR-STLP_DIG-4
4.0 ULTRA (BLACK BOX WASTE TREATMENT AND IMMOBILIZATION PLANT/TANK-SIDE CESIUM REMOVAL/LOW-ACTIVITY WASTE PRETREATMENT SYSTEM)

Ultra is a simplified model for TSCR, LAWPS, and the WTP facilities created with the goal of reducing model run time while approximating the results of the full model.

4.1 ULTRA SYSTEM REQUIREMENTS

4.1.1 Pretreat Tank Waste

Unique ID: BMR-ULTRA_SR-1

TSCR, LAWPS, and the WTP Pretreatment Facility shall pretreat Hanford tank waste to prepare feed for the WTP LAW Vitrification Facility, Supplemental LAW Treatment, and the WTP HLW Vitrification Facility.

Basis: N/A

4.1.2 Treat Low-Activity Waste (LAW)

Unique ID: BMR-ULTRA_SR-2

The WTP LAW Vitrification Facility and Supplemental LAW Treatment shall immobilize low-activity waste (LAW) using a vitrification process.

Basis: N/A

4.1.3 Treat High-Level Waste (HLW)

Unique ID: BMR-ULTRA_SR-3

The WTP HLW Vitrification Facility shall immobilize high-level waste (HLW) using a vitrification process.

Basis: N/A

4.2 ULTRA FIGURES AND DIAGRAMS

4.2.1 Ultra WTP Model Sequence

Unique ID: BMR-ULTRA_FIG-1

Ultra WTP Model Sequence

4.3 ULTRA TANK-SIDE CESIUM REMOVAL/LOW-ACTIVITY WASTE PRETREATMENT SYSTEM

A simplified model for TSCR and LAWPS. Ultra TSCR/LAWPS removes cesium and solids from the waste feed from DST system feed tank, sends the pretreated feed forward to the DST system interim LAW storage tank (for delivery to the Ultra LAW/SLAW), and sends a stream representing the filter flushes and column replacement chemical additions to the designated DST system tank.
The primary simplification and difference between Ultra TSCR/LAWPS and the full-detail modeling of these facilities is that Ultra models the rates of pretreatment and returns to the DSTs at an average rate, instead of modeling the specific processes of column replacement and flushing.

4.3.1 Functional Requirements

4.3.1.1 Receive Waste Feed from DSTs

Unique ID: BMR-ULTRA.FR-1

The Ultra TSCR/LAWPS System shall be capable of receiving LAW feed from the DST System.

Basis: N/A

4.3.1.2 Pretreat Waste Feed

Unique ID: BMR-ULTRA.FR-4

The Ultra TSCR/LAWPS System shall be capable pretreating LAW feed by selectively removing cesium.

Basis: N/A

4.3.1.3 Send LAW to DSTs

Unique ID: BMR-ULTRA.FR-2

The Ultra TSCR/LAWPS System shall be capable of sending LAW (pretreated LAW feed) to the DST System.

Basis: N/A

4.3.1.4 Return Plant Wash to DSTs

Unique ID: BMR-ULTRA.FR-3

The Ultra TSCR/LAWPS System shall be capable of returning plant wash liquids to the DST System.

Basis: N/A

4.3.2 Model Requirements

4.3.2.1 Ultra TSCR/LAWPS Operation Trigger

Unique ID: BMR-ULTRA.MR-1

After the TSCR Start Date has passed, Ultra TSCR/LAWPS shall operate when there is pumpable supernatant volume available in the TSCR/LAWPS Feed Tank and space available in the TSCR/LAWPS Returns Receipt Tank and Interim LAW Storage Tank.

Basis: Trigger operation when both waste feed and space for the pretreated waste is available.
4.3.2.2 Ultra TSCR/LAWPS Current System

Unique ID: BMR-ULTRA_MR-8

Starting on the TSCR Start Date, the current system shall be TSCR. The current system shall switch to LAWPS when, for the first time after the TSCR End Date, the pumpable supernatant volume of the TSCR/LAWPS Feed Tank contains less than the TSCR Maximum Column Loading of cesium-137.

Basis: TSCR is shut down in favor of LAWPS on the end of the first feed campaign finishing after the LAWPS ready date. This is consistent with MYOP, Rev. 7 (MR-50331, Rev. 0).

4.3.2.3 Ultra TSCR/LAWPS Process Volume

Unique ID: BMR-ULTRA_MR-2

The Ultra TSCR/LAWPS process volume shall be the maximum limited only by all of the following constraints:

- Transferring no more than the pumpable supernatant volume in the TSCR/LAWPS Feed Tank,
- Transferring no more than the Ultra TSCR/LAWPS Maximum Process Volume,
- Transferring no more to the TSCR/LAWPS Returns Receipt Tank than the available space in the TSCR/LAWPS Returns Receipt Tank,
- And transferring no more to the Interim LAW Storage Tank than the available space in the Interim LAW Storage Tank.

Basis: Minimize the number of required transfers by transferring the maximum possible volume while not creating a transfer so long in duration that it risks causing outages in the WTP.

4.3.2.4 Ultra TSCR/LAWPS Process Duration

Unique ID: BMR-ULTRA_MR-4

The Ultra TSCR/LAWPS process duration shall be calculated based on the Ultra TSCR/LAWPS Process Volume transferred from the TSCR/LAWPS Feed Tank to the Ultra TSCR/LAWPS System and the Ultra TSCR/LAWPS Average Feed Rate calculated based on the Ultra TSCR/LAWPS Current System.

Basis: Average feed rate based on multiplying the instantaneous feed rate by the fraction of the time that the process is running (accounting for downtime required for column replacements). LAWPS is not projected to be down for a significant amount of time for column replacement, so the average feed rate is equal to the instantaneous feed rate.

4.3.2.5 Ultra TSCR/LAWPS Process Procedure

Unique ID: BMR-ULTRA_MR-3

When Ultra TSCR/LAWPS Operation is Triggered, the Ultra TSCR/LAWPS Process Volume shall be processed according to the following actions, performed in sequential order:

1. Ultra TSCR/LAWPS Solids Filtration
2. Ultra TSCR/LAWPS CsIX
3. Ultra TSCR/LAWPS Transfer Pretreated LAW Feed to DSTs

**Basis:** Procedure designed to mimic the major waste processing operations in both the TSCR and LAWPS flowsheets.

### 4.3.2.6 Ultra TSCR/LAWPS Solids Filtration

**Unique ID:** BMR-ULTRA_MR-5

Solids filtration for Ultra TSCR/LAWPS shall be simulated by transferring an additional volume of supernatant from the TSCR/LAWPS Feed Tank to the Ultra TSCR/LAWPS System and then splitting all solids and that extra amount of liquids to the TSCR/LAWPS Returns Receipt Tank. The additional volume of supernatant shall be equal to the Ultra TSCR/LAWPS Average Feed to Plant Wash Rate (calculated based on the Ultra TSCR/LAWPS Current System) over the Ultra TSCR/LAWPS Process Duration. The remainder of the stream from the TSCR/LAWPS Feed Tank to the Ultra TSCR/LAWPS System shall continue on to Ultra TSCR/LAWPS CsIX.

**Basis:** TSCR and LAWPS have prefilters capable of removing nearly all solids. The average rate that liquid feed is diverted to the plant wash receiver tank to flush the solids from the prefilters is based on the flush frequency, duration, rate, and amount of downtime required for column changeout (included in the TSCR/LAWPS Average Feed Rate).

### 4.3.2.7 Ultra TSCR/LAWPS CsIX

**Unique ID:** BMR-ULTRA_MR-6

CsIX for Ultra TSCR/LAWPS shall be simulated by removing cesium species, including Cs+, 137-Cs (and daughter 137m-Ba), and 134-Cs, from the steam to the extent specified in either the TSCR CsIX Cesium Removal Fraction or the LAWPS CsIX Cesium Removal Fraction (dependent on the Ultra TSCR/LAWPS Current System). Additionally, a volume of 0.1 Molar Caustic shall be transferred to the TSCR/LAWPS Returns Receipt Tank, based on the Ultra TSCR/LAWPS Process Duration and the Ultra TSCR/LAWPS Average Caustic to Plant Wash Rate (calculated based on the Ultra TSCR/LAWPS Current System). The remainder of the stream from the TSCR/LAWPS Feed Tank to the Ultra TSCR/LAWPS System shall continue on to DST System.

**Basis:** The average rate of 0.1 molar caustic and inhibited water (all modeled as 0.1 molar caustic for simplicity) to the plant wash receiver tank is based on the maximum column loading and amount of downtime required for column changeout (included in the TSCR/LAWPS Average Feed Rate).

### 4.3.2.8 Ultra TSCR/LAWPS Transfer Pretreated LAW Feed to DSTs

**Unique ID:** BMR-ULTRA_MR-7

The stream of pretreated LAW feed from the Ultra TSCR/LAWPS CsIX shall be transferred into the Interim LAW Storage Tank.

**Basis:** N/A
4.3.2.9 Ultra TSCR/LAWPS Transfer Pretreated LAW Feed to Ultra LAW/SLAW

**Unique ID:** BMR-ULTRA_MR-9

One separate *LAW fraction* lag storage vessel with the *Treated LAW Concentrate Storage Vessel (TCP-VSL-00001) Vessel Parameters* shall exist for receiving from the *Interim LAW Storage Tank* (in addition to those used by Ultra PT). The *Interim LAW Storage Tank* shall transfer to this vessel instantaneously whenever the vessel is emptied and there is *pumpable supernatant volume* in the *Interim LAW Storage Tank*.

**Basis:** This is needed to model DFLAW vitrification. The same vessel volume as for PT is used for simplicity and to balance artificially increased holdup of LAW with faster run time through operating on larger batches.

4.3.3 Technical Requirements

4.3.3.1 Ultra TSCR/LAWPS Maximum Process Volume

**Unique ID:** BMR-ULTRA_TR-4

The maximum process volume for *TSCR* and *LAWPS* shall be 50,000 gallons.

**Basis:** Limiting the maximum processing volume is necessary since the time required to fill AP-106 could be long enough to lead to unnecessary delays in treating the waste while waiting for the volume to complete processing.

4.3.3.2 Ultra TSCR/LAWPS Average Feed Rate

**Unique ID:** BMR-ULTRA_TR-1

The average feed rate to *LAWPS* shall be the *LAWPS Feed Rate*. The average feed rate to *TSCR* shall be determined based on the following formula from the *TSCR Feed Rate*, the cesium concentration of the feed (in Curies per gallon), the *TSCR Maximum Column Loading*, and the *TSCR Column Replacement Duration* (in minutes):

\[
\text{Average Feed Rate} = \frac{\text{Feed Rate}}{1 + \text{Feed Rate} \times \text{Cesium Concentration} / \text{Maximum Column Loading} \times \text{Column Replacement Duration}}
\]

**Basis:** Multiply the feed rate by the fraction of the time that the process is running (accounting for downtime required for column replacements). LAWPS is not projected to be down for a significant amount of time for column replacement, so the average feed rate is equal to the instantaneous feed rate.

4.3.3.3 Ultra TSCR/LAWPS Average Feed to Plant Wash Rate

**Unique ID:** BMR-ULTRA_TR-2

The average feed to plant wash rate for *TSCR* and *LAWPS* shall be determined based on the formula below based on the *Ultra TSCR/LAWPS Average Feed Rate* and other, process specific parameters. For *TSCR*, the *TSCR Feed Rate*, *TSCR Flush Interval Duration*, and *TSCR Flush Duration and Rate* shall be used. For *LAWPS*, the *LAWPS Feed Rate*, *LAWPS Flush Interval Duration*, and *LAWPS Flush Duration and Rate* shall be used.
### 4.3.3.4 Ultra TSCR/LAWPS Average Caustic to Plant Wash Rate

**Unique ID:** BMR-ULTRA_TR-3

The average caustic to plant wash rate for TSCR and LAWPS shall be determined based on the formula below based on the Ultra TSCR/LAWPS Average Feed Rate, the feed cesium concentration (in Curies per gallon) and other, process specific parameters. For TSCR, the TSCR Maximum Column Loading, TSCR Displacement Volume, TSCR Rinse Volume, and TSCR Conditioning Volume shall be used. For LAWPS, the LAWPS Maximum Column Loading, LAWPS Displacement Volume, LAWPS Rinse Volume, and LAWPS Conditioning Volume shall be used.

\[
\text{Average Feed to Plant Wash Rate} = \text{Average Feed Rate} \times \frac{\text{Flush Duration}}{\text{Flush Interval Duration}} \times \frac{\text{Flush Rate}}{\text{Feed Rate}}
\]

**Basis:** This is the average rate of 0.1 molar caustic and inhibited water (all modeled as 0.1 molar caustic for simplicity) to the plant wash receiver tank based on the maximum column loading and amount of downtime required for column changeout (included in the TSCR/LAWPS Average Feed Rate).

### 4.4 ULTRA PRETREATMENT

A simplified model for the WTP Pretreatment Facility. Ultra PT approximates the processes of solids washing, caustic leaching, oxidative leaching, cesium ion exchange, and treated LAW concentration. It also receives a supplemental sodium addition representing additions from other, less significant process (caustic additions for aluminum solubility after caustic leaching, HLW canister decontamination, etc). Ultra PT contains tankage approximating the holdup of the WTP Pretreatment Facility.

The difference between Ultra PT and the full-detail modeling of this facility is that Ultra models the rate of pretreatment at an average rate, includes only the most significant unit operations, and models separations at an average efficiency, with the rates and efficiencies based on the results of the full detail model. Therefore Ultra PT does not need to include almost any of the vessels in the full-detail Pretreatment Facility model, instead approximating the total holdup using a few large vessels.

#### 4.4.1 Functional Requirements

##### 4.4.1.1 Receive Waste Feed from DSTs

**Unique ID:** BMR-ULTRA_FR-5

The *Ultra PT System* shall be capable of receiving LAW feed from the *DST System*.
Basis: N/A

4.4.1.2 Receive Waste Feed from TWCS

Unique ID: BMR-ULTRA_FR-6

The Ultra PT System shall be capable of receiving HLW feed from the TWCS System.

Basis: N/A

4.4.1.3 Pretreat Waste Feed

Unique ID: BMR-ULTRA_FR-7

The Ultra PT System shall be capable of pretreating waste feed by selectively removing cesium from the liquids and by washing and leaching the solids.

Basis: N/A

4.4.1.4 Send LAW to Ultra LAW/SLAW

Unique ID: BMR-ULTRA_FR-8

The Ultra PT System shall be capable of sending LAW to the Ultra LAW/SLAW System.

Basis: N/A

4.4.1.5 Send HLW to Ultra HLW

Unique ID: BMR-ULTRA_FR-9

The Ultra PT System shall be capable of sending HLW to the Ultra HLW System.

Basis: N/A

4.4.2 Model Requirements

4.4.2.1 Ultra PT Operation Trigger

Unique ID: BMR-ULTRA_MR-22

Ultra PT shall operate when waste is available in either the HLP Feed Receipt Vessel (HLP-VSL-00022) or the FRP Waste Feed Receipt Vessels (FRP-VSL-00002A/B/C/D) and space is available below the set volume in both the Ultra PT HLP Lag Storage Vessels and the Ultra PT LAW Concentrate Storage Vessels.

4.4.2.2 Ultra PT Process Volume

Unique ID: BMR-ULTRA_MR-23

The Ultra PT process volume shall be the maximum limited only by all of the following constraints:

- Transferring no more than the volume of waste available in the HLP Feed Receipt Vessel (HLP-VSL-00022) currently transferring out,
- Transferring no more than the volume of waste available in the FRP Waste Feed Receipt Vessel (FRP-VSL-00002A/B/C/D) currently transferring out,
Transferring no more to the Ultra PT HLW Fraction Lag Storage Vessel than the space available below the set volume in the Ultra PT HLW Fraction Lag Storage Vessel currently receiving the HLW fraction,

And transferring no more to the Ultra PT LAW Fraction Lag Storage Vessel then the space available below the set volume in the Ultra PT LAW Fraction Lag Storage Vessel current receiving the LAW fraction.

4.4.2.3 Ultra PT Process Duration

Unique ID: BMR-ULTRA_MR-12

Using the stream composition after Front End Washing, the Ultra PT process duration shall be determined by converting both the liquids (i.e. LAW fraction) and solids fractions (i.e. HLW fraction) into gallons and calculating the duration based on a rate of the Ultra PT Maximum Liquids Rate or the Ultra PT Maximum Solids Rate, whichever is limiting.

4.4.2.4 Ultra PT Processing Procedure

Unique ID: BMR-ULTRA_MR-24

When Ultra PT Operation is Triggered, the Ultra PT Process Volume shall be processed according to the following actions, performed in sequential order:

1. Ultra PT Blend Feed
2. Ultra PT Initial Phase Split
3. Ultra PT Front-End Solids Washing
4. Ultra PT Caustic Leaching
5. Ultra PT Oxidative Leaching
6. Ultra PT CsIX
7. Ultra PT Sodium Adjustment
8. Ultra PT Adjust Water in the LAW Fraction and Ultra PT Adjust Water in the HLW Fraction (simultaneous)
9. Ultra PT Receive LAW Fraction into Lag Storage Vessels and Ultra PT Receive HLW Fraction into Lag Storage Vessels (simultaneous)

4.4.2.5 Ultra PT Blend Feed

Unique ID: BMR-ULTRA_MR-10

Upon HLP Feed Receipt Vessel (HLP-VSL-00022) discharge, if waste is available in the FRP Waste Feed Receipt Vessels (FRP-VSL-00002A/B/C/D), the material collected as HLW Feed (HLP-VSL-00022) shall be combined with a calculated quantity of the material collected as LAW Feed (FRP-VSL-00002A/B/C/D) to target the UFP Feed Preparation Vessels (UFP-VSL-00001A/B) Feed Blending Weight Percent Solids Goal. If waste is not available in the FRP Waste Feed Receipt Vessels (FRP-VSL-00002A/B/C/D), no blending shall take place.
4.4.2.6 Ultra PT Initial Phase Split

Unique ID: BMR-ULTRA_MR-21

The blended feed received by the Ultra PT shall be split into a "HLW fraction" and a "LAW fraction" with the solids in the feed becoming the initial HLW fraction and the liquids in the feed becoming the initial LAW fraction.

4.4.2.7 Ultra PT Front-End Solids Washing

Unique ID: BMR-ULTRA_MR-11

The solids resulting from the blending step shall be subjected to a washing step whereby a portion of selected species in the solids is dissolved in accordance with the Front End Wash Factors. For negative "wash factors," as with oxalate, components from the LAW fraction shall be precipitated to increase the amount in the HLW fraction by that fractional amount.

The dissolved quantity of each species is added to the LAW fraction and subtracted from the HLW fraction. The increase in oxalate in the HLW fraction is subtracted from the LAW fraction.

4.4.2.8 Ultra PT Caustic Leaching

Unique ID: BMR-ULTRA_MR-13

The HLW fraction is subjected to caustic leaching whereby a portion of selected species in the solids is dissolved according to the following procedure:

1. Apply the Boehmite Leach Factor.
2. Apply the G-Calc Leach Factors.
3. Apply TOPSim leach factors to all other components (i.e. do not apply the TOPSim ALOOH leach factor).
4. Subtract the dissolved quantity of each species from the HLW fraction and add it to the LAW fraction.
5. Add the Caustic Leaching Chemical Addition Volume of 19M NaOH to the LAW fraction. (An explicit chemical addition is not necessary; this may be modeled as a manipulation of the component array.)

4.4.2.9 Ultra PT Oxidative Leaching

Unique ID: BMR-ULTRA_MR-14

When the mass fraction of chromium remaining in the leached solids of the HLW fraction is greater than the UFP Feed Vessels (UFP-VSL-00002A/B) - Oxidative Leach Trigger - Maximum Chromium, oxidative leaching shall be performed according to the following the procedure:

1. Calculate the required amount of permanganate to be added based on a molar ratio of 1.1 moles of permanganate per mole of chromium.
2. Dissolve a portion of selected species in the HLW fraction in accordance with the UFP Feed Vessels (UFP-VSL-00002A/B) - Oxidative Leach Reactions and Conversions.
3. Subtract the dissolved quantity of each species from the HLW fraction and add it to the LAW fraction.
4. Add a molar amount of manganese dioxide (MnO$_2$) to the *HLW fraction* equal to the amount calculated in step (1). (An explicit chemical addition is not necessary; this may be modeled as a manipulation of the component array.)

5. Add a molar amount of sodium hydroxide (NaOH) to the *LAW fraction* equal to the amount calculated in step (1). (An explicit chemical addition is not necessary; this may be modeled as a manipulation of the component array.)

4.4.2.10 Ultra PT CsIX

*Unique ID:* BMR-ULTRA_MR-15

Cesium species, including Cs$^+$, 137-Cs (and daughter 137m-Ba), and 134-Cs shall be subtracted from the *LAW fraction* and added to the *HLW fraction* in accordance with *Cesium Ion Exchange Columns (CXP-IXC-00001/2/3/4)* Mass Balance.

4.4.2.11 Ultra PT Sodium Adjustment

*Unique ID:* BMR-ULTRA_MR-16

The sodium in the liquids fraction shall be multiplied by the *Sodium Adjustment Factor* to simulate the addition of other chemicals added during the Pretreatment processes.

4.4.2.12 Ultra PT Adjust Water in the LAW Fraction

*Unique ID:* BMR-ULTRA_MR-17

Water shall be added or removed from the *LAW fraction* to target the *Treated LAW Evaporator (TLP-SEP-00001) Target Concentration Endpoint*. (An explicit chemical addition is not necessary; this may be modeled as a manipulation of the component array.)

4.4.2.13 Ultra PT Adjust Water in the HLW Fraction

*Unique ID:* BMR-ULTRA_MR-18

Water shall be added to the HLW Fraction to target the *UFP Feed Vessels (UFP-VSL-00002A/B) - Final Solids Concentration Endpoint*. (An explicit chemical addition is not necessary; this may be modeled as a manipulation of the component array.)

4.4.2.14 Ultra PT Receive HLW Fraction into Lag Storage Vessels

*Unique ID:* BMR-ULTRA_MR-19

Ultra shall have three *HLW fraction* lag storage vessels, each with the *HLW Feed Blending Vessel (HLP-VSL-00028)* vessel parameters, into which the *HLW fraction* is received.

4.4.2.15 Ultra PT Receive LAW Fraction into Lag Storage Vessels

*Unique ID:* BMR-ULTRA_MR-20

Ultra shall have three *LAW fraction* lag storage vessels, each with the *Treated LAW Concentrate Storage Vessel (TCP-VSL-00001)* vessel parameters, into which the *LAW fraction* is received.
4.4.3 Technical Requirements

4.4.3.1 Ultra PT Front End Wash Factors

Unique ID: BMR-ULTRA_TR-5

The wash factors in the following table shall be used to simulate solids washing which occurs in the UFP Feed Preparation Vessels.

<table>
<thead>
<tr>
<th>Species</th>
<th>Wash Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Al(OH)$_3$</td>
<td>0.11</td>
</tr>
<tr>
<td>C$_2$O$_4$$^-^2$</td>
<td>-0.22</td>
</tr>
<tr>
<td>CO$_3$$^-^2$</td>
<td>1.0</td>
</tr>
<tr>
<td>Cl$^-$</td>
<td>1.0</td>
</tr>
<tr>
<td>F$^-$</td>
<td>0.46</td>
</tr>
<tr>
<td>H$_2$O</td>
<td>0.91</td>
</tr>
<tr>
<td>Na$^+$</td>
<td>0.63</td>
</tr>
<tr>
<td>NO$_2$$^-^-$</td>
<td>1.0</td>
</tr>
<tr>
<td>NO$_3$$^-^-$</td>
<td>1.0</td>
</tr>
<tr>
<td>OH$^-$</td>
<td>1.0</td>
</tr>
<tr>
<td>PO$_4$$^{3^-}$</td>
<td>0.91</td>
</tr>
<tr>
<td>SO$_4$$^{2^-}$</td>
<td>0.34</td>
</tr>
</tbody>
</table>

Basis: Based on average values across a number of SP8 scenarios for how the solids transferred from HLP-22 differed from those received in UFP-2A/B. See the attached spreadsheet used to derive these factors.

4.4.3.2 Ultra PT Maximum Liquids Rate

Unique ID: BMR-ULTRA_TR-10

The maximum liquids rate shall be 500,000 gallons per 30 days.

Basis: Liquids rate is based on average rate from SP8 Scenario 11 (liquids-only PT) feed vector run through WTP-only model at 100% melter TOE. A limitation of that method of determining the rate (and therefore of Ultra) is that the liquids rate is based on rate with LAW feed only and may be slightly lower when solids are being processed due to washing and leaching.

4.4.3.3 Ultra PT Maximum Solids Rate

Unique ID: BMR-ULTRA_TR-11

The maximum solids rate shall be 6,500 gallons per 30 days.

Basis: Solids rate based on the average SP8 baseline case throughput through UFP-2A/B after SLAW starts up.
4.4.3.4 Ultra PT Boehmite Leach Factor

Unique ID: BMR-ULTRA_TR-7

The leach factor for boehmite (AlOOH) shall be calculated per the following equation: $1 - \left[ 2.4 \times 10^{-5} \times x^2 + 3.1 \times 10^{-4} \times x + 0.62 \right]$ where $x = \frac{\text{kmol Al(OH)}_3}{(\text{gallons solids} / 1200)}$.

Basis: Based on data from the SP8 Baseline Case. See the attached spreadsheet used to derive the equation.

4.4.3.5 Ultra PT G-Calc Leach Factors

Unique ID: BMR-ULTRA_TR-8

A leach factor of 1.0 shall be used for all G-Calc components including: Al(OH)$_3$, C$_2$O$_4^{2-}$, Cl$^-$, CO$_3^{2-}$, F$^-$, Na$^+$, NO$_2^-$, NO$_3^-$, OH$^-$, PO$_4^{3-}$, SO$_4^{2-}$.

Basis: Based on data from the SP8 Baseline Case; washing and leaching in the UFP Feed Vessels (UFP-VSL-00002A/B) dissolves virtually all of components with dynamic solubility modeled.

4.4.3.6 Ultra PT Caustic Leaching Chemical Addition Volume

Unique ID: BMR-ULTRA_TR-6

Calculate the gallons of 19M caustic required for leaching by the following procedure:

1. Evaluate the equation $89 \times \left[ (\text{kmol AlOOH} + \text{kmol Al(OH)}_3)/(\text{gallons solids} / 1,200) \right] + 625$ (result is in gallons).
2. Take the minimum of the result from step (1) and 9,600 gallons.
3. Multiply the result of step (2) by the number of batches (gallons of solids / 1200) to determine the gallons of 19M caustic required for leaching.

Basis: Based on data from the SP8 Baseline Case. See the attached spreadsheet used to derive the equation.

4.4.3.7 Ultra PT Sodium Adjustment Factor

Unique ID: BMR-ULTRA_TR-9

The sodium adjustment factor shall be 1.035.

Basis: Based on analysis of the SP8 Baseline Case to determine the fraction of sodium in the melter feed not attributable to the feed or additions to UFP-VSL-00002A/B for caustic or oxidative leaching, such as additions to UFP-VSL-00062A/B/C for aluminum solubility.

4.5 ULTRA LOW-ACTIVITY WASTE/SUPPLEMENTAL LOW-ACTIVITY WASTE

A simplified model for the WTP LAW Vitrification Facility and LAW Supplemental Treatment. Ultra LAW/SLAW uses a correlation predicting the effects of recycle and the selected LAW glass model to predict the average glass formulation for feeds from tank farms (DFLAW) or Ultra PT, then adds the glass formers, applies the reactions converting the waste feed to oxides, and transfers to the LAW containers object at a rate equivalent to the combined rates of the WTP LAW Vitrification Facility and LAW Supplemental Treatment.
4.5.1 Functional Requirements

4.5.1.1 Receive LAW from Tank Farms

Unique ID: BMR-ULTRA_FR-17

The *Ultra LAW/SLAW System* shall be capable of receiving *LAW* from the *Ultra TSCR/LAWPS System*.

Basis: N/A

4.5.1.2 Receive LAW from Ultra PT

Unique ID: BMR-ULTRA_FR-14

The *Ultra LAW/SLAW System* shall be capable of receiving *LAW* from the *Ultra PT System*.

Basis: N/A

4.5.1.3 Vitrify Waste

Unique ID: BMR-ULTRA_FR-15

The *Ultra LAW/SLAW System* shall be capable of vitrifying *LAW* into *ILAW* glass.

Basis: N/A

4.5.1.4 Send LAW Glass to ILAW Containers

Unique ID: BMR-ULTRA_FR-16

The *Ultra LAW/SLAW System* shall be capable of sending *ILAW* glass to the *ILAW containers object*.

Basis: N/A

4.5.2 Model Requirements

4.5.2.1 Ultra LAW/SLAW Glass Formers Addition

Unique ID: BMR-ULTRA_MR-25

When an *Ultra PT LAW Fraction Lag Storage Vessel* is filled to the set volume or at the end of the mission (the TWCS cleaned out, no feed remains in either of the *HLP Feed Receipt Vessel (HLP-VSL-00022)* or the *FRP Waste Feed Receipt Vessels (FRP-VSL-00002A/B/C/D)*), glass formers shall be added to the *Ultra PT LAW Fraction Lag Storage Vessel*. The required glass formers shall be calculated per the *LAW Selected Glass Model* based on the composition of the *Ultra PT LAW Fraction Lag Storage Vessel* with the *Ultra LAW/SLAW Composition Adjustments for LAW Glass Formulation* applied shall be added to the *Ultra PT LAW Fraction Lag Storage Vessel*. (An explicit addition of glass formers is not necessary; this may be modeled as a manipulation of the component array.)

Basis: Adjustments to composition based on approximating the effect of offgas condensate recycle into the feed by calculating the steady state concentration for that feed.
4.5.2.2 Ultra LAW/SLAW Melter Reactions Application

Unique ID: BMR-ULTRA_MR-26

When the glass formers have been added to an Ultra PT LAW Fraction Lag Storage Vessel, the LAW Glass Melt Reactions, with the exception of halide-to-gas and sulfate decomposition reactions, shall be applied to the Ultra PT LAW Fraction Lag Storage Vessel. Note that melter splits shall not be applied to the Ultra PT LAW Fraction Lag Storage Vessel.

Basis: The offgas system and recycle is not modeled explicitly and accounted for elsewhere (in the glass formulation), so reactions which volatilize components which will ultimately be incorporated into the glass are not modeled. Reactions are found in Section 4.8.15 LAW Melter Process (LMP) System in 24590-WTP-MDD-PR-01-002, WTP MDD.

4.5.2.3 Ultra LAW/SLAW Transfer to Containers

Unique ID: BMR-ULTRA_MR-27

Once its contents have been converted to oxides, the Ultra PT LAW Fraction Lag Storage Vessel shall transfer the volume above the minimum volume to the LAW-Canister accumulation vessel at a rate (MT/day) determined by combining the melter rates for the WTP LAW Vitrification Facility and LAW Supplemental Treatment:

- For the WTP LAW Vitrification Facility, the rate is minimum of the LAW Melter Treatment Capacity available per the LAW Melter Ramp Rate and the LAW Melter Variable Rate.
- For LAW Supplemental Treatment, the rate is minimum of the SLAW Melter Treatment Capacity available per the SLAW Melter Ramp Rate and the SLAW Melter Variable Rate.

Basis: LAW Melter Capacity: Table C.7-1.1 in Section C.7(b)(1) of DE-AC27-01RV14136, WTP/DOE Statement of Work

LAW Melter Ramp Rate: WRPS-1700082, Meeting Minutes: DFLAW Schedule and Process Assumptions for MYOP

SLAW Melter Capacity and Ramp Rate: SLAW Treatment facility is presently assumed to be another vitrification facility with the same technical design, glass chemistry, melters, and similar feed and offgas equipment as the WTP LAW vitrification facility. These parameters number are found in the "Glass Production" section for the Baseline Case in ORP-11242, System Plan Rev. 8.

LAW/SLAW Melter Variable Rate: 24590-WTP-MCR-PE-13-0024, LAW Melt Rate

4.5.3 Technical Requirements

4.5.3.1 Ultra LAW/SLAW Composition Adjustments for LAW Glass Formulation

Unique ID: BMR-ULTRA_TR-13

The Ultra composition adjustments for LAW glass formulation are as follows:

- Multiply the amount of chloride (Cl\(^-\)) in the melter feed by 1.811.
- Multiply the amount of fluoride (F\(^-\)) in the melter feed by 1.949.
Change the amount of sulfate (SO$_4^{2-}$) in the melter feed reflect a sulfate to sodium ratio (S) determined as follows (where x is the sulfate to sodium ratio of the actual melter feed, capped at 0.0074 for the BARD glass model):

\[
\frac{S}{x} = \text{MAX}\left(\frac{x + c \times x \times (0.216 - 73.5 \times c \times x)}{73.5 \times c \times x - 0.216 - 1}, 1\right)
\]

- For $x \leq 0.0127$, where $c$ is 0.54 for the BARD glass model and 0.62 for the DOE 2013 and 2016 glass models.
- For $x > 0.0127$, $S / x = 1.550$

**Basis:** Approximate the effect of offgas condensate recycle into the feed by calculating the steady state concentration for that feed.

Halide and top end sulfate factors derived from summing the infinite geometric series based on the conversions in the LAW melter, LOP SBS, and LOP WESP. Factor = $1 / (1 - \text{melter to SBS conversion} \times (\text{SBS to RLD conversion} + (\text{SBS to WESP conversion}) \times \text{WESP to RLD conversion}))$. See the attached Word file for the derivation of the low-end sulfate correlation.

An equivalent calculation for feed to the HLW melter is not required since the HLW melter offgas condensate is not recycled into the HLW melter feed (and the HLW melter feed does not contain any volatile halides or sulfate in Ultra anyway).

### 4.6 WASTE TREATMENT AND IMMOBILIZATION PLANT ULTRA HIGH-LEVEL WASTE

A simplified model for the WTP HLW Vitrification Facility. Ultra HLW uses the selected HLW glass model to predict the average glass formulation for feeds from Ultra PT, then adds the glass formers, applies the reactions converting the waste feed to oxides, and transfers to the HLW canisters object at a rate equivalent to the combined rates of the WTP HLW Vitrification Facility. Ultra HLW does not include an accounting-for of recycle because the feed is low in volatiles. However, the canister decontamination chemicals are represented in the supplemental sodium addition to Ultra PT.

#### 4.6.1 Functional Requirements

##### 4.6.1.1 Receive HLW from Ultra PT

**Unique ID:** BMR-ULTRA_FR-18

The *Ultra HLW System* shall be capable of receiving HLW from the *Ultra PT System*.

**Basis:** N/A
4.6.1.2 Vitrify Waste

**Unique ID:** BMR-ULTRA_FR-19

The *Ultra HLW System* shall be capable of vitrifying *HLW* into *IHLW* glass.

**Basis:** N/A

4.6.1.3 Send HLW Glass to HLW Canisters

**Unique ID:** BMR-ULTRA_FR-20

The *Ultra HLW System* shall be capable of sending *IHLW* glass to the *IHLW canisters object.*

**Basis:** N/A

4.6.2 Model Requirements

4.6.2.1 Ultra HLW Glass Formers Addition

**Unique ID:** BMR-ULTRA_MR-28

When an *Ultra PT HLW Fraction Lag Storage Vessel* is filled to the set volume or at the end of the mission (the TWCS cleaned out, no feed remains in either of the *HLP Feed Receipt Vessel (HLP-VSL-00022)* or the *FRP Waste Feed Receipt Vessels (FRP-VSL-00002A/B/C/D)*), glass formers shall be added to the *Ultra PT HLW Fraction Lag Storage Vessel.* The required glass formers shall be calculated per the *HLW Selected Glass Model* based on the composition of the *Ultra PT HLW Fraction Lag Storage Vessel.* (An explicit addition of glass formers is not necessary; this may be modeled as a manipulation of the component array.)

**Basis:** For the HLW process, no halides of sulfate is in the melter feed, so it is not necessary to approximate the recycle.

4.6.2.2 Ultra HLW Melter Reactions Application

**Unique ID:** BMR-ULTRA_MR-29

When the glass formers have been added to an *Ultra PT HLW Fraction Lag Storage Vessel*, the *HLW Glass Melt Reactions*, with the exception of halide-to-gas and sulfate decomposition reactions, shall be applied to the *Ultra PT HLW Fraction Lag Storage Vessel.* Note that melter splits shall not be applied to the *Ultra PT HLW Fraction Lag Storage Vessel.*

**Basis:** The offgas system and recycle is not modeled explicitly and accounted for elsewhere (in the glass formulation), so reactions which volatilize components which will ultimately be incorporated into the glass are not modeled. Reactions in the melter are discussed in the BARD Section 4.2.3.3.3.

4.6.2.3 Ultra HLW Transfer to Canisters

**Unique ID:** BMR-ULTRA_MR-30

Once its contents have been converted to oxides, the *Ultra PT HLW Fraction Lag Storage Vessel* shall transfer the volume above the minimum volume to the *IHLW canisters at a the WTP HLW Vitrification Facility Melter Rate.* This rate is equal to the minimum of the rate per the HLW Melter Start Date and *HLW Melter Ramp Rate* and the *HLW Melter Variable Rate.*
**Basis:** HLW melter capacity per BARD Section 4.2.1.1 with the ramp rates verbally selected by WRPS, ORP, and BNI on approximately 10/1/2014. No basis was given on why these rates were chosen or if they are to supercede the contractual hot commissioning requirements. Email from C. Harrington (ORP) to L. Thompson, Strategic Plan Assumptions, 10/2/2014. The ramp up rates match those used in ORP-11242, Rev. 6. The ramp dates use an even interval to meet the requirement of starting operation on 12/31/2031 and reaching 70% TOE by 12/31/2034, using the original melters, and 70% TOE with replacement melters by 12/31/2036. The variable rate is based on BARD Section 4.2.3.4.1.
5.0 EQUIPMENT NAMES AND NUMBERS

5.1 242-A EVAPORATOR

242-A Evaporator Equipment

5.1.1 242-A - 242-A Separator Vessel
Unique ID: BMR-TXT-287
The equipment "242-A" refers to the separator vessel of the 242-A Evaporator.

5.1.2 242-A-CONDENSER
Unique ID: BMR-TXT-288
The 242-A-CONDENSER is the condenser portion of the 242-A Evaporator where the offgas is cooled and condensed.

5.1.3 242-A-STACK
Unique ID: BMR-TXT-289
The 242-A-STACK is where the non-condensable gases from the 242-A Evaporator are sent to the atmosphere.

5.2 CH-TRU

Contact-Handled Transuranic (CH-TRU) Waste System Equipment

5.2.1 CH-TRU-PACKAGES - CH-TRU Product Accumulator
Unique ID: BMR-TXT-165
CH-TRU-PACKAGES receives and accumulates the concentrated CH-TRU product from the CH-TRU dryer.

5.2.2 SUP-TRU-DRYER - CH-TRU Dryer
Unique ID: BMR-TXT-161
SUP-TRU-DRYER receives and concentrates CH-TRU waste from the CH-TRU receipt vessels.

5.2.3 SUP-TRU-DRYER-CONDENSER - CH-TRU Demister
Unique ID: BMR-TXT-162
SUP-TRU-DRYER-CONDENSER condenses and cools offgas received from the CH-TRU dryer.
5.2.4 SUP-TRU-FEED1/2/3/4/5 - CH-TRU Receipt Vessels
Unique ID: BMR-TXT-160
SUP-TRU-FEED1, SUP-TRU-FEED2, SUP-TRU-FEED3, SUP-TRU-FEED4, and SUP-TRU-FEED5 receive waste identified as CH-TRU from the SST system and transfer the waste downstream for drying.

5.2.5 SUP-TRU-STACK - CH-TRU Stack
Unique ID: BMR-TXT-163
SUP-TRU-STACK receives the non-condensable stream from the CH-TRU demister.

5.3 CNP
Cesium Nitric Acid Recovery Process (CNP) System Equipment

5.3.1 CNP-DISTC-00001 - Cesium Evaporator Nitric Acid Rectifier
Unique ID: BMR-TXT-228
The Cesium Evaporator Nitric Acid Rectifier (CNP-DISTC-00001) column recovers the nitric acid from the CNP evaporator overheads.

5.3.2 CNP-EVAP-00001 - Cesium Evaporator Separator Vessel
Unique ID: BMR-TXT-227
The Cesium Evaporator Separator Vessel (CNP-EVAP-00001) evaporates nitric acid solution from the eluate to recover and reuse the acid.

5.3.3 CNP-VSL-00003 - Cesium Concentrate Storage Vessel
Unique ID: BMR-TXT-190
The cesium concentrate storage vessel receives the cesium product from the CNP evaporator, and sends it to HLP.

5.3.4 CNP-VSL-00004 - Cesium Evaporator Recovered Nitric Acid Vessel
Unique ID: BMR-TXT-229
The Cesium Evaporator Recovered Nitric Acid Vessel (CNP-VSL-00004) receives the reclaimed nitric acid from the rectifier and provides it to the CXP columns for elution.

5.4 CRP
Cesium Fresh Resin Addition and Replacement Process (CRP) System Equipment

5.4.1 CRP-VSL-00001 - Cesium Resin Addition Vessel
Unique ID: BMR-TXT-241
The fresh resin is slurried in the Cesium Resin Addition Vessel (CRP-VSL-00001) for transfer to the ion exchange columns.
5.5 CXP

Cesium Ion-Exchange Process (CXP) System Equipment

5.5.1 CXP-FILT-00001 - Cesium Ion Exchange Guard Filter

Unique ID: BMR-TXT-220

The cesium ion exchange guard filter (CXP-FILT-00001) removes captures solids prior to the feed entering the ion exchange columns.

5.5.2 CXP-IXC-00001/2/3/4 - Cesium Ion Exchange Columns

Unique ID: BMR-TXT-221

The WTP cesium ion exchange columns consist of four identical columns; CXP-IXC-00001, CXP-IXC-00002, CXP-IXC-00003, CXP-IXC-00004 which remove the cesium from the waste.

5.5.3 CXP-VSL-00004 - Cesium Ion Exchange Feed Vessel

Unique ID: BMR-TXT-219

The cesium ion exchange feed vessel (CXP-VSL-00004) receives feed from the UFP and transfers it downstream to the ion exchange guard filter and columns. The original name of this vessel was the Cesium Ion Exchange Caustic Rinse Collection Vessel but was repurposed as part of the 2006 External Flow sheet Review Team evaluation (24590-WTP-RPT-PET-09-004, Recommendation of Alternative to Mitigate Solids Precipitation in Ion Exchange Feed).

5.5.4 CXP-VSL-00005 - Cesium Reagent Vessel

Unique ID: BMR-TXT-222

The Cesium Reagent Vessel (CXP-VSL-00005) is filled with dilute caustic which is used for column displacement during the regeneration cycle.

5.5.5 CXP-VSL-00026A/B/C - Treated LAW Collection Vessels

Unique ID: BMR-TXT-223

The Treated LAW Collection Vessels (CXP-VSL-00026A/B/C) consist of three identical vessels which receive feed from the ion exchange columns and transfers it downstream to the TLP.

5.6 EMF

5.6.1 EMF-VSL-00002 - EMF SBS Condensate Receipt Vessel

Unique ID: BMR-TXT-329

The EMF SBS Condensate Receipt Vessel, EMF-VSL-00002, receives dilute SBS and WESP condensate from LAW Offgas for feed to the EMF Evaporator.
5.6.2 EMF-DMST-00001 - EMF Evaporator Demister/Condenser

Unique ID: BMR-TXT-330

The EMF Evaporator Demister/Condenser (EMF-DMST-00001) consists of a demister unit, and three condenser units (primary, inter, secondary) which cool and condense the overheads from the EMF Evaporator (EMF-SEP-00001).

5.6.3 EMF-SEP-00001 - EMF Evaporator

Unique ID: BMR-TXT-331

The EMF Evaporator, EMF-SEP-00001, represents a reboiler and separator vessel which concentrates dilute LAW SBS/WESP condensate for recycle to LAW Vitrification (LCP-VSL-00001_2).

5.6.4 EMF-SEP-00001A - EMF Evaporator Bottoms Vessel

Unique ID: BMR-TXT-332

5.6.5 EMF-VSL-00001A/B/C - EMF Concentrate Storage Vessels

Unique ID: BMR-TXT-333

5.6.6 EMF-VSL-00001D - EMF Corrosion Mitigation Vessel

Unique ID: BMR-TXT-334

5.6.7 EMF-VSL-00001E/F EMF Corrosion Mitigation Vessels

Unique ID: BMR-TXT-434

5.7 ETF

Effluent Treatment Facility (ETF) Equipment

5.7.1 ETF-LIQUID-EFFLUENT - ETF Liquid Storage Vessel

Unique ID: BMR-TXT-211

The vessel identified as ETF-LIQUID-EFFLUENT that accumulates the separated liquid stream from the ETF Separation Vessel.

5.7.2 ETF-SOLID-EFFLUENT - ETF Solids Storage Vessel

Unique ID: BMR-TXT-212

The vessel identified as ETF-SOLID-EFFLUENT that accumulates the separated solids stream from the ETF Separation Vessel.

5.7.3 ETF-SPLITS - ETF Separation Vessel

Unique ID: BMR-TXT-210

The block splitter identified as ETF-SPLITS where the incoming stream from LERF is separated into liquid and solids streams.
5.8 FEP

Feed Evaporator Process (FEP) System Equipment

5.8.1 FEP-DMST-00001A - Waste Feed Evaporator Demister

Unique ID: BMR-TXT-158

The waste feed evaporator demister (FEP-DMST-00001A) consists of a demister unit, and three condenser units (primary, inter, secondary) which cool and condense the overheads from the Waste Feed Evaporator (FEP-SEP-00001A).

5.8.2 FEP-SEP-00001A - Waste Feed Evaporator

Unique ID: BMR-TXT-145

The Waste Feed Evaporator, FEP-SEP-00001A represents a reboiler and separator vessel which concentrates dilute recycle streams and transfers the concentrate to the UFP.

5.8.3 FEP-VSL-00005A - Waste Feed Evaporator Condensate Vessel

Unique ID: BMR-TXT-159

The waste feed evaporator condensate vessel (FEP-VSL-00005A) receives condensate from the Waste Feed Evaporator Condenser (FEP-COND-00001A).

5.8.4 FEP-VSL-00017A/B - Waste Feed Evaporator Feed Vessels

Unique ID: BMR-TXT-144

The Waste Feed Evaporator Feed Vessels, FEP-VSL-00017A and FEP-VSL-00017B receive streams from throughout the Pretreatment Facility and feed these recycle streams to the FEP evaporator.

5.9 FRP

Feed Receipt Process (FRP) System Equipment

5.9.1 FRP-VSL-00002A/B/C/D - LAW Waste Feed Receipt Vessels

Unique ID: BMR-TXT-135

The LAW waste feed receipt vessels are the vessels within the FRP System designated to receive LAW feed from the tank farms.

5.10 GFR

Glass Former Receipt (GFR) System Equipment

5.10.1 GFR-TK-00022_23 - LAW Glass Former Feed Hopper

Unique ID: BMR-TXT-244

The LAW Glass Former Feed Hopper (GFR-TK-00022_23) receives glass formers.
5.10.2 GFR-TK-00025_31 - HLW Glass Former Feed Hopper

Unique ID: BMR-TXT-326

The HLW Glass Former Feed Hopper (GFR-TK-00025_31) receives glass formers.

5.11 HFP

High-Level Waste Melter Feed Preparation (HFP) System Equipment

5.11.1 HFP-VSL-00001_5 - HLW Melter Feed Process System Vessels

Unique ID: BMR-TXT-189

The HLW Melter Feed Process System Vessels (HFP-VSL-00001 and HFP-VSL-00005) receive feed from *HLW Feed Blending Vessel (HLP-VSL-00028)* and glass formers from GFR-TK-000. Which then is transferred to be mixed downstream in batches to the HLW Melter Feed Vessel HFP-VSL-00002_6. The vessels are modeled as a single vessel with the designation HFP-VSL-00001_5.

5.11.2 HFP-VSL-00002_6 - HLW Melter Feed Process System Vessels

Unique ID: BMR-TXT-325

The HLW Melter Feed Process System Vessel (HFP-VSL-00002_6) supplies continual feed to the HLW melter (HMP-MLTR-00001_2) for each batch of feed prepared.

5.12 HLP

High-Level Waste Lag Storage and Feed Blending Process (HLP) System Equipment

5.12.1 HLP-VSL-00022 - HLW Feed Receipt Vessel

Unique ID: BMR-TXT-177

The HLW feed receipt vessel receives HLW slurries and associated flushes from the Tank Farms.

5.12.2 HLP-VSL-00027A - HLW Lag Storage Vessel

Unique ID: BMR-TXT-178

Vessel HLP-VSL-00027A is one of two *HLW* lag storage vessels which receives *pretreated process slurries* from *UFP*.

5.12.3 HLP-VSL-00027B - HLW Lag Storage Vessel

Unique ID: BMR-TXT-179

Vessel HLP-VSL-00027B is one of two *HLW* lag storage vessels which receives *pretreated process slurries* from *UFP* and also receives and neutralizes the *cesium product* from *CNP*. 

5-23
5.12.4 HLP-VSL-00028 - HLW Feed Blending Vessel

Unique ID: BMR-TXT-180

The HLW Feed Blending Vessel, HLP-VSL-00028, receives pretreated process slurries from the upstream vessels, HLW Lag Storage Vessel (HLP-VSL-00027A) and HLW Lag Storage Vessel (HLP-VSL-00027B) and also receives and neutralizes the cesium product from CNP.

5.13 HMP

High Level Waste Melter Process (HMP) System Equipment

5.13.1 FAILED-HLW MELTERS - HLW Melter Collection Vessel

Unique ID: BMR-TXT-346

FAILED-HLW MELTERS receives failed melters from HMP-MLTR-00001_2.

5.13.2 HMP-MLTR-00001_2 - HLW Melter

Unique ID: BMR-TXT-345

The HLW Melter (HMP-MLTR-00001_2) converts feed from HFP-VSL-00002_6 to IHLW glass.

5.14 HOP

High-Level Waste Offgas Process (HOP) System Equipment

5.14.1 HOP-SCB-00001_2 - HLW Submerged Bed Scrubber

Unique ID: BMR-TXT-284

The HLW submerged bed scrubber (SBS) removes particulates from the melter offgas and cools the offgas to a desired temperature by using chilled water.

5.14.2 HOP-VSL-00903_4 - HLW SBS Condensate Receiver Vessels

Unique ID: BMR-TXT-354

The SBS condensate receiver vessels collect the liquid offgas condensate from the HLW SBS columns.

5.14.3 HOP-WESP-00001_2 - HLW Wet Electrostatic Precipitator

Unique ID: BMR-TXT-355

The wet electrostatic precipitator removes aerosols and particulates from the HLW offgas stream down to submicron size.
5.14.4 HOP-HEME-00001_2 - HLW High Efficiency Mist Eliminator  
Unique ID: BMR-TXT-356  
The high efficiency mist eliminator (HEME) further remove radioactive aerosols from the HLW melter offgas and reduces the solids-loading rate on the high-efficiency particulate air (HEPA) filters.

5.14.5 HOP-HEPA-00001-2AB_7-8AB - HLW High Efficiency Particulate Air Filter  
Unique ID: BMR-TXT-357  
The high efficiency particulate air filter (HEPA) removes particulate and a small amount of gasses from the HLW offgas stream.

5.14.6 HOP-ADBR-00001_2AB - HLW Carbon Adsorber  
Unique ID: BMR-TXT-358  
The HLW activated carbon adsorber captures mercury, 129-I, and HCL and HF from the HLW offgas stream.

5.14.7 HOP-ABS-00002_3 - HLW Silver Mordenite Absorber Column  
Unique ID: BMR-TXT-359  
The silver mordenite absorber columns removes 129-I from the melter offgas stream as well as adsorbs volatile compounds that contain chlorine or fluorine.

5.14.8 HOP-SCR-00001_2 - NOx Selective Catalytic Converter  
Unique ID: BMR-TXT-360  
The HLW NOx selective catalytic converter primarily removes NO₂, NO₃, and SO₂ gasses from the HLW offgas stream using pure ammonia gas.

5.14.9 HLW-OFFGAS-STACK  
Unique ID: BMR-TXT-361  
The HLW Off-gas stack represents the exhaust fans and stack which provide the motive force for air movement of the melter offgas and the vessel ventilation offgas up through the stack.
5.15 LAWPS

5.15.1 RMF-VSL-00001 - LAWPS CFF Filter Feed Tank / Cross-Flow Filter
Unique ID: BMR-TXT-335

5.15.2 LAWPS-SCIX-00001/2 - LAWPS Ion Exchange Columns
Unique ID: BMR-TXT-336

5.15.3 ELC-VSL-00001 - LAWPS Eluate Collection Vessel
Unique ID: BMR-TXT-337

5.15.4 TLS-VSL-00001/2/3 - LAWPS Pretreated Feed Lag Storage Vessels
Unique ID: BMR-TXT-338

5.16 LCP
Low-Activity Waste Concentrate Receipt Process (LCP) System Equipment

5.16.1 LCP-VSL-00001_2 - LAW Concentrate Receipt Vessel
Unique ID: BMR-TXT-242
The LAW Concentrate Receipt Vessel (LCP-VSL-00001_2) receives concentrated pretreated LAW from TCP and, during DFLAW, receives pretreated LAW from LAWPS.

5.17 LERF
Liquid Effluent Retention Facility (LERF) Equipment

5.17.1 LERF-BASIN-1/2 - LERF Basins
Unique ID: BMR-TXT-14
(LERF-BASIN-1 and LERF-BASIN-2) Liquid effluent receiving and storage vessels.

5.18 LFP
Low-Activity Waste Melter Feed Preparation (LFP) System Equipment

5.18.1 LFP-VSL-00001_3 - LAW Melter Feed Preparation Vessel
Unique ID: BMR-TXT-243
The LAW Melter Feed Preparation Vessel (LFP-VSL-00001_3) receives feed from LCP-VSL-00001_2 and glass formers from GFR-TK-00022_23.

5.18.2 LFP-VSL-00002_4 - LAW Melter Feed Vessel
Unique ID: BMR-TXT-245
LAW Melter Feed Vessel (LFP-VSL-00002_4) receives from LFP-VSL-00001_3.
5.19  LMP

Low-Activity Waste Melter Process (LMP) System Equipment

5.19.1 FAILED-LAW MELTERS - LAW Melter Collection Vessel

Unique ID: BMR-TXT-251

FAILED-LAW MELTERS receives failed melters from LMP-MLTR-00001_2.

5.19.2 LAW-Canister Accumulation Vessel

Unique ID: BMR-TXT-417

LAW-Canister Accumulation Vessel receives ILAW from LMP-MLTR-00001_2. This is labeled as LAW-CANISTERS in TOPSim.

5.19.3 LMP-MLTR-00001_2 - LAW Melter

Unique ID: BMR-TXT-246

The LAW Melter (LMP-MLTR-00001_2) converts feed from LFP-VSL-00002_4 to ILAW glass.

5.20  LOP

Low-Activity Waste Offgas Process (LOP) System Equipment

5.20.1 LOP-SCB-00001_2 - LAW Submerged Bed Scrubber

Unique ID: BMR-TXT-283

The LAW submerged bed scrubber (SBS) removes particles and aerosols from the melter offgas and cools the offgas to a desired temperature by using chilled water.

5.20.2 LOP-VSL-00001_2 - LAW SBS Condensate Vessel

Unique ID: BMR-TXT-413

The LAW SBS condensate receipt vessel collects overflow liquid offgas condensate from the LAW SBS, and supply consumed liquid in LAW SBS.

5.20.3 LOP-WESP-00001_2 - LAW Wet Electrostatic Precipitator

Unique ID: BMR-TXT-282

The LAW Wet Electrostatic Precipitator removes particles and aerosols greater than approximately one-micrometer from LAW offgas stream.

5.21  LVP

LAW Secondary Offgas/Vessel Process System (LVP) Equipment

5.21.1 LVP-TK-00001 - Caustic Collection Vessel

Unique ID: BMR-TXT-274

The caustic collection vessel receives caustic scrubber solution.
5.21.2 LVP-HEPA-00001AB - High Efficiency Particulate Air Filter
Unique ID: BMR-TXT-348
The LAW High Efficiency Particulate Air Filter removes particulate and a small amount of gases from the LAW offgas stream.

5.21.3 LVP-ADBR-00001AB - Carbon Adsorber
Unique ID: BMR-TXT-349
The Law Carbon Adsorber captures mercury, 129-I, and HCL and HF from the LAW offgas stream.

5.21.4 LVP-SCR-00001_2 - NOx Selective Catalytic Reducer
Unique ID: BMR-TXT-350
The LAW NO\textsubscript{x} Catalytic Oxidizer Reducer selective catalytic primarily removes NO\textsubscript{2}, NO\textsubscript{3}, and SO\textsubscript{2} gasses from the LAW offgas stream using pure ammonia gas.

5.21.5 LVP-SCB-00001 - Caustic Scrubber Column
Unique ID: BMR-TXT-351
The LAW Caustic Scrubber Column removes the remaining acid gases such as HCl and SO\textsubscript{2} as well as quenching and cooling hot gasses.

5.21.6 LVP-TK-00001 - Caustic Scrubber Collection Vessel
Unique ID: BMR-TXT-352
The LAW Caustic Scrubber Collection Vessel is accumulates and neutralizes the collected condensate from the caustic scrubber column.

5.21.7 LAW-OFFGAS-STACK
Unique ID: BMR-TXT-353
The LAW offgas stack represents the exhaust fans and stack which provide the motive force for air movement of the melter offgas and the vessel ventilation offgas up through the stack.

5.22 PWD
Plant Wash and Disposal (PWD) System Equipment

5.22.1 PWD-VSL-00015/16 - Acidic/Alkaline Effluent Vessels
Unique ID: BMR-TXT-141
The Acidic/Alkaline Effluent Vessels named PWD-VSL-00015 and PWD-VSL-00016.
5.22.2 PWD-VSL-00033 - Ultimate Overflow Vessel
Unique ID: BMR-TXT-267
The Ultimate Overflow Vessel (PWD-VSL-00033) receives flushes and drains from pretreatment and the post-transfer line flush from tank farms.

5.22.3 PWD-VSL-00043 - HLW Effluent Transfer Vessel
Unique ID: BMR-TXT-139
The HLW Effluent Transfer Vessel identified as PWD-VSL-00043.

5.22.4 PWD-VSL-00044 - Plant Wash Vessel
Unique ID: BMR-TXT-154
The plant wash vessel, PWD-VSL-00044, receives effluent from various sources in the pretreatment facility and recycles it to the FEP.

5.23 RDP
Resin Collection and Dewatering Process (RDP) System Equipment

5.23.1 RDP-VSL-00002A - Spent Resin Slurry Vessel
Unique ID: BMR-TXT-155
The spent resin slurry vessel, RDP-VSL-00002A, is used to store and transfer liquids required for resin replacement.

5.23.2 RDP-VSL-00002B - Spent Resin Slurry Vessel
Unique ID: BMR-TXT-156
The spent resin slurry vessel RDP-VSL-00002B, is used to store, sample and transfer the spent resin slurry.

5.23.3 RDP-VSL-00002C - Spent Resin Slurry Vessel
Unique ID: BMR-TXT-157
The spent resin slurry vessel, RDP-VSL-00002C is used to temporarily store spent resin liquids.

5.24 RLD
Radioactive Liquid Disposal (RLD) System Equipment

5.24.1 RLD-VSL-00004 - C3/C5 Drains/Sump Collection Vessel
Unique ID: BMR-TXT-279
The C3/C5 Drains/Sump Collection Vessel (RLD-VSL-00004) receives liquids continuously from the LAW WESP columns.
5.24.2 RLD-VSL-00005 - SBS Condensate Collection Vessel

Unique ID: BMR-TXT-257

The SBS Condensate Collection Vessel (RLD-VSL-00005) receives condensate from the LAW submerged bed scrubber as well as the wet electrostatic precipitator (WESP) condensate.

5.24.3 RLD-VSL-00006A - Process Condensate Vessel

Unique ID: BMR-TXT-148

The process condensate vessel RLD-VSL-00006A receives process condensate from the FEP and TLP evaporators. Process condensate is recycled to pretreatment for solids washing, dilution and line flushes and excess process condensate is sent to RLD-VSL-00006B and then to LERF/ETF.

5.24.4 RLD-VSL-00006B - Process Condensate Vessel

Unique ID: BMR-TXT-273

The process condensate vessel RLD-VSL-00006B receives process condensate from the RLD-VSL-0006A vessel.

5.24.5 RLD-VSL-00007 - Acidic Waste Vessel

Unique ID: BMR-TXT-268

The Acidic Waste Vessel (RLD-VSL-00007) receives HLW SBS Condensate and the canister decontamination waste.

5.24.6 RLD-VSL-00008 - Acidic Waste Vessel

Unique ID: BMR-TXT-281

The Acidic Waste Vessel (RLD-VSL-00008) receives HLW SBS Condensate and the canister decontamination waste.

5.24.7 RLD-VSL-00017A/B - Alkaline Effluent Vessels

Unique ID: BMR-TXT-252

The Alkaline Effluent Vessels (RLD-VSL-00017A/B) receives dilute solutions throughout PT.

5.25 SLAW

Supplemental Low-Activity Waste (SLAW) System Equipment

5.25.1 SLAW-BUFFER-TANK - SLAW Pretreated LAW Storage Tank

Unique ID: BMR-TXT-260

SLAW Pretreated LAW Storage Tank, SLAW-BUFFER-TANK, is the feed receipt tank for SLAW process and receives pretreated LAW from various sources in WTP Pretreatment facility, LAWPS, and STLP.
5.25.2 SLCP-VSL-00001_2 - SLAW Concentrate Receipt Vessel

Unique ID: BMR-TXT-364

SLAW Concentrate Receipt Vessel, SLCP-VSL-00001_2, receive *pretreated LAW* from *SLAW-BUFFER-TANK*.

5.25.3 SGFR-TK-00022_23 - SLAW Glass Former Feed Hopper

Unique ID: BMR-TXT-374

SLAW Glass Former Feed Hopper, SGFR-TK-00022_23, receive various *glass formers* reagents for ZnO, Fe₂O₃, SiO₂, Li₂O, B₂O₃, Al₂O₃, MgO, CaO, TiO₂, ZrO₂, Na₂O, and sucrose from solid chem-adds supply tank.

5.25.4 SLFP-VSL-00001_3 - SLAW Melter Feed Preparation Vessel

Unique ID: BMR-TXT-375

SLAW Melter Feed Vessel, SLFP-VSL-00001_3, receive *pretreated LAW* from SLCP-VSL-00001_2 and glass formers from SGFR-VSL-00022_23.

5.25.5 SLFP-VSL-00002_4 - SLAW Melter Feed Vessel

Unique ID: BMR-TXT-376

SLAW Melter Feed Vessel, SLFP-VSL-00002_4, receives blended *pretreated LAW* and glass formers from SLFP-VSL-00001_3.

5.25.6 SLMP-MLTR-00001_2 - SLAW Melter

Unique ID: BMR-TXT-378

SLAW Melter, SLMP-MLTR-00001_2, converts feed from SLFP-VSL-00001_3 to *S-ILAW* glass.

5.25.7 SLAW-CANISTER Accumulation Vessel

Unique ID: BMR-TXT-379

SLAW-Canister Accumulation Vessel receives *S-ILAW* from SLMP-MLTR-00001_2. This is labeled as SLAW-CANISTERS in TOPSim.

5.25.8 FAILED-SLAW-MELTERS - Failed SLAW Melters Collection Vessel

Unique ID: BMR-TXT-380

Failed SLAW Melters Collection Vessel, FAILED-SLAW-MELTERS, is the collection vessel for inventory of modeled spent SLAW melters with remained S-ILAW glass at the end of melter design life or when failed prior.

5.26 SLOP

Second Low-Activity Waste Offgas Process (LOP) System Equipment
5.26.1 SLOP-SCB-00001_2 - SLAW Submerged Bed Scrubber

Unique ID: BMR-TXT-420

The SLAW submerged bed scrubber (SBS) removes particles and aerosols from the melter offgas and cools the offgas to a desired temperature by using chilled water.

5.26.2 SLOP-VSL-00001_2 - SLAW SBS Condensate Vessel

Unique ID: BMR-TXT-421

The SLAW SBS condensate receipt vessel collects overflow liquid offgas condensate from the SLAW SBS, and supply consumed liquid in SLAW SBS.

5.26.3 SLOP-WESP-00001_2 - SLAW Wet Electrostatic Precipitator

Unique ID: BMR-TXT-422

The SLAW Wet Electrostatic Precipitator removes particles and aerosols greater than approximately one-micrometer from SLAW offgas stream.

5.26.4 SRLD-VSL-00004 - SLAW WESP Collection Vessel

Unique ID: BMR-TXT-306

The SLAW WESP Condensate Collection Vessel (SRLD-VSL-00004) receives liquids continuously from the SLAW Wet Electrostatic Precipitator (SLOP-WESP-00001_2).

5.26.5 SRLD-VSL-00005 - SLAW SBS Condensate Collection Vessel

Unique ID: BMR-TXT-305

The SLAW SBS Condensate Collection Vessel (SRLD-VSL-00005) receives condensate from the SLAW submerged bed scrubber (SLOP-SCB-00001_2) and SLAW WESP Condensate Collection Vessel (SRLD-VSL-00004).

5.27 SLVP

Second LAW Secondary Offgas/Vessel Process System (SLVP) Equipment

5.27.1 SLVP-HEPA-00001AB - High Efficiency Particulate Air Filter

Unique ID: BMR-TXT-390

The Second LAW High Efficiency Particulate Air Filter removes particulate and a small amount of gasses from the SLAW offgas stream.

5.27.2 SLVP-ADBR-00001AB - Carbon Adsorber

Unique ID: BMR-TXT-391

The SLAW Carbon Adsorber captures mercury, 129-I, and HCL and HF from the SLAW offgas stream.
5.27.3 SLVP-SCR-00001_2 - NOx Selective Catalytic Reducer
Unique ID: BMR-TXT-392
The SLAW NOx Catalytic Oxidizer Reducer selective catalytic primarily removes NO2, NO3, and SO2 gasses from the SLAW offgas stream using pure ammonia gas.

5.27.4 SLVP-SCB-00001 - Caustic Scrubber Column
Unique ID: BMR-TXT-393
The SLAW Caustic Scrubber Column removes the remaining acid gases such as HCl and SO2 as well as quenching and cooling hot gasses.

5.27.5 SLVP-TK-00001 - Caustic Scrubber Collection Vessel
Unique ID: BMR-TXT-394
The SLAW Caustic Scrubber Collection Vessel is accumulates and neutralizes the collected condensate from the caustic scrubber column.

5.27.6 SLAW-OFFGAS-STACK
Unique ID: BMR-TXT-395
The SLAW offgas stack represents the exhaust fans and stack which provide the motive force for air movement of the melter offgas and the vessel ventilation offgas up through the stack.

5.28 STLP
Second LAW Treated Low-Activity Waste Evaporator Process (STLP) System Equipment

5.28.1 STLP-DMST-00001 - SLAW Evaporator Demister
Unique ID: BMR-TXT-298
The SLAW evaporator demister represents the demister and condenser units which cool the evaporator offgas.

5.28.2 STLP-SEP-00001 - SLAW Evaporator
Unique ID: BMR-TXT-299
The SLAW Evaporator (STLP-SEP-00001) concentrates SLAW melter offgas condensate.

5.28.3 STLP-VSL-00009A/B - SLAW SBS Condensate Receipt Vessels
Unique ID: BMR-TXT-301
The SLAW SBS/WESP Condensate Receipt Vessels (STLP-VSL-00009A/B) receive melter offgas condensate from the SLOP system.
5.28.4 STCP-VSL-00001 - SLAW Evaporator Concentrate Storage Vessel
Unique ID: BMR-TXT-302
The SLAW Evaporator Concentrate Storage Vessel (STCP-VSL-00001) receives and stores the SLAW evaporator concentrate then sends it downstream to the SLAW buffer tank.

5.29 TCP
Treated Low-Activity Waste Concentrate Storage Process (TCP) System Equipment

5.29.1 TCP-VSL-00001 - Treated LAW Concentrate Storage Vessel
Unique ID: BMR-TXT-232
The Treated LAW Concentrate Storage Vessel (TCP-VSL-00001) receives and stores treated LAW concentrate then sends it downstream to the LAW melter.

5.30 TLP
Treated Low-Activity Waste Evaporator Process (TLP) System Equipment

5.30.1 TLP-DMST-00001 - Treated LAW Evaporator Demister
Unique ID: BMR-TXT-258
The treated LAW evaporator demister represents the demister and the three condenser units which cool the evaporator offgas.

5.30.2 TLP-SEP-00001 - Treated LAW Evaporator
Unique ID: BMR-TXT-231
The TLP evaporator (TLP-SEP-00001) concentrates LAW melter offgas condensate and cesium-reduced treated LAW.

5.30.3 TLP-VSL-00002 - Treated LAW Evaporator Condensate Vessel
Unique ID: BMR-TXT-259
The Treated LAW Evaporator Condensate Vessel (TLP-VSL-00002) collects the condensate from the treated LAW evaporator offgas.

5.30.4 TLP-VSL-00009A/B - LAW SBS Condensate Receipt Vessels
Unique ID: BMR-TXT-230
The LAW SBS condensate receipt vessels (TLP-VSL-00009A/B) receive melter offgas condensate from the LOP system.

5.31 UFP
Ultrafiltration Process (UFP) System Equipment
5.31.1 UFP-VSL-00001A/B - UFP Feed Preparation Vessels

**Unique ID:** BMR-TXT-137

Ultrafiltration Feed Preparation Vessels; UFP-VSL-00001A and UFP-VSL-00001B.

5.31.2 UFP-VSL-00002A/B - UFP Feed Vessels

**Unique ID:** BMR-TXT-186

The ultrafiltration feed vessels - UFP-VSL-00002A and UFP-VSL-00002B feed and receive from the cross-flow filters in UFP.

5.31.3 UFP-VSL-00062A/B/C - UFP Permeate Receipt Vessels

**Unique ID:** BMR-TXT-195

The UFP permeate receipt vessels consist of three identical vessels; UFP-VSL-00062A, UFP-VSL-00062B, and UFP-VSL-00062C. The three vessels receive permeate and wash solution from the UFP Feed Vessels (UFP-VSL-00002A/B) and send it downstream to the Cesium Ion Exchange Caustic Rinse Collection Vessel (CXP-VSL-00004) and Acidic/Alkaline Effluent Vessels (PWD-VSL-00015 and PWD-VSL-00016).
6.0 REFERENCE DOCUMENTS

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