WASTE TREATMENT AND IMMOBILIZATION PLANT
CHAPTER 4.0
PROCESS INFORMATION

CHANGE CONTROL LOG

Change Control Logs ensure that changes to this unit are performed in a methodical, controlled, coordinated, and transparent manner. Each unit addendum will have its own change control log with a modification history table. The "**Modification Number**" represents Ecology's method for tracking the different versions of the permit. This log will serve as an up to date record of modifications and version history of the unit.

Modification History Table

Modification Date	Modification Number
12/15/2016	8C.2016.Q3
06/20/2016	8C.2016.4F

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4.0 PROCESS INFORMATION

4.1 Process Description

~~Mixed waste is managed by the~~The Hanford Tank Waste Treatment and Immobilization Plant (WTP) is a Treatment, Storage, and Disposal Facility, permitted as Operating Unit Group 10 under the Hanford Dangerous Waste Permit. The WTP includes six major facilities. These facilities are the Low-Activity Waste (LAW) Vitrification Facility, the High-Level Waste (HLW) Vitrification Facility, the Pretreatment Facility, the Analytical Laboratory (Lab), the Direct-Feed Low-Activity Waste Effluent Management Facility (EMF), and the Balance of Facilities (BOF).

The WTP manages mixed and dangerous wastes using ~~tanks~~tank systems, containment buildings, container storage areas, and miscellaneous unit systems. The floors and lower portions of the black cells and hot cell walls are lined with stainless steel for secondary containment. Black cells and hot cells ~~will be~~are equipped with an instrumented sump or sumps for leak detection. Liquids are removed from the black cell sumps by steam ejectors.

~~The pretreatment facility~~The WTP uses two separate waste process system configurations during mixed waste treatment operations. These configurations are the Baseline configuration, and the Direct Feed Low-Activity Waste (DFLAW) configuration.

Baseline Configuration

In the Baseline configuration, characterized low-activity waste and high-level waste are sent directly from the Hanford Tank Farms to the Pretreatment Facility. The mixed waste is pretreated in the Pretreatment Facility and sent to either the HLW Vitrification Facility or the LAW Vitrification Facility for processing, depending on the waste characterization. Underground waste transfer lines allow for the transfer of waste from the Hanford Tank Farms to the Pretreatment Facility, and to and from the LAW Vitrification Facility, HLW Vitrification Facility, Lab, and other Treatment, Storage, and Disposal (TSD) Facilities.

The Pretreatment Facility, in the Baseline configuration, uses tank systems, miscellaneous unit systems (defined in Operating Unit Group 10, Section III.10.G of this Permit), and containment buildings to prepare waste feed from the Hanford ~~Site double-shell tank (DST) system~~Tank Farms for vitrification.

The ~~low-activity waste (~~LAW~~)~~ ~~v~~Vitrification ~~f~~Facility uses miscellaneous treatment unit sub-systems and equipment (defined in Operating Unit Group 10, Section III.10.H and III.10.I of this Permit), tank systems, and containment buildings to vitrify LAW feed.

The ~~high-level waste (~~HLW~~)~~ ~~v~~Vitrification ~~f~~Facility uses miscellaneous treatment unit sub-systems and equipment (defined in Operating Unit Group 10, Section III.10.J and III.10.K of this Permit), tank systems, containment buildings, and container storage areas to vitrify HLW feed. ~~A tank system and a container storage area are used at the analytical laboratory (Lab). Container storage is used in the balance of facilities (BOF) for waste management activities. These waste management activities are discussed in the following sections and in Appendix 4D for the pretreatment facility, Appendix 4E for the LAW vitrification facility, Appendix 4F for the HLW vitrification facility, Appendix 4H for the Lab and Appendix 4I for the BOF. Appendix 4G is reserved for the direct-feed low-activity waste (DFLAW) effluent management facility (EMF) and will be completed and submitted at a later date.~~

A tank system and a container storage area are used at the Lab. Container storage is used in the BOF for waste management activities.

DFLAW Configuration

In the DFLAW configuration, treated low-activity waste from the Hanford Tank Farms Low-Activity Waste Pretreatment System (LAWPS) is transferred to the LAW Vitrification Facility via an underground waste transfer line. The LAWPS is permitted as a separate TSD Facility under the Hanford Site-Wide Dangerous Waste Permit (Site-wide DWP). The DFLAW configuration consists of the EMF, which includes the Direct Feed LAW EMF Process System (DEP), a dedicated ventilation system, and dedicated utilities, and underground waste transfer lines that allow for the transfer of waste to and from the LAW Vitrification Facility, Lab, and other TSD Facilities. The DFLAW configuration is independent of the Baseline configuration, and is only used prior to Pretreatment Facility startup and in the event of a prolonged Pretreatment Facility outage. The EMF uses tank systems and miscellaneous treatment unit sub-systems and equipment, defined in Operating Unit Group 10, Section III.10.M.

Waste Management

Waste management activities are discussed in the following sections and in Chapter 4D for the Pretreatment Facility, Chapter 4E for the LAW Vitrification Facility, Chapter 4F for the HLW Vitrification Facility, Chapter 4G for the EMF, Chapter 4H for the Lab, and Chapter 4I for the BOF.

Integrated Control Network

WTP operates an Integrated Control Network (ICN). The ICN provides a real-time control and data acquisition system platform responsible for the operation and control, and alarm management, of WTP processes during normal operating conditions. The ICN integrates the WTP control systems, such as the Process Control System (PCJ), the Mechanical Handling Control System (MHJ), and the Autosampling Control System (ASJ). The ICN includes network hardware devices (switches and routers), linking devices, computer servers, operating consoles and workstations, local operator interfaces, panels, enclosures, and an operating system software platform.

The WTP control systems serve as the controller logic that generate control outputs to the WTP processes, including, mechanical handling, autosampling, and ventilation. The control systems conduct various functions, including:

- Monitoring and/or controlling the electrical services
- Monitoring environmental and stack discharge equipment
- Controlling non-safety services and utilities.

The control systems send data to the ICN where it is passed to the plant information network. The plant information network is a network designed to store plant operating system data and information applicable to the WTP Dangerous Waste Permit (DWP). The following are examples of the plant information network capabilities:

- Capture and store information related to WTP DWP sample requests, sample statuses, and sample results.
- Capture and store information related to the tracking of dangerous/mixed waste containers throughout the facilities, from point of generation to off-site shipment; including containers located in permitted container storage areas, 90-day accumulation areas and satellite accumulation areas.

More information on the ICN and plant information network will be provided prior to the initial receipt of dangerous and/or mixed waste, as required in WTP DWP permit condition III.10.D.10.c.v.

4.1.1 Process Overview

~~The~~In the DFLAW configuration, waste from the Hanford Tank Farms is pumped to the LAWPS where it is processed to meet contractual requirements for transfer of waste directly to the LAW Vitrification Facility. The LAWPS Facility is permitted as a separate TSD Facility under the Site-Wide DWP. After sampling the waste stream, and confirmation by the WTP that it meets LAW waste acceptance criteria, it is then pumped directly to the LAW Vitrification Facility.

In the Baseline configuration, the WTP will store and treat waste feed from the Hanford ~~Site DST system~~Tank Farms in the ~~p~~Pretreatment ~~f~~Facility. The ~~p~~Pretreatment ~~f~~Facility will separate the waste into two feed streams for the LAW and HLW ~~melters.~~Vitrification facilities. Feed from the ~~DST~~

~~system~~Hanford Tank Farms is expected to be of four major waste feed types, or waste feed envelopes A, B, C, and D. For the DFLAW configuration, waste feed will come from waste feed envelope E. These waste feed envelopes are described as follows:

- Envelope A. This waste feed envelope will contain cesium at concentrations high enough to warrant removal of these radionuclides during pretreatment, to ensure that the ~~i~~Immobilized ~~l~~Low-~~a~~Activity ~~w~~Waste (ILAW) glass will meet applicable requirements.
- Envelope B. This waste feed envelope will contain higher concentrations of cesium than envelope A. Cesium must be removed to comply with the ILAW specifications. This envelope may also contain concentrations of chlorine, chromium, fluorine, phosphates, and sulfates that are higher than those found in envelope A, which may limit the waste incorporation rate into the glass.
- Envelope C. This waste feed envelope will contain organic compounds containing complexed strontium and transuranics (TRU) that will require removal in a processing step unique to this waste envelope. As with envelopes A and B, cesium will also require removal in the pretreatment process to ensure that ILAW glass meets applicable requirements.
- Envelope D. HLW feed will be in the form of a slurry containing approximately 10 to 200~~-~~ grams of unwashed solids per liter. The liquid fraction of the slurry will be separated from the solids and classified as envelope~~-~~ A, B, or C waste. The solid fraction will be envelope~~-~~ D waste.
- Envelope E. Direct feed from LAWPS, with a nominal sodium concentration of 5 to 8 molar.

The WTP treatment processes are designed to immobilize the waste constituents in a glass matrix by vitrification and to treat the offgas from the processes to a level that protects human health and the environment.

Two similarly designed vitrification systems ~~will be~~are used in the WTP in the Baseline configuration. One system ~~will immobilize~~immobilizes the pretreated LAW feed and the second ~~will immobilize~~immobilizes the pretreated HLW feed. The dangerous waste constituents in the melter feed ~~will be~~is destroyed, removed, or immobilized in a glass matrix through the vitrification process.

The ILAW and ~~i~~Immobilized ~~h~~High-~~l~~Level ~~w~~Waste (IHLW) produced by the WTP will be in the form of glass. The glass is packaged in stainless steel containers for ILAW and stainless steel canisters for IHLW and placed in permitted ~~treatment, storage, and/or disposal (TSD) facilities~~ TSD Facilities.

Secondary waste streams (e.g., dangerous and mixed solid waste, ~~nonradioactive and nondangerous liquid effluents,~~ mixed waste and dangerous liquid effluents) ~~will be~~are characterized and recycled into the treatment process, transported to permitted TSD ~~f~~Facilities located on the Hanford Site, or transported off-site, as appropriate.

Nonradioactive dangerous waste will also be generated by laboratory and maintenance activities. This waste will be managed at the WTP until it can be transferred to an off-site TSD unit. There are ~~four~~ six primary components of the WTP: ~~pretreatment~~Pretreatment Facility, LAW ~~vitrification~~ Vitrification Facility, HLW ~~vitrification, and~~Vitrification Facility, EMF, the ~~analytical laboratory. In addition, each of these waste treatment processes is supported by~~Lab, and the supporting BOF -systems and utilities ~~known as the balance of facilities~~. The following discussion presents an overview of these waste treatment processes and ~~balance of facilities~~BOF systems at the WTP. Figure 4A-1 in ~~Appendix~~ Chapter 4A presents a simplified process flow diagram of the WTP treatment processes.

Pretreatment

~~The~~In the Baseline configuration, waste feed ~~will be~~is stored and subsequently treated in the ~~p~~Pretreatment ~~f~~Facility prior to vitrification. The processes in the ~~pretreatment facility will condition~~Pretreatment Facility conditions the waste feed and removes cesium, strontium, TRU compounds, and entrained solids. The waste feed ~~will~~is also ~~be~~ processed through ultrafiltration to separate the solids.

There ~~will be three~~are four types of waste management units in the ~~pretreatment facility, as follows~~Pretreatment Facility:

- Container storage areas
- Tank systems
- Containment buildings
- Miscellaneous unit systems

The structure of the ~~p~~Pretreatment ~~f~~Facility is supported by a reinforced concrete foundation. The superstructure ~~will be~~is made of structural steelwork with a metal roof. Typically, the process cells within the ~~p~~Pretreatment ~~f~~Facility ~~will be~~are constructed of reinforced concrete. Secondary containment is provided as required for tank systems and miscellaneous unit systems managing dangerous or mixed waste. Secondary containment consists of either stainless steel liners or special protective coatings. Table~~-~~ 4D-3 in ~~Appendix~~ Chapter 4D provides information on secondary containment. Figure 4A-2 and 4A-~~02A~~2A in ~~Appendix~~ Chapter 4A present simplified process flow diagrams of the pretreatment processes.

LAW Vitrification Facility

The LAW ~~v~~Vitrification ~~facility~~Facility will house the vitrification systems for production of the ILAW. ~~Three~~ Four types of waste management units will be located in the LAW ~~v~~Vitrification ~~f~~Facility, as follows:

- Container Storage Areas
- Tank systems
- Containment buildings
- Miscellaneous treatment unit sub-systems and equipment

The LAW ~~vitrification facility will be~~Vitrification Facility is constructed of reinforced concrete and structural steelwork. The below-grade portion of the building structure is made of reinforced concrete, and the superstructure ~~will be~~is made of reinforced concrete and structural steelwork with a metal roof. The ~~facility~~LAW Vitrification Facility structure ~~will be~~is supported by a reinforced concrete mat foundation.

Secondary containment is provided as required for tank systems and miscellaneous unit sub-systems and equipment managing dangerous or mixed waste. Secondary containment consists of either stainless steel liners or protective coatings. Table~~-~~ 4E-3 in ~~Appendix~~ Chapter 4E provides information on secondary containment. Figure~~-~~ 4A-3 in ~~Appendix~~ Chapter 4A presents a simplified process flow diagram of the LAW ~~vitrification~~ Vitrification Facility treatment processes.

HLW Vitrification Facility

The HLW ~~vitrification facility will house~~Vitrification Facility houses the vitrification systems for producing IHLW. Four types of waste management units ~~will be~~are located in the HLW ~~v~~Vitrification ~~f~~Facility, as follows:

- Container storage areas
- Tank systems
- Containment buildings
- Miscellaneous treatment sub-systems and equipment

The HLW ~~v~~Vitrification ~~f~~Facility ~~will be~~is constructed of reinforced concrete and structural steelwork. The lower elevations of the building structure are reinforced concrete construction, and the upper elevations made of structural steelwork with a metal roof. The ~~facility~~HLW Vitrification Facility structure ~~will be~~is supported by a reinforced concrete mat foundation. Secondary containment is provided as required for tank systems and miscellaneous unit sub-systems and equipment managing dangerous or mixed waste. Secondary containment consists of either stainless steel liner or protective coating. Table~~-~~ 4F-3 in ~~Appendix~~ Chapter 4F provides information on secondary containment. Figure~~-~~ 4A-4 in ~~Appendix~~ Chapter 4A presents a simplified process flow diagram of the HLW ~~vitrification~~Vitrification Facility treatment processes.

Direct Feed Low-Activity Waste Effluent Management Facility (EMF)

The EMF consists of four primary buildings: the LAW Effluent Process Building, the LAW Effluent Drain Tank Building, the LAW Effluent Electrical Building, and the LAW Effluent Utility Building. The EMF contains an evaporator system, nine major process vessels, two supporting reagent product storage tanks, HVAC equipment, and electrical utilities. The buildings are constructed of reinforced concrete and structural steelwork with a metal roof. The EMF structures are supported by a reinforced concrete mat foundation.

The EMF is designed with a minimum of a 48-hour effluent storage capacity, and includes underground waste transfer lines to transfer waste to and from the LAW Vitrification Facility, Lab, and other TSD Facilities. Secondary wastes generated by the EMF are managed as described in Chapter 4G.1

There are two types of waste management units in the EMF:

- Tank Systems
- Miscellaneous unit systems

Analytical Laboratory

~~The analytical laboratory will house~~The Lab houses the hot cells, laboratories, and systems for analyzing process samples and managing regulatory compliance samples. Two types of waste management units ~~will be~~are located in the ~~analytical laboratory, as follows~~Lab:

- Container storage areas
- Tank systems

The ~~analytical laboratory will be~~Lab is constructed of reinforced concrete, structural steelwork, and a metal roof. The below-grade portions of the building structure ~~will be~~are constructed of reinforced concrete. The ~~analytical laboratory~~Lab structure will be supported by a reinforced concrete mat foundation. Secondary containment is provided as required for tank systems managing dangerous or mixed waste. Secondary containment consists of either stainless steel liner or protective coating. Table~~-~~ 4H-2 in ~~Appendix~~ Chapter 4H provides information on secondary containment.

Balance of Facilities

The ~~balance of facilities~~BOF includes support systems and utilities required for the waste treatment processes within the ~~pretreatment~~Pretreatment Facility, LAW ~~vitrification~~Vitrification Facility, HLW ~~vitrification~~Vitrification Facility, and the ~~analytical laboratory. The balance of facilities~~Lab. BOF support systems and utilities include, but are not limited to, heating and cooling, process steam, process water, chilled water, primary and secondary power supplies, and compressed air. The ~~balance of facilities~~BOF also includes the ~~g~~Glass ~~f~~Former ~~r~~Reagent system (GFR) that supplies glass former reagents to the LAW and HLW ~~v~~Vitrification facilities. Regulated waste management units within the ~~balance of facilities~~BOF include the HLW ~~f~~Failed ~~m~~Melter ~~s~~Storage ~~f~~Facility and the ~~n~~Nonradioactive ~~d~~Dangerous ~~w~~Waste ~~s~~Storage ~~a~~Area.

4.2 Tank Systems

This section contains descriptive information for each tank system used for managing mixed waste. The term "tank systems" refers to mixed waste storage or treatment tanks, including primary containment sumps, and their associated ancillary equipment and containment systems. Figures and permit drawings depicting design features of tank systems are found in DWP Operating Unit Group 10.

The following text uses the terms "vessel" and "tank". The term "vessel" is an engineering term and denotes more robust construction than a typical mixed waste storage or treatment tank. The term "vessel" is included due to the use of the term in the American Society of Mechanical Engineers (ASME) codes and specifications~~, which will be~~ that are followed for most tank construction at the WTP.

4.2.1 Design, Installation, and Assessment of Tank Systems

This section describes the attributes of tank systems ~~that will contain~~containing mixed waste. Tanks and ancillary equipment containing only additives or reagents, such as glass-forming chemicals, precipitation reagents, or unused resin, are not regulated under the Resource Conservation and Recovery Act (RCRA) or the Washington State Dangerous Waste Program, and are therefore not included.

Tank systems ~~that will contain~~containing mixed waste are designed to comply with worst-case scenarios, such as extreme pH, temperature, and pressure conditions. The WTP ~~will be~~is entirely new construction, and there ~~will be~~are no "existing tanks" in the plant.

Tank systems, with the exception of the two outside tanks at the ~~pretreatment facility, will be~~ Pretreatment Facility and the eight outside vessels at the EMF, are located indoors and within process cells, process rooms, or caves with controlled access.

4.2.1.1 Design Requirements

Tanks

Most of the tanks that come in contact with the waste ~~will be~~are operated under atmospheric pressure conditions at the WTP. The mixed waste tanks ~~will be~~are designed, at a minimum, to *Boiler and Pressure Vessel Code* (ASME 2000), the American Petroleum Institute (API) codes, or other appropriate design codes. Tank integrity ~~will be~~is reinforced by additional requirements of the tank group and seismic category assignment to each tank.

The vessels ~~will be~~are designed for seismic loading in accordance with the *Uniform Building Code* (UBC) standard for Zone 2B (UBC 1997).

The codes and standards that ~~will be~~are followed for design, construction, and inspection for the tanks are identified below, as applicable:

- ANSI American National Standards Institute
- API American Petroleum Institute
- ASME American Society of Mechanical Engineers
- ASNT American Society of Non-Destructive Testing
- ASTM American Society for Testing and Materials
- EPA US Environmental Protection Agency
- NACE National Association of Corrosion Engineers
- NBBPVI The National Board of Boilers and Pressure Vessel Inspectors
- OSHA Occupational Safety and Health Administration
- PFI Pipe Fabrication Institute
- UBC Uniform Building Code

- WRC Welding Research Council

Permit documents describing tank design requirements are located in DWP Operating Unit Group 10, Appendix 7.7:

- Specification for Pressure Vessel Design and Fabrication, 24590-WTP-3PS-MV00-T0001
- Seismic Qualification Criteria for Pressure Vessels, 24590-WTP-3PS-MV00-T0002
- Specification for Pressure Vessel Fatigue Analysis, 24590-WTP-3PS-MV00-T0003

Piping and Pipe Support Design

The design code of the WTP piping and pipe supports is ASME B31.3 Code (ASME 1996), as well as the United States Department of Energy (DOE) seismic requirements. In compliance with DOE seismic requirements (DOE 1996), response spectrum method, or UBC (UBC 1997) static method is used for the seismic analysis of the piping systems.

Additional information for piping and pipe support design is included in the following documents, which are included in DWP Operating Unit Group 10 Appendices as indicated:

- *Material for Ancillary Equipment*, 24590-WTP-PER-M-02-002 (Appendix 7.9)
- *Piping Material Class Description*, 24590-WTP-PER-PL-02-001 (Appendix 7.24)
- *Ancillary Equipment Pipe Support Design*, 24590-WTP-PER-PS-02-001 (Appendix 7.5)

4.2.1.2 Physical Information for Tanks

Tables in ~~Appendices~~ Chapters 4D, 4E, 4F, 4G, and 4H list current tank design information (capacity, materials of construction, and dimensions). The tank systems are grouped by plant and process system.

Tank operation is generally automated. However, operator intervention can be used when human decisions or approval are required for initiation and termination of a process operation. Descriptions of tank system operation for major WTP process systems are identified in ~~Appendices~~ Chapters 4D, 4E, 4F, 4G, and 4H.

4.2.2 Ancillary Equipment Requirements

Information concerning ancillary equipment is provided in the following subsections.

4.2.2.1 Transfer or Pressure Control Devices

Several fluid transfer devices ~~will be~~are used in the WTP. These devices include mechanical pumps, reverse flow diverters, and steam ejectors. Breakpots and seal pots, although not fluid transfer devices, are an important component of vessel operations. These components are discussed in the following sections.

Mechanical Pumps

Mechanical pumps ~~will be~~are used for operations that require high-flow pumps (such as through the evaporator circuits) or high-pressure head pumps (such as for pumping a waste stream through ultrafiltration circuits). Mechanical pumps ~~will be~~are located in process cells, process rooms, or caves. In general, mechanical pumps ~~will be~~are repaired in place, or removed to a maintenance area. However, remotely maintained pumps ~~will be~~are used in areas where maintenance activities would result in a significant radiation dose to the operators.

For normal process operating sequences, mechanical pumps and associated valves ~~will be~~are controlled by the process control system. In systems where off-normal conditions ~~would~~ require pump shutdown, the design ~~will~~ includes an alarm mechanism that ~~will~~ also trips the transfer device. The pump system is designed to allow for the drainage of liquid from the pump, and for the introduction of flush liquids at the end of transfers to reduce residual contamination.

Reverse Flow Diverters

Reverse flow diverters ~~will~~ provide for the maintenance-free pulsed or metered transfer of liquids or slurries throughout the treatment process. A reverse flow diverter does not need to be fully submerged in order to remove the contents of a vessel, and it maintains a small and predictable volume of tank contents following its use. Operation of the reverse flow diverter is cyclical, following timed phases: suction phase, drive phase, and blowdown. The following paragraphs describe a typical reverse flow diverter system arrangement.

Suction phase: In the suction phase, the secondary automatic valve A is open, admitting air to the suction jet pump. Valve B is shut and liquid is drawn from the supply tank through the reverse flow diverter and into the charge vessel. The suction ejector is designed so that it cannot produce a vacuum capable of lifting liquid higher than a certain valve known as the “suction lift”. After a short time, the liquid reaches this “suction lift” height and stops, then valve A is shut.

Drive phase: When valve A is shut, valve B is opened, admitting air to the drive nozzle. Air passes through the nozzle and pressurizes the charge vessel. Liquid is forced across the reverse flow diverter and into the delivery pipe. The delivery pipe is quickly filled with liquid that flows into the delivery vessel.

Blowdown phase: When the charge vessel is nearly empty, valve B is shut; no air is supplied to either jet pump. The compressed air in the charge vessel passes back through the paired jet pumps, down the vent pipe, and into vessel vent system.

Shortly after blowdown begins, the pressure in the charge vessel falls below the delivery head, and the flow of liquid into the delivery vessel is halted.

The liquid in the delivery vessel then falls back down the pipe, across the reverse flow diverter, and into the charge vessel. After a short time, the pressure in the charge vessel falls to zero (gauge). The cycle is now complete.

Steam Ejectors

Steam ejectors are used to transfer process liquids, or to reduce the operating pressure of a system by gas removal. They empty liquid from vessels by means of suction lift, using a simple control system.

An automated control valve supplies high-pressure steam to the steam ejector. This steam accelerates through a nozzle, creating a differential pressure along a submerged suction leg within the vessel. The pressure than forces the liquid up the suction pipe. This effect is known as *striking*. The steam then conveys the liquid to the destination vessel, normally via a breakpot. Control is established using liquid level instrumentation in the vessel being emptied, and using a temperature indicator, such as a thermocouple, within the breakpot.

Seal Pots

A seal pot is a type of hydraulic seal. A hydraulic seal is used primarily to maintain a separation between vessel vent or offgas systems for feed and receipt vessels. This separation is necessary to prevent migration of airborne contamination between the vessels. Without the seal, airflow could occur due to the different pressures in the vent systems. The seal is a slug of liquid in the interconnecting pipe work that remains after each liquid transfer is completed, blocking airflow between vessels.

The seal can be provided by constructing a simple “U” shape in the piping. Different piping arrangements are used for different purposes. A seal pot is a small vessel with one (inlet or outlet) pipe submerged in the liquid slug in the lower part of the pot, while the other pipe terminates in the top of the pot, above the static liquid level. The pot may be provided with a level indicator or alarm, if necessary, to ensure adequate liquid level. Periodic liquid additions may be needed to maintain the seal, especially if the pipeline is infrequently used.

Breakpots

The main function of the breakpot is to reduce the amount of mixed waste material entrained into the vessel ventilation system. Breakpots are provided on transfer lines that use steam ejectors for moving liquids by pressure flow. These types of transfers create the potential for air entrainment of mixed waste contamination. Breakpots function to convert steam from pressure flow to liquid gravity flow, thereby reducing both the effluent loading on the downstream vessel ventilation treatment system and the mixed waste contamination levels in the vessel vent ductwork. Breakpots also serve a secondary purpose by providing a siphon break for other transfer systems where siphoning could occur.

Breakpots are typically placed at a high point in the discharge line from the steam ejector. Liquid ~~will be~~is pumped into the breakpot through an inlet nozzle in its wall. The incoming liquid ~~will be~~is directed towards a baffle. Within the baffle, noncondensed steam and gases ~~will~~ disengage. The breakpot ~~will be~~is self-draining; the liquid ~~will~~ drains through the breakpot discharge pipe to the destination vessel.

~~Above the inlet nozzle(s) will be a~~A packed bed where disentrainment of the gas stream ~~will occur.~~ occurs is located above the inlet nozzle(s). The exiting gas from the packed section ~~will~~ passes into the vessel ventilation system. The packed bed can be washed periodically using a wash ring permanently installed above the packed bed.

4.2.2.2 Bulges

Bulges ~~are intended to~~ allow hands-on maintenance of equipment after process fluids are flushed from the bulge piping and components. Bulges provide shielding to personnel during process operation and allow vulnerable or failure prone components to be located outside the process environment. The cell wall provides shielding between the cell and the bulge interior. The bulge includes shielding and contamination control as needed, depending on the process fluid within the bulge piping.

A typical bulge consists of a metal frame attached to the outside wall of a process cell; the frame is used to support the piping and components as well as the shielding plates (usually steel), which are bolted to the frame. Bulges provide secondary containment for DWP ancillary equipment inside the bulge.

The ancillary equipment located inside the bulges ~~will be~~are provided with leak detection or the bulge is provided with a drain line that flows to a sump equipped with leak detection. Leak detection can be provided internal to the bulge or in the sump associated with bulge drain line.

There are two classifications of bulges used at the WTP. One is a “process” bulge; the other is a “service” bulge. The process bulge contains valves, pumps, piping, etc. The service bulge contains valves used to transfer reagents, steam, etc., to the in-cell process equipment. The design of the two bulges is similar.

Bulges are equipped with several wash systems, facilitating washing both internal and external piping, components, and bulge confinement surfaces. Decontamination of the equipment internals and associated piping is achieved by externally connecting a flushing system located on the outside of the bulge. Wash fluids could be water or more aggressive media such as nitric acid, provided compatibility with the bulge materials is ensured.

Additional information on process bulges may be found in *Process Bulge Design and Fabrication* (24590-WTP-3PS-MX00-T0~~P~~001), located in DWP Operating Unit Group 10, Appendix 7.7 and ~~Appendix~~ Chapter 4A, Figure 4A-127.

4.2.2.3 Description of WTP Piping System

Detailed information on piping is included in *Piping Material Class Description* (24590-WTP-PER-PL-02-001), located in DWP Operating Unit Group 10, Appendix 7.2~~4~~.

Interplant Piping Transfer Lines

~~Waste~~In both the Baseline and DFLAW configurations, waste feed from the ~~DST system~~ Hanford Tank Farms and the LAWPS will be transported to the WTP via ~~the~~ underground waste transfer lines.

The waste feed transfer lines ~~will be~~are double-walled pipe. The inner pipe ~~will be~~is constructed of stainless steel, while the outer secondary containment pipe ~~will be~~is constructed of carbon steel. The carbon steel outer pipe ~~will be~~is coated with a ~~corrosion-resistant material.~~fusion bonded epoxy (FBE) coating. In addition, the coated outer pipe for the waste transfer lines ~~from the DST to the pretreatment facility will be~~are surrounded by an injected closed-cell polyurethane foam insulation and a ~~seamless~~ high-density polyethylene outer ~~shell.~~jacket. This extra layer of protective material ~~will~~ isolates the waste transfer lines from soil. ~~The waste transfer lines between the pretreatment facility and the other WTP process plants will not have this extra barrier from the soil, but will be cathodically protected as described later in this section.~~

~~A leak detection system will be provided for the entire length of the waste transfer line. Pumping will be terminated, and reception of waste feed from the DST system unit will stop, when a leak is identified by the leak detection system.~~

The inner pipe ~~will be~~is supported by guides, saddles, support keys, or anchors within the outer pipe. The inner pipe ~~will~~ transports waste and maintains the pressure boundary, while the outer pipe ~~will~~ provides secondary containment for the inner pipe. The piping system ~~will be~~is buried under a minimum depth of soil for radiation shielding. The minimum depth of soil ~~will be~~was finalized at the detail design phase and will not be less than the 2 feet (ft) freeze depth. A heat trace system is not required for pipes buried below freeze depth.

~~The piping system will have a continuous slope down toward the pretreatment facility. Released liquids resulting from leaks to the outer pipe can~~In the baseline configuration, the waste transfer lines between the Pretreatment Facility and the other WTP process plants do not have this extra barrier from the soil, but are cathodically protected as described later in this section. In the DFLAW configuration, the new effluent or process waste transfer lines between the LAWPS and the EMF, starting at the DOE interface point at the WTP property boundary and ending at the LAW, and from the EMF back to the Hanford Tank Farms ending at DOE interface point at the WTP property boundary, utilize the High Density Polyethylene (HDPE) jacketed design to isolate the transfer lines from the soil environment. Similarly, the transfer lines between the LAW and EMF, the Lab and EMF, and the EMF to the intersection of the existing transfer line between the Pretreatment Facility and the LERF/ETF interface point, utilize the HDPE jacketed design. In the DFLAW configuration, the cathodically protected intra-facility piping system between the Pretreatment Facility and the other WTP facilities will be isolated, and not used. However, the cathodic protection system will remain operational even though wastes are not being managed in these process transfer lines.

A leak detection system is provided for each of the underground waste transfer lines. A leak detection alarm will send a signal to stop waste transfer pumps and terminate the transfer of waste feed.

The underground piping system has a continuous slope down toward the Pretreatment Facility from the Hanford Tank Farms in the Baseline configuration. In the DFLAW configuration all transfer lines slope to Leak Detection Boxes (LDBs) located in the LAW Effluent Drain Tank Building. The exception is the Liquid Effluent Retention Facility/Effluent Treatment Facility (LERF/ETF) transfer line LDBs which are located at the LERF/ETF interface point on the WTP property line. Released liquids resulting from leaks to the outer pipe will be removed as required by WAC 173-303-640(4)(b). The piping system ~~will be~~is designed to allow water flushing to occur~~ in both directions~~.

Liquid Effluent Transfer Lines

~~Liquid~~In the Baseline configuration, liquid effluent generated at the WTP ~~will be~~is routed to the ~~p~~Pretreatment ~~f~~Facility for recycling through the WTP ~~or disposal~~and then transferred to the Liquid Effluent Retention Facility (LERF) and Effluent Treatment Facility (ETF) for treatment and disposal.

~~An~~To support the Baseline configuration two HDPE jacketed waste effluent ~~line will be~~lines are routed from the ~~p~~Pretreatment ~~f~~Facility to the LERF ~~and ETF. This~~ /ETF interface point located northwest of the EMF along the WTP property line. In the DFLAW configuration two HDPE transfer lines intersect the existing LERF/ETF transfer lines between the Pretreatment Facility and the interface point. In this configuration the transfer line ~~is a buried pipe, constructed of materials that are compatible with the waste, under a minimum 2 ft of soil serving as freeze protection.~~between the Pretreatment Facility and the line intersection is isolated to prevent fluids from flowing to the Pretreatment Facility. The pipes ~~will~~ have a continuous downwards slope towards the LERF ~~and ETF, and will be designed to maintain structural integrity~~/ETF. A leak detection system ~~will be~~ is provided for the LERF/ETF waste transfer lines at the LERF/ETF interface point.

Intraplant Piping

~~Within~~Pipelines within the plants, ~~the pipelines~~ associated with the tank ~~system will be~~systems located in process cells, black cells, bulges and pipe and pump pits, are typically single-walled pipelines. Secondary containment ~~will be~~is provided ~~for piping within the plants by double-walled pipe or~~by partially lined process cells, process rooms, or caves. ~~If needed, other~~Secondary containment ~~methods such as a bulge~~to support unique processes is provided by pump and pipe pits, melter encasement assembly areas, and bulges or concrete ducts with liners ~~will be provided~~ at appropriate locations. The bulge or concrete ducts ~~will be~~are provided with a low point which ~~will~~ drains to process cells, process rooms, or caves. The leak detection equipment located within the process cells, process rooms, and caves ~~will warn~~provides warning of a piping leak through leak detection alarms.

Piping between plants and the two outdoor tanks at the ~~pretreatment facility will be double-walled~~Pretreatment Facility, and the eight EMF outdoor vessels, are double-walled, FBE-coated, insulated, HDPE-jacketed lines. The majority of the transfer lines are located below grade, and below the freeze line~~, similar to the waste transfer line~~. The above ground segment of the lines to the associated vessels are insulated and heat traced to prevent freezing.

Cathodic Protection

An impressed current cathodic protection system ~~will be~~is used in the Baseline configuration for eliminating or mitigating corrosion on underground piping. The cathodic protection system ~~will~~ maintains a negative ~~polarized~~ pipe to soil potential ~~between~~ on the protected pipe ~~and~~ relative to a saturated copper/copper sulfate reference electrode.

The impressed current cathodic protection system uses direct current provided by a rectifier that is powered from the plant's normal 480 Vac power system. The direct current from the rectifier is connected across the buried anode wire and the protected pipe. The current flows from the anode wire, which is positive, through the electrolyte, to the protected pipe, which is negative, and back to the rectifier completing the electrical circuit.

An annual survey, recommended by NACE International (formerly the National Association of Corrosion Engineers), ~~will be~~is performed on the ~~overall~~ system provided with cathodic protection. Test stations ~~will be~~are provided to permit potential measurements. Additional information on inspections is provided in Operating Unit Group 10, Chapter ~~6.0~~6A.

The following waste transfer lines are provided with cathodic protection at the WTP. The waste transfer lines are double encased and constructed of materials that are compatible with the waste:

- Mixed waste transfer lines between the Pretreatment Facility and the HLW Vitrification Facility
- Mixed waste transfer lines between the Pretreatment Facility and the LAW Vitrification Facility
- Mixed waste transfer line between the Analytical Laboratory and the Pretreatment Facility

Corrosion Protection

The following WTP waste transfer and effluent transfer lines that utilize FBE, thermal insulation, and an HPDE jacket, are isolated from soil moisture with an external ~~waterproof~~ water resistant barrier to provide corrosion protection:

- DOE waste feed pipelines from the Hanford Tank Farm interface point to the ~~PTF~~Pretreatment Facility
- Radioactive/dangerous waste effluent transfer lines from the ~~PTF~~ Pretreatment to the ETF/LERF interface point
- Mixed waste transfer lines from the LAWPS to the EMF starting at the DOE interface point at the WTP property boundary and ending at the LAW Vitrification Facility
- Mixed waste transfer lines from the EMF back to the Hanford Tank Farms beginning at EMF and ending at the DOE interface point at the WTP property boundary
- Mixed waste transfer lines from the LAW Vitrification Facility to the EMF
- Mixed waste transfer lines from the Lab to the EMF
- Mixed waste transfer lines from the EMF to an intersection point on the existing transfer line from the Pretreatment Facility to the LERF/ETF interface point at the WTP property boundary

The incoming DOE waste feed pipelines that interface with the WTP pipelines are intentionally not cathodically protected. Consistent with the existing Hanford Tank Farm waste transfer design, transfer lines from the WTP interface point, the Waste Feed Receipt Process (FRP) transfer lines and the LERF/ETF effluent coaxial transfer lines are furnished with additional corrosion protection by the addition of an external ~~waterproof~~ water resistant barrier. This barrier isolates the lines from moisture in the surrounding soils and provides corrosion protection in lieu of cathodic protection.

The barrier consists of a 2~~-~~-inch layer of sprayed or injected closed-cell polyurethane foam with an external jacket of extruded HDPE jacket with a minimum thickness of ~~150~~ 140 mils. This barrier is located over the fusion bonded epoxy coated carbon steel outer encasement pipe which provides secondary containment for the inner stainless steel process line.

The incoming waste transfer lines are also bonded at the crossing of the plant service air piping between the ~~PTF~~ Pretreatment Facility and the HLW Vitrification Facility on the opposite end (which is ~~perpendicular~~cathodically protected piping). ~~The waste feed lines, therefore, may receive some amount of protective cathodic protection current in the area where they are bonded.~~ This area is defined as the "zone of influence." Bonding is provided to minimize stray electrical currents that may occur in the zone of influence~~ and thereby eliminate the possible corrosion process. The waste feed lines are also provided with the test stations at both ends to allow potential tests that will indicate if corrosion is a concern~~.

4.2.2.4 Description of Foundations

Tank systems containing mixed waste ~~will be~~are located indoors in process cells or caves, which ~~will be~~are an integral part~~s~~ of the ~~pretreatment facility, analytical laboratory~~Pretreatment Facility, Lab, the LAW ~~vitrification facility~~Vitrification Facility, HLW Vitrification Facility, and the ~~HLW vitrification facility with the~~EMF. The exception ~~of~~ being two outdoor Pretreatment Facility tanks and eight outdoor EMF vessels. Therefore, the design requirements of the tank systems ~~will be~~are met by the structural integrity of the plants. WTP compliance with UBC seismic design requirements, found in DWP Operating Unit Group 10, Supplement 1, provides the seismic design requirements for the WTP. The outdoor tanks ~~will be~~and vessels are located outside of the ~~p~~Pretreatment ~~f~~Facility and EMF on ~~a~~ protectively-coated concrete pads and concrete berms. The concrete pads for these tanks ~~will be~~are sufficient to support the tanks and vessels.

Additional information on the design criteria, load definitions, load combinations, and methodology for the structural design and analysis may be found in *Secondary Containment Design* (24590-WTP-PER-CSA-02-001), located in DWP Operating Unit Group 10, Appendix 7.5.

4.2.3 Integrity Assessments

~~A w~~Written ~~a~~Assessments of the adequacy of the design of tank systems and miscellaneous treatment systems ~~will be~~are prepared on a system-by-system basis. Separate reports are prepared for tanks, tank system ancillary equipment, and associated secondary containment systems. Each assessment ~~will be~~is reviewed and certified by an independent, qualified, registered professional engineer to attest that the tank and miscellaneous treatment systems are adequately designed for managing dangerous waste. Each assessment ~~will~~ includes an evaluation of the foundation, structural support, seams, connections, pressure controls, compatibility of the waste with the materials of construction, and corrosion controls for each mixed waste management system, as appropriate. ~~Assessment~~Integrity assessment reports are located in DWP Operating Unit Group 10, Appendix 8.11 for the ~~p~~Pretreatment ~~f~~Facility, Appendix 9.11 for the LAW ~~v~~Vitrification ~~f~~Facility, Appendix 10.11 for the HLW ~~v~~Vitrification ~~f~~Facility, and Appendix 11.11 for the Lab, and Appendix 13.11 for the EMF.

4.2.4 Additional Requirements for Existing Tanks

Tanks and vessels ~~to be~~that are permitted in the WTP ~~will be~~are newly constructed; pre-existing tanks will not be used. Therefore, the requirements of this section do not apply.

4.2.5 Additional Requirements for New Tanks

~~Installation of tank systems will be~~Tank system installation is performed in a manner designed to prevent damage to the tank system. The WTP uses an independent, qualified installation inspector, or an independent qualified registered professional engineer to perform tank system installation inspections. Inspection activities ~~will~~ include testing tanks for tightness, verifying protection of ancillary equipment against physical damage and stress, and evaluating evidence of corrosion. The inspections ~~will~~ document weld breaks, punctures, coating scrapes, cracks, corrosion, and other structural defects. Installation inspections ~~will~~ conform to permit requirements and consensus-recognized standards. Inspection findings and corrective actions, as appropriate, ~~will be~~are documented in post-inspection reports.

Additional information describing the installation of tank systems and associated inspections are provided in *Installation of Tank Systems and Miscellaneous Unit Systems*, 24590-WTP-PER-CON-02-001.

4.2.5.1 Additional Requirements for New On-Ground or Underground Tanks

The majority of the tanks and vessels to be constructed in the WTP ~~will be~~are located within the ~~p~~Pretreatment ~~f~~Facility, the ~~analytical laboratory~~Lab, the LAW ~~vitrification plant~~Vitrification Facility, and the HLW ~~vitrification facility~~Vitrification Facility. Therefore, the requirements of this section do not apply to the indoor tanks.

The two outdoor Process Condensate Tanks located at the ~~p~~Pretreatment ~~f~~Facility (RLD-TK-00006A/B) ~~will be~~, and the eight outdoor vessels at the EMF (DEP-VSL-00002, DEP-VSL-00003A/3B/3C, DEP-VSL-00004A/4B, and DEP-VSL-00005A/5B), are located within a bermed and lined secondary containment system and ~~will~~ are not be in direct contact with soil. The design of the outdoor tanks' concrete pad ~~will address~~addresses backfill, soil saturation, seismic forces, and freeze thaw effects. A portion of the ancillary piping for the unit ~~will be~~is in contact with the soil, and the effects of corrosion on the piping ~~will be~~are addressed in the final design.

4.2.6 Secondary Containment and Release Detection for Tank Systems

This section provides information about the secondary containment for tank systems that ~~will~~ contain mixed waste in the WTP. Descriptions of equipment and procedures used for detecting and managing releases or spills from tank systems are also provided.

A number of documents are provided in appendices to DWP Operating Unit Group 10 that provide detailed information regarding the design of the secondary containment system. These documents include the following:

- *Secondary Containment Design*, 24590-WTP-PER-CSA-02-001, located in Appendix 7.5
- Material Selection for Building Secondary Containment/Leak Detection, 24590-WTP-PER-M-02-001, located in Appendix 7.9
- *Leak Detection in Secondary Containment Systems*, 24590-WTP-PER-J-02-002, located in Appendix 7.5
- *Flooding Volume for PT Facility*, 24590-PTF-PER-M-02-005, located in Appendix 8.8
- *Flooding Volume for 28 Ft Level in PT Facility*, 24590-PTF-PER-M-03-001, located in Appendix 8.8
- Flooding Volume for 56 Ft Level in PT Facility, 24590-PTF-PER-M-04-001, located in Appendix 8.8
- Flooding Volume for 77 Ft Level in PT Facility, 24590-PTF-PER-M-04-0003, located in Appendix 8.8
- Flooding Volume for Room P-0150 in the PT Facility, 24590-PTF-PER-M-04-0008, located in Appendix 8.8.
- Flooding Volume for Room P-0119 in the PT Facility, 24590-PTF-PER-M-04-0005, located in Appendix 8.8.
- Flooding Volume for Room P-0123A in the PT Facility, 24590-PTF-PER-M-04-0007, located in Appendix 8.8.
- Dangerous Waste Permit (DWP) Liner Heights in the LAW Facility, 24590-LAW-PER-M-02-002, located in Appendix 9.8
- *Flooding Volume for the HLW Facility*, 24590-HLW-PER-M-02-003, located in Appendix 10.8
- Dangerous Waste Permit Liner Heights in the LAB Facility, 24590-LAB-PER-M-02-001, located in Appendix 11.8
- Leak Detection Capability in the Pretreatment Facility, 24590-PTF-PER-M-04-0010, located in Appendix 8.18
- Waste Removal Capability for the Pretreatment Facility, 24590-PTF-PER-M-04-0011, located in Appendix 8.18
- Leak Detection Capability in the Low Activity Waste Facility, 24590-LAW-PER-M-05-002, located in Appendix 9.18
- *Waste Removal Capability for LAW Vitrification*, 24590-LAW-PER-M-05-001, located in Appendix 9.18
- *Leak Detection Capability in the HLW Facility*, 24590-HLW-PER-M-04-002, located in Appendix 10.18
- *HLW Facility Waste Removal Capability*, 24590-HLW-PER-M-04-0001, located in Appendix 10.18
- Lab Minimum Leak Rate Detection Capabilities for Leak Detection Boxes, Cell Sumps, and Pit Sumps, 24590-LAB-PER-M-04-0001, located in Appendix 11.18
- LAB Waste Removal Capability for the Effluent Vessels Cells, 24590-LAB-PER-M-04-0002, located in Appendix 11.18
- System Logic Description for the Direct Feed LAW Effluent Management Facility Process System (DEP), 24590-BOF-PER-J-16-001, located in Appendix 13.13
- Leak Detection Capability for EMF Facility, 24590-BOF-PER-M-16-001, located in Appendix 13.18

- Waste Removal Capacity for the Direct Feed LAW Effluent Management Facility (EMF), 24590-BPF-PER-M-16-002, located in Appendix 13.18
- Dangerous Waste Permit (DWP) Liner Heights in the Effluent Management Facility (EMF), 24590-BOF-PER-M-16-003, located in Appendix 13.8

4.2.6.1 Secondary Containment System Requirements

Most of the tank systems containing mixed waste ~~will be~~are located within the plants, although two tanks ~~will be~~are located outside the ~~pretreatment facility.~~Pretreatment Facility, and eight vessels are located outside of the EMF. Tank systems containing mixed waste that are located within the plants ~~will be~~are arranged within process cells, process rooms, caves, or other areas provided with secondary containment liners or coatings. The outside tanks ~~will be~~and vessels are located on a ~~coated,~~ bermed, concrete pad ~~within concrete berms~~, provided with special protective coatings and covings or waterstops, or provided with stainless steel liners that ~~will~~ provide secondary containment.

The secondary containment systems ~~will be~~are designed, installed, and operated to prevent migration of waste or accumulated liquid to soil, groundwater, or surface water. The piping associated with the tank systems ~~will be~~are located in the process cells, process rooms, caves, berms, or bulges. Secondary containment for piping systems ~~will be~~is incorporated into the design.

Tank systems and wet miscellaneous treatment systems ~~will be~~are provided with secondary containment that can contain 100% of the volume from the largest tank within the containment area. In the ~~p~~Pretreatment ~~f~~Facility, the 15 black cells and the hot cell at the 0’ (~~foot~~ft) elevation are interconnected through hydraulic connections (open penetrations that interconnect adjacent cells) such that the combined secondary containment volume is available, if necessary, to contain a 100% leak from the largest tank. A leak to the hot cell floor, if large enough, ~~will~~ drains to the overflow vessels in the pit at -45’ (~~foot~~ft) elevation and ultimately to the -45’ (~~foot~~ft) pit secondary containment if the volume of the overflow vessel(s) is exceeded. Secondary containment areas lined with stainless steel ~~will~~ have a gradient (minimum 1%) designed to channel fluids to a sump. In some cases, there may be more than a single sump. For example, the hot cell in the ~~p~~Pretreatment ~~f~~Facility has three instrumented sumps for leak detection. Fire suppression water is included as appropriate in determining the height of the secondary containment. Table~~-~~ 4D-3 in ~~Appendix~~ Chapter 4D, Table~~-~~ 4E-3 in ~~Appendix~~ Chapter 4E, Table~~-~~ 4F-3 in ~~Appendix~~ Chapter 4F, Table~~-~~ 4G-3 in Chapter 4G, and Table 4H-2 in ~~Appendix~~ Chapter 4H summarize the calculated minimum liner height at the four process plants and the Lab. The flooding volume documents identified above present the secondary containment height for each plant.

A concrete berm with protective ~~coating will be~~coatings or stainless liners is used for the ~~pretreatment facility~~Pretreatment Facility and EMF outdoor tanks~~. This~~ and vessels. These secondary containment ~~area will be~~areas are capable of holding 100% of the volume from the largest tank within the berm, plus the precipitation from a 25-year, 24-hour rainfall event, as required under WAC 173-303-640(4)(e)(i)(B).

The WTP uses selected industry standards to ensure secondary containment systems have sufficient strength, thickness, and compatibility with waste. The design includes an engineered structural base to protect against failure resulting both from excess force applied during catastrophic events or settlement, and from the stress of daily operation.

In the event of a spill or release, the secondary containment design ~~will~~ prevents released mixed waste from reaching the environment, and ~~will~~ safely contains the waste until it can be transferred to an appropriate collection tank.

The following subsections provide detailed descriptions of typical secondary containment systems that will be used at the WTP.

Process Cells

Process cells ~~will be~~are located within process plants. Process cells ~~will~~ are typically ~~be~~ constructed of concrete walls to protect plant operators and the environment from radiological exposure and to prevent migration of waste or accumulated liquid to soil, groundwater, or surface water. Operator access to the process cells ~~will~~ is not ~~be~~ allowed during normal operations. However, access is allowed for certain areas within WTP for nonroutine operations such as equipment replacement or maintenance. Process cells are provided with liners and special protective coatings as required. Systems within process cells that manage mixed waste have secondary containment (for example, process vessels, and piping).

Black Cells

A black cell is a type of process cell that may contain vessels, evaporators, and piping systems that are used to support process waste stream storage and blending functions. No active equipment (i.e., equipment with moving parts) components are located in the black cell. The design for the vessels and piping is all welded construction. Some instrumentation (e.g., thermocouples, radiation detectors) are remotely replaceable by insertion into sealed pipe wells. The black cell vessels and design do not possess design features for remote replacement. The black cell concept is used in areas where the risk of vessel or piping failure due to corrosion or erosion is low. The ~~WTP pretreatment facility~~Pretreatment Facility contains fifteen black cells and the HLW Vitrification ~~f~~Facility contains three black cells.

Hot Cell

Alternatively, a hot cell is a type of process cell that contains active equipment and ~~will~~ periodically needs to be remotely accessed for equipment maintenance or replacement.

All process cells ~~will be~~are provided with secondary containment as required. The floor ~~will be~~is sloped to a collection sump to allow for collection and removal of accumulated liquid within the sump.

~~Process Rooms~~

~~Process rooms will be located in the LAW vitrification facility and will be very similar to process caves. Access to process rooms will not be allowed during normal operations. However, access will be allowed for certain areas within WTP for nonroutine operations such as equipment replacement or maintenance. Process rooms will be provided with secondary containment as required. Systems within process rooms that manage mixed waste will have secondary containment (for example, the locally shielded melter and piping).~~

Caves

Caves ~~will be~~are located within process plants. Caves ~~will~~ typically ~~be~~ are constructed with concrete walls thick enough to protect personnel from exposure to mixed waste. Caves ~~will~~ house mechanical handling equipment designed for remote operation and maintenance. They ~~will~~ generally have viewing windows and closed circuit television to allow observation of the cave operations and for overseeing remote maintenance. The cave floors and portions of the walls ~~will be~~are provided with secondary containment as required. The floor of the cave ~~will be~~is sloped to a collection sump to allow for collection and removal of accumulated liquid within the sump.

Berms

Concrete berms ~~will be~~are used at the LAW Vitrification Facility for the Caustic Collection Tank (LVP-TK-00001)~~ and~~. The berms are of sufficient structural strength and height to contain the 100% of the volume of the largest tank.

Vault-like structures are used for the two outdoor Process Condensate Tanks (RLD-TK-00006A/B) at the ~~pretreatment facility. The berms will be~~Pretreatment Facility, and the eight outdoor vessels at EMF (DEP-VSL-00002,~~/~~ DEP-VSL-00003A/B/C, DEP-VSL-00004A/B, and DEP-VSL-00005A/B). These vault-like structures are of sufficient structural strength and height to contain the 100% of the volume of the largest tank plus, for the outdoor Process Condensate Tanks, the amount of precipitation that results from the 24-hour, 25-year storm event.

A protective coating ~~will be~~is applied to the concrete pad and a portion of the berms and vault-like structures to prevent contaminant penetration into the concrete. The containment system ~~will be~~is designed to allow for the discharge of storm water after visual or other testing.

Drip Pan

The ancillary equipment/piping may be provided with a drip pan, sloped, or otherwise designed to perform the secondary containment functions, including leak detection. One such drip pan is located in the HLW ~~v~~Vitrification ~~f~~Facility Drum Transfer Tunnel (H-B015). Design details of the HLW drip pan are provided in the *Secondary Containment Design*, 24590-WTP-PER-CSA-02-001, located in Operating Unit Group 10 Appendix 7.5.

LAW Melter Feed Line Encasement Assembly

The feed lines that transfer wastes from the LAW ~~m~~Melter ~~f~~Feed ~~p~~Process (LFP) system to the melters are housed in the LAW Melter Feed Line Encasement Assemblies (LMP-LDB-00001/00002). The encasement assemblies are a sloped bellows encasement that contains the feed line where they travel between the process cells and the melter gallery. The encasement assemblies are equipped with leak detection cables that run under the feed lines and into the bellows. The assemblies are equipped with drain lines to flow to sumps in the LAW process cells.

Autosampling System (ASX) Samplers

The autosampling system (ASX) samplers in the ~~PTF~~Pretreatment Facility, HLW Vitrification, and LAW Vitrification facilities contain both upper and lower secondary containment liners and leak detection systems. The upper containment area is designed to collect a potential leak from the incoming sample feed and return lines where they connect to the ISOLOK® sampling device. If a leak occurs in the upper containment area, the leak flows to the sloped liner which diverts the leak to the annular space of the coaxial sample return lines. Leaks flow down the secondary containment pipe and discharge to secondary containment with leak detection, typically a sump with a radar level detector. The ASX sample feed and sample return lines, and the routing of potential leaks in the annular space of the return lines are shown on the associated process system piping and instrumentation diagrams (P&IDs) provided in Operating Unit Group 10, Appendix 8.2, 9.2, and 10.2.

The sloped stainless steel liner in the lower containment area is designed to divert liquids to a sloped collection trough. The trough contains a removable weir that allows liquids to collect and activate the thermal level detection switch and alarms to indicate that a leak has occurred. Effluent from a leak flows to the same drain line that manages ISOLOK flush solutions. The ISOLOK flush lines terminate below the top of the trough drain to ensure that the leak detection system is not activated when flushing the ISOLOK. The ASX lower containment area drain lines are shown on the associated process system P&IDs provided in Operating Unit Group 10, Appendix 8.2, 9.2, and 10.2.

Sump and Leak Detection Boxes and Secondary Containment Drain Systems

Sumps, leak detection boxes, and secondary containment drain systems for the ~~three~~ four process plants and the ~~analytical laboratory~~Lab are listed in Table~~-~~ 4D-4 in ~~Appendix~~ Chapter 4D, Table~~-~~ 4E-4 in ~~Appendix~~ Chapter 4E, Table~~-~~ 4F-4 in ~~Appendix~~ Chapter 4F, Table~~-~~ 4G-4 in Chapter 4G, and Table 4H-3 in ~~Appendix~~ Chapter 4H and described in the following sections. Systems ~~will~~ monitor and collect liquids managed in the system. Sumps, leak detection boxes, and secondary containment drains ~~will be~~are provided with a stainless steel liner or equivalent to act as the secondary containment. The sumps and leak detection boxes within the process areas ~~will~~ provide a low point for each secondary containment. The sumps and leak detection boxes ~~will~~ serve the following functions:

- Low point containment.
- Removal of material by means of sump emptying ejectors or pumps.
- Sampling of sump contents by means of sump sampling ejectors.

The following sections describe the type of sump used at the WTP and the secondary containment drains.

Sumps and Leak Detection Boxes

Sumps and leak detection boxes are part of the secondary containment system provided for tank systems and wet miscellaneous treatment systems. Sumps and leak detection boxes are located at a low point in the secondary containment systems, and are equipped with leak detection instrumentation and corresponding alarm. Mechanical or fluidic pumps are used to remove liquid that may accumulate in a sump or leak detection box.

A typical sump design is shown in *Secondary Containment Design*, 24590-WTP-PER-CSA-02-001, located in Operating Unit Group 10 Appendix 7.5. Design details of each sump and leak detection box, such as the sump size, capacity, level detection instrumentation and pumps or ejectors are included in Table- 4D-4 in ~~Appendix~~ Chapter 4D, Table- 4E-4 in ~~Appendix~~ Chapter 4E, Table- 4F-4 in ~~Appendix~~ Chapter 4F, Table- 4G-4 in Chapter 4G, and Table 4H-3 in ~~Appendix~~ Chapter 4H and shown on the P&IDs for the Radioactive Liquid Waste Disposal (RLD) and/or Plant Wash and Disposal (PWD) systems, located in Operating Unit Group 10 Appendices 8.2, 9.2, 10.2, and 11.2.

Four sumps located in the HLW ~~v~~Vitrification ~~f~~Facility Melter Cave 1 and 2 (HSH-SUMP-00003/7/8/9) ~~will be~~are equipped with stainless steel sump baskets. Sump baskets ~~will~~ capture and retain small objects which may be inadvertently dropped into the sump, and prevent them from entering the piping. The baskets ~~will be~~are provided with a lifting bail for the crane to remove from the sump and handles for the power manipulator to empty into a waste bucket. A typical sump basket design is shown in *Secondary Containment Design*, 24590-WTP-PER-CSA-02-001, Figure 10, located in Operating Unit Group 10 Appendix 7.5. Sump baskets are also identified on the P&IDs for the HLW RLD system, located in Operating Unit Group 10 Appendix 10.2. Sumps in the Pretreatment Facility, LAW, Lab and EMF are provided with screened or perforated covers to prevent small objects from falling into, or accumulating in the sump. An example of a typical sump screened cover is shown *Secondary Containment Design*, 24590-WTP-PER-CSA-02-001, Figure 20, located in Operating Unit Group 10 Appendix 7.5.

Secondary Containment Drains

Many of the bulges, the autosamplers, and some process areas ~~will~~ have secondary containment drains. This type of liquid collection system ~~will be~~is located in a low spot in the cell formed by the sloping floor. Liquid detection instrumentation ~~will be~~is provided for the secondary containment drains. ~~Liquid collected will~~Collected liquids gravity-drain to a collection vessel with a tank level indicator. The ~~liquid~~ managed liquids could be waste released from a tank system, including ancillary equipment, or water used to wash the exterior of tanks or the walls of the containment area. -Design details of each secondary containment drain/drain line are included in Table- 4D-4 in ~~Appendix~~ Chapter 4D, Table- 4E-4 in ~~Appendix~~ Chapter 4E, Table- 4F-4 in ~~Appendix~~ Chapter 4F, Table- 4G-4 in Chapter 4G, Table 4H-3 in ~~Appendix~~ Chapter 4H and shown on the P&IDs for the RLD and/or PWD systems, located in Operating Unit Group 10 Appendices 8.2, 9.2, 10.2, and 11.2.

Design Requirements

The process cells, process rooms, or caves with mixed waste vessel or tank systems will be partially lined with stainless steel or special protective coating, which will cover the floor and extend up the sides of the process cell or cave to a height that can contain 100 percent of the volume from the largest tank within the process cell or cave. Table- 4D-3 in ~~Appendix~~ Chapter 4D, Table- 4E-3 in ~~Appendix~~ Chapter 4E, Table 4F-3 in ~~Appendix~~ Chapter 4F, Table- 4G-4 in Chapter 4G, and Table 4H-2 in ~~Appendix~~ Chapter 4H present the calculated minimum secondary containment liner height at the four process plants and the Lab.

A concrete berm with special protective ~~coating will be~~coatings or stainless liner are used for the ~~p~~Pretreatment ~~f~~Facility and EMF outdoor tanks and vessels. ~~This~~ These secondary containment ~~area will be~~areas are capable of holding 100% of the volume from the largest tank within the berm, plus the precipitation from a 25-year, 24-hour rainfall event, as required under WAC 173-303-640(4)(e)(i)(B).

The WTP uses consensus-recognized standards to ensure that the process cells, process rooms, caves, or berms provide secondary containment with sufficient strength, thickness, and compatibility with waste. The design includes an engineered structural base to protect the cells, caves, berms and tank systems against failure resulting both from excess force applied during catastrophic events or settlement, and from the stress of daily operation. In the event of a spill or release, the structural and foundation design for tank and process cells, process rooms, caves and berms ~~will~~ prevents released mixed waste from reaching the environment, and ~~will~~ safely contains the waste until it can be transferred to an appropriate collection tank.

4.2.6.2 Management of Release or Spill to Sump and Secondary Containment Drain Systems

The WTP uses dry sumps and leak detection boxes as part of the secondary containment and leak detection systems. Sumps and leak detection boxes are instrumented to inform the operator to investigate the cause of the liquid detected in the sump or leak detection box. Secondary containment systems are sloped to direct flow of leaks or spills to the sump or leak detection box. To remove liquid from the sumps or leak detection boxes in a timely fashion, sumps and leak detection boxes ~~will be~~are equipped with mechanical or fluidic pumps.

A detection alarm indicating that there is liquid in the sump or leak detection box will be investigated to determine if the alarm is valid. If the alarm is valid, the incident will be corrected. ~~-~~Mixed waste released from the primary system and collected in a sump or leak detection box will be removed within 24 hours, or in as timely a manner as possible. If the released material cannot be removed within 24 hours, the Washington State Department of Ecology (Ecology) will be notified.

4.2.6.3 Additional Requirements for Secondary Containment

The WTP dangerous waste storage tanks have vault-type secondary containments that have either ~~of~~chemical-resistant water stops and special protective coatings or the following configurations that the Department of Ecology has approved as equivalent to a coating/water stop system:

- An impermeable interior coating that is compatible with the stored waste and a polymeric filler material at interior corners and construction joints that performs a function equivalent to a water stop.
- A welded stainless steel liner attached to walls and floors.

Ancillary equipment such as piping is addressed within Section 4.2. Other types of ancillary equipment such as pumps, seal pots, and reverse flow diverters are provided with secondary containment. Inspection of ancillary equipment is addressed in Operating Unit Group 10, Chapter 6.0.

4.2.7 Variances from Secondary Containment Requirements

No variances from secondary containment requirements are sought for the WTP tank systems. Tank systems ~~will be~~are provided with secondary containment as identified in the flooding volume documents described in the previous sections.

4.2.8 Tank Management Practices

The following provides the basic philosophy for the WTP vessel overflow systems. Three types of barriers exist to prevent overfill of process equipment: preventive controls, detectors, and regulators.

Preventive controls promote controlled filling within normal process ranges. Detectors recognize if a vessel is being overfilled and alert an operator. Lastly, if preventive controls and detectors fail to stop overfill from occurring, regulators trip a control sequence that stops inflow and/or initiates outflow. The principal design concept to control vessel overflow is to prevent an overflow from occurring. The engineering design ~~will~~ minimizes the likelihood of tank, ancillary equipment, and containment system overflows, and over-pressurization, ruptures, leaks, corrosion, and other failures.

In general, overflows ~~will be~~are prevented by inventory control in conjunction with level monitoring. The fluid levels in a vessel ~~will be~~are maintained within low- and high-level ranges. Appropriate alarm settings ~~will be~~are used to note deviations from the designed settings. Automatic trip action ~~will be~~is designed to shut down feed to the vessel when the high-level settings are exceeded. These automatic trip actions ~~will be~~are provided for vessels with the potential for high operational and environmental impact in case of an accident or release.

Most of the WTP tank systems ~~will be~~are designed to incorporate minimal or zero maintenance requirements and ~~will be~~are based on a design life of approximately 40 years. The design emphasis of zero maintenance ~~will~~ minimizes the likelihood of spills and overflows in the tank systems. In the event that the process controls fail to prohibit vessel overfilling, engineered overflows ~~will be~~are provided to prevent liquid from entering the vessel ventilation systems. Vessels that are nominally operating at atmospheric pressure ~~will~~ have a suitable gravity or engineered overflow system, unless an overflow can be shown not to be possible. Vessels or systems that normally operate at above atmospheric pressures ~~will~~ are not be provided with overflows.

The following principles apply when designing an engineered overflow system:

- The overflow system for vessels must be instantaneously and continuously available for use.
- Overflowed process streams must be returned to the waste treatment process.
- Overflow systems must meet the requirements of WAC 173-303, *Dangerous Waste Regulations*, Section 640, Tank Systems. In meeting these requirements, overflowing direct to the cell floor ~~will~~ is only ~~be~~ considered as the last overflow in a cascaded system. Where an overflow is from a vessel to the cell, the overflow system ~~will~~ maintains segregation of the cell and vessel ventilation systems. The compatibility of the overflowing liquid and the recipient vessel ~~will be~~is considered.
- A vessel overflow line is sized to handle the maximum inflow to the vessel without the liquid level in the overflowing tank reaching an unacceptably high level. No valves or other restrictions are permitted in the overflow line. This line is also designed to prevent the buildup of material that could cause blockages.
- The overflow receiver is sufficiently sized to contain the overflow.
- Inspections ~~will be~~are performed on the various tank and overflow systems, using the example schedules described in DWP Operating Unit Group 10, Chapter ~~6.0~~6A.

4.2.9 Labels or Signs

Tanks managing mixed or dangerous waste ~~will be~~are labeled according to the requirements of DWP permit conditions DWP III.10.E.5.e, for routinely non-accessible tanks, and DWP III.10.E.5.f, for tanks not addressed in DWP III.10.E.5.e. The labels ~~will~~ inform employees and emergency personnel of the types of waste present, warn of the identified risks, and provide other pertinent information.

4.2.10 Air Emissions

This section describes air emissions from vessel ventilation systems and reverse flow diverter exhausts. Organic emissions from vents associated with evaporator or distillation units are also discussed.

4.2.10.1 Tank System Emissions

Most of the tanks ~~will be~~are connected to a vessel ventilation system to collect vapors. Vessel vents ~~will be~~are located on ~~major~~ process vessels and tanks, breakpots, and other small vessels. Exhaust from reverse flow diverters and pulse jet mixers ~~will~~ are also ~~be~~ collected.

4.2.10.2 Process Vents

The air emission regulations, specified under WAC 173-303-690 and 40 CFR 264 Subpart AA, apply to process vents associated with distillation, fractionation, thin-film evaporation, and air or steam stripping operations that manage mixed waste with total organic carbon concentrations of at least 10 parts per million by weight. The WTP does not use these regulated processes; therefore, this regulation does not apply to the WTP.

4.2.10.3 Equipment Leaks

Regulations provided in WAC 173-303-691 and 40 CFR 264 Subpart BB contain the "Air Emission Standards for Equipment Leaks". These air emission standards do not apply to the WTP because waste feed entering the WTP contains less than 10% total organic carbon by weight and is excluded under 40 CFR 264.1050(b).

4.2.10.4 Tanks and Containers

The regulations specified under WAC 173-303-692 and 40 CFR 264 Subpart CC do not apply to the WTP mixed waste tank systems and containers. These tanks and containers qualify as waste management units that are "used solely for the management of radioactive dangerous waste in accordance with applicable regulations under the authority of the Atomic Energy Act and the Nuclear Waste Policy Act" and are excluded under 40 CFR 264.1080(b)(6). Containers bearing nonradioactive, dangerous waste, such as maintenance and laboratory waste, that is not excluded under 40 CFR 264.1080 (b)(2) or 40 CFR 264.1080(b)(8), will comply with the tank and container standards specified under 40 CFR 264 Subpart CC.

4.2.11 Management of Ignitable, Reactive and Incompatible Waste in Tanks

~~Mixed~~In the Baseline configuration, mixed waste from the ~~DST system unit will~~Hanford Tank Farms is initially ~~be~~ designated as both ignitable (D001) and reactive (D003). The D001 and D003 waste numbers ~~will be~~are as described in the waste analysis plan in DWP Operating Unit Group 10, Appendix 3A. ~~The~~The Pretreatment Facility process vessels ~~will be~~are located in a manner that meets the National Fire Protection Association (NFPA) buffer zone requirements for process vessels, as contained in Tables 2-1 through 2-6 of the *NFPA-30 Flammable and Combustible Liquids Code* (NFPA 1981). The process vessels ~~will be~~are designed to store the waste in such a way that it ~~will be~~is protected from materials or conditions that could cause the contents to ignite or react. Vessel contents will be constantly mixed and will be actively vented to process stacks, which will be equipped with vapor collection and treatment systems that will manage emissions. Further information on waste numbers is contained in DWP Operating Unit Group 10, Appendix 3A.

In the DFLAW configuration, the treated low-activity waste received from LAWPS will not demonstrate the characteristics of ignitable or reactive waste.

Ignitable or reactive waste may be generated from laboratory or maintenance activities. This waste ~~will be~~is accumulated and managed in compliance with regulatory requirements, in approved containers. Potentially incompatible waste generated from laboratory or maintenance activities will not be stored in the tank systems.

A potential for incompatibility may exist, for example when nitric acid is used to elute waste components from ion-exchange column resins that were previously regenerated with sodium hydroxide. To minimize a reaction, water flushes ~~will be~~are performed between batches.

Process reagents that could react with waste in the tank systems ~~will be~~are stored in areas that are separated by physical barriers from process tanks. Potentially incompatible wastes generated from laboratory or maintenance activities will not be stored in proximity to each other in the tank systems.

4.3 LAW and HLW Miscellaneous Treatment Sub-Systems [WAC 173-303-680 and WAC 173-303-806(4)(i)]

The LAW vitrification system and HLW vitrification system consist of the vitrification melters, offgas treatment equipment, and associated equipment. The melters immobilize mixed waste in a glass matrix. The LAW vitrification system and the HLW vitrification system contain two melters each. The following sections provide additional information on the vitrification systems.

Other miscellaneous treatment sub-systems, and their associated process control features, are described in Section 4.2.

4.3.1 Melter Capacity and Production

For the melters, throughput is defined on the basis of quantity of glass waste produced. In turn, the quantity of glass waste produced depends on the degree to which the feed can be incorporated into the glass matrix. The maximum design throughput of the LAW Melter systems ~~will be~~is approximately 15 metric tons per day of glass waste for each melter and approximately 30 metric tons per day. The production rate of the HLW Melters is approximately 3 metric tons per day for each melter and approximately 6 metric tons per day throughput.

4.3.2 Description of Melter Units [WAC 173-303-806(4)(i)(i)]

The LAW Melter systems are located in the melter galleries and the HLW Melters are housed within the melter caves as depicted in the general arrangement plan and section permit drawings, which are found in DWP Operating Unit Group 10, Appendix 9.4 for the LAW ~~v~~Vitrification ~~f~~Facility and Appendix 10.4 for the HLW ~~v~~Vitrification ~~f~~Facility. The following subsections provide detailed descriptions of the melter units.

Low-Activity Waste Melter Units

Figure 4A-48 in ~~Appendix~~ Chapter 4A provides a sketch of a~~n~~ LAW Melter. Each LAW Melter (LMP-MLTR-00001/2) is a rectangular shell, lined with refractory material. An additional outer steel casing with access panels ~~will be~~is provided to enclose the LAW Melter. This outer steel casing is designed to provide local shielding and containment. Each LAW Melter has a nominal design capacity of approximately 15 metric tons of glass waste per day. Each ~~will have~~has a molten glass surface area of approximately ~~108~~ 107 square feet (ft^2). Each of the two LAW melters has external dimensions of approximately ~~26~~ 31 × 21 × 16 ft high, and weighs approximately ~~270~~ 295 metric tons empty and ~~290~~ 318 metric tons with glass. The operating temperature of the melter is between ~~950~~1050°C and ~~1250~~1200°C.

The locally shielded LAW Melter (LMP-MLTR-00001/2) ~~will be~~is operated and maintained in a personnel access area. The melter ~~will be~~is maintained at a lower pressure than the surrounding room to prevent escape of contaminants. Consumable melter parts ~~will be~~are replaced through access panels. The melters ~~will be~~are transported in and out of the gallery on a rail system. A transporter ~~will move~~moves the melters to and from the LAW ~~v~~Vitrification ~~f~~Facility.

The melter refractory package is designed to serve as a mechanical, thermal, and electrical barrier between the molten glass residing in the melter and the melter shell. The refractory package is housed in a steel shell and provides containment for the molten glass. Active cooling on the outside of the refractory package is provided by water jackets. The water jackets ~~will be~~are in the intermediate loop of a two-loop system that ~~will~~ transfers heat from the LAW Melter through heat exchangers to cooling towers. The intermediate loop containing the water jacket ~~will be~~is a closed system that isolates the water circulating through the water jacket from the water in the cooling water loop circulating to the cooling tower. Mixed waste material leaking into the intermediate loop cooling water ~~will be~~is prevented from becoming an inadvertent discharge via the cooling tower. The refractory package ~~will~~ provides adequate containment if there is a temporary loss of cooling. Penetrations in the melter system are sealed using appropriate gaskets and flanges. This system is designed for plenum temperatures of up to 1,100°C. The LAW melter lid is composed of steel and refractory material layers.

Each LAW Melter (LMP-MLTR-00001/2) ~~will~~ uses two independent discharge chambers. An air lift pumps molten glass from the bottom of the melter pool, through a riser, into a discharge chamber, and pours it into an ILAW container. The ILAW is then allowed to cool, forming a highly durable borosilicate glass waste form within the container.

Spent LAW Melters ~~will~~ are initially be managed within the LAW melter gallery containment building unit. Spent LAW Melters ~~will be~~are removed from the melter gallery and transported using a transport and rail system. If necessary, the melter exterior surfaces will be decontaminated prior to transfer to a Hanford Site TSD unit.

High-Level Waste Melter Units

Figure 4A-~~54~~ 27 in ~~Appendix~~ Chapter 4A provides a sketch of an HLW Melter. In addition, the HLW melter mechanical assembly drawings (24590-HLW-MF-HMP-00001/2/3) are located in Operating Unit Group 10, Appendix 10.6~~2~~. Each HLW Melter (HMP-MLTR-00001/2) is a rectangular shell, lined with refractory material. They have four compartments: a glass tank, two discharge chambers, and a plenum just above the glass tank. The tanks are lined with refractory material designed to withstand corrosion by molten glass.

The HLW Melter systems consist of two melters. Each HLW Melter (HMP-MLTR-00001/2) is designed for glass production rates up to 3 metric tons per day (MTG/d). The normal operating temperature of the melter is between 950°C and 1250°C. The HLW Melters have a molten glass surface area of approximately 40 ft^2. The HLW Melters have external dimensions of approximately 11 ft high × 14 ft deep × 14 ft wide. The glass contained in a full HLW Melter has a volume of approximately 145 ft^3 and weighs approximately 9.1 metric tons. An entire melter, including the supporting structure and transport mechanism, weighs approximately 90 metric tons empty and approximately 99 metric tons full.

The HLW Melters (HMP-MLTR-00001/2) ~~have been~~are designed to be remotely operated and maintained. Remote maintenance ~~will be~~is performed by a power manipulator, overhead crane, and auxiliary hoist, or by through-wall master-slave manipulators. The melter ~~will be~~is positioned within the HLW ~~v~~Vitrification ~~f~~Facility for ease of access and viewing of both discharge chambers during operations, and for viewing access to the melter lid to facilitate removal and replacement of subcomponents, if needed. A rail and bogie transport system ~~will~~ facilitates remote removal and replacement of the entire melter structure.

The HLW Melters (HMP-MLTR-00001/2) ~~will~~ uses a refractory package similar to the LAW melter to contain the molten glass. The refractory package is designed to serve as a mechanical, thermal, and electrical barrier between the molten glass inside the melter and the melter shell.

The HLW Melters ~~will~~ also use an outer shell, which, with the refractory package, ~~will~~ contains the molten glass and melter offgas. Active cooling on the exterior of the melter ~~will be~~is provided by a water jacket, which ~~will be~~is in a two-loop system that ~~will~~ transfers heat from the HLW Melter through heat exchangers to cooling towers. The loop containing the water jacket ~~will be~~is a closed system that isolates the water circulating through the water jacket from the water in the cooling water loop circulating to the cooling tower. Mixed waste material leaking into the intermediate loop cooling water ~~will be~~is prevented from becoming an inadvertent discharge through the cooling tower. The refractory package ~~will~~ provides adequate containment should there be a loss of cooling. The HLW Melter lid ~~will be~~is constructed of a steel outer shell and insulated from the melter plenum by refractory material.

The HLW Melter ~~will~~ uses two independent discharge chambers. Discharge ~~will be~~is achieved by transferring the molten glass from the bottom of the melter pool, through a riser, ~~from which it will be~~and then poured into a stainless steel IHLW canister. Glass waste transfer ~~will be~~is accomplished through air lifting. The IHLW ~~will~~ is then be allowed to cool, forming a highly durable borosilicate glass waste form.

Spent HLW Melters ~~will be~~are removed from the melter cave and placed in an overpack. The spent melter ~~will be~~is treated as newly generated waste, and ~~will~~ is initially ~~be~~ managed within the HLW melter containment buildings. If necessary, the overpack will be decontaminated using a dry process. Failed HLW Melters ~~will be~~are stored in the failed melter storage building.

4.3.3 Automatic Waste Feed Cut-Off System

The LAW and HLW Melters ~~will be~~are equipped with the ability to cut off waste feed. Automatic waste feed cut-off systems terminate feed to the Melter if a specified operating condition is exceeded. This design approach is consistent with the WAC 173-303-680 regulatory requirements.

The LAW (LMP-MLTR-00001/2) and HLW (HMP-MLTR-00001/2) Melters are fed via air displacement slurry pumps that utilize pressurized air as the motive force. These pumps supply feed to the melters in slugs that act to keep lines from plugging. The feed is injected into the melters through the feed nozzles on top of the Melter creating a “cold cap”, where waste feed undergoes several physical and chemical changes. The glass product in the melter is then “air lifted” through the discharge chamber and into the glass container. Melter offgas is generated from the vitrification of LAW and HLW of which the rate of generation is dynamic and not steady state. The offgas is then carried away and treated via a dedicated offgas system.

The melter systems are designed to minimize the need for automatic waste feed cut-off functions. Control of melter level and plenum pressure, process alarming, and optimized operating procedures ~~will be~~are in place to reduce the occurrences of interlocking. Given the processing speeds and the relatively slow rates of change in the operating states of the melter, operators should have adequate time to react to upset conditions. An example of the slow rate of change can be seen in the volume of feed per air displacement slurry pump feed cycle when increasing melter level. Each pump cycle adds approximately ~~1~~ one gallon of slurry into the melter. At ~~1~~ one gallon of volume, the liquid level rises no greater than 0.01 inch inside the melter. This provides ample time for operator response.

Previous operating experience with similar melter systems has shown the following operating conditions warrant automatic waste feed cut off:

- Maximum melter chamber pressure
- Minimum off-gas temperature at the thermo catalytic oxidizer bed inlet
- Maximum carbon bed adsorber bed temperature
- Maximum stack gas flow rate
- Maximum stack gas carbon monoxide

These interlocks have been sufficient to allow continued melter operations without inadvertent feed cut off signals, yet provide a sufficient safety margin.

4.3.4 Offgas Treatment System

The offgas treatment system ~~will remove~~treats or removes steam, aerosols, entrained particulates, decomposition products, and volatile contaminants that are generated from the vitrification processes and the vessel ventilation systems. The typical constituents contained in the melter offgas stream are as follows:

- Nitrogen oxides from decomposition of metal nitrates in the melter feed.
- Chloride, fluoride, and sulfur as oxides, acid gases, and salts.

- Entrained feed material and glass.

A detailed description of the current offgas treatment trains for the LAW (LMP-MLTR-00001/2) and HLW (HMP-MLTR-00001/2) Melters is provided in ~~Appendix~~ Chapter 4E and ~~Appendix~~ Chapter 4F, respectively.

4.3.5 Miscellaneous Unit Emissions Performance

The WTP melter systems are thermal treatment units classified as miscellaneous units in Washington Administrative Code (WAC 173-303-680). The dangerous waste regulations require that permits for miscellaneous units include such terms, conditions, and provisions that are necessary to protect human health and the environment and are appropriate for the miscellaneous unit being permitted. ~~The Department of~~ Ecology has determined that regulations that are most appropriate to apply to the melters and offgas systems (melter systems) are found in the tank requirements (WAC 173-303-640) and applicable sections of the incinerator requirements (WAC 173-303-670) and 40 CFR Section 63.1203. As applied to the melter systems, the tank regulations primarily provide requirements for structural integrity, material compatibility, secondary containments, etc.

The incinerator regulations primarily provide operational requirements for parameters such as temperature, pressure, feed rate, demonstration testing, and performance standards, etc. ~~The Department of~~ Ecology determined and incorporated into the final WTP Dangerous Waste Permit issued in September 2002 the standards specified in 40 CFR Section 63.1203 in the following table apply to the WTP melter system miscellaneous units.

Miscellaneous Unit Emissions Performance Standards	
Pollutant	**Ecology-directed requirement**
PODC	99.99% DRE
Dioxins and Furans	0.20 ng TEQ/dscm
Mercury	45 µg/dscm
Lead and Cadmium	120 µg/dscm, combined emissions
Arsenic, Beryllium, Chromium	97 µg/dscm, combined emissions
Carbon Monoxide and Hydrocarbons	Carbon monoxide not in excess of 100 ppmv over an hourly rolling average, dry basis, and hydrocarbons not in excess of 10 ppmv over an hourly rolling average, dry basis, and reported as propane, at any time during the DRE test runs or their equivalent, or hydrocarbons not in excess of 10 ppmv, over an hourly rolling average, dry basis, and reported as propane
Hydrochloric Acid and Chlorine Gas	21 ppmv, combined emissions, expressed as hydrochloric acid equivalents, dry basis
Particulate Matter	34 mg/dscm

- PODC is Principle Organic Dangerous Constituent
- TEQ is dioxin/furan toxicity equivalence defined in 40 CFR 63.1201(a)
- dscm is dry standard cubic meter
- ppmv is parts per million by volume
- Rolling average is the average of all 1- minute averages over the averaging period [40 CFR 63.1201(a)]

DOE intends that the melter systems be designed and constructed so that they operate in compliance with the appropriate and applicable standards. Environmental performance demonstrations during cold commissioning of the HLW and LAW ~~v~~Vitrification facilities ~~will be~~are used to verify compliance with the Destruction and Removal Efficiency (DRE) and other applicable air emission standards. The final WTP Dangerous Waste Permit issued in September 2002 also requires periodic demonstration testing ~~will~~ be performed after the WTP has begun processing radioactive wastes (Ecology, 2001).

4.3.6 Physical and Chemical Characteristics of Waste [WAC 173-303-680(2)(a)(i)]

A description of the waste characteristics of the LAW and HLW feeds is presented in DWP Operating Unit Group 10, Chapter 3.0 (see Appendix 3A). The immobilized waste generated by the vitrification processes ~~will be~~is in the form of glass that maintains its chemical and physical integrity during long-term storage. The ~~w~~Waste ~~a~~Analysis ~~p~~Plan (Appendix 3A) describes the types and frequency of analysis that will be performed on the glass waste.

~~4.3.7~~4.1.1 ~~Treatment Effectiveness Report [WAC 173-303-806(4)(i)(iv)]~~

~~4.3.8~~4.1.1 ~~A treatment effectiveness report evaluating the performance of the miscellaneous treatment sub-systems, and their effectiveness in treating the LAW and HLW, will be located in DWP Operating Unit Group 10, Appendix 9 for LAW and Appendix 10 for HLW. The report will use the results of the environmental performance demonstration and the risk assessment activities to document treatment effectiveness of miscellaneous treatment sub-systems.~~

~~4.3.9~~4.3.7 Environmental Performance Standards for Melter Systems [WAC 173-303-680(2)]

An environmental performance demonstration will be conducted to demonstrate the efficiency of the LAW and HLW Melter systems and their respective air pollution control systems. Emissions from the LAW and HLW systems will be sampled and analyzed during an environmental demonstration performed during cold commissioning. The data developed during the environmental performance demonstration ~~will~~ supports the screening-level risk assessment, which ~~will~~ supports the development of environmental performance standards for the LAW and HLW Melter systems.

The operational activities of the WTP include methods intended to ensure proper performance of equipment and processes. These methods include sampling of materials, use of direct process controls, development of equipment life specifications and ongoing maintenance.

~~4.3.9.1~~4.3.7.1 Protection of Groundwater, Subsurface Environment, Surface Water, Wetlands and Soil Surface [WAC 173-303-680(2)(a) and (b)]

The LAW Melters ~~will be~~are located in the LAW ~~m~~Melter ~~g~~Gallery (L-0112) within the LAW ~~v~~Vitrification ~~f~~Facility. The HLW Melters ~~will be~~are located in the HLW ~~m~~Melter ~~c~~Caves (H-0117, H-0106) within the HLW ~~v~~Vitrification ~~f~~Facility. Both plants are designed to comply with standards that ensure protection of the surface and subsurface environments. The vitrification plants ~~will be~~are completely enclosed and are designed to have sufficient structural strength and corrosion protection to prevent collapse or other structural failure. In addition, the melter systems, melter feed systems, and related piping ~~will be~~are provided with secondary containment, to minimize the potential for release. The LAW melter gallery (L-0112) and the HLW melter caves (H-0117, H-0106) will be permitted as containment buildings and are described in ~~Appendix~~ Chapter 4E and ~~Appendix~~ Chapter 4F, respectively.

Floors within the vitrification plants ~~will be~~are protected in a manner consistent with the intended usage of the space. The floor and portions of the walls of HLW Melter cave ~~will be~~are partially lined with stainless steel. Nonradioactive materials usage areas requiring heavy equipment ~~will~~ have concrete floors with hardener and sealer finishes.

The *Hanford Facility Dangerous Waste Permit Application General Information Portion*, Section 5.4 (DOE-RL 1998), provides climatological data, topography, hydrogeological and geological characteristics, groundwater flow quantity and direction, groundwater quality data, and surface water quantity and quality data for the area around the WTP.

~~4.3.9.2~~4.3.7.2 Protection of the Atmosphere [WAC 173-303-680(2)(c)]

A risk assessment ~~will be~~is performed to evaluate the impacts of the WTP emissions on human and ecological receptors. Actual offgas emissions ~~will be~~is measured during an environmental performance demonstration that ~~will be~~is performed as part of the WTP commissioning activities. The data ~~will be~~is used during a screening-level risk assessment that ~~will be~~is performed to determine ecological and human health risk. The emissions data and the results of the screening level risk assessment ~~will be~~are used to establish operating conditions for the melters that do not endanger human health and the environment.

4.3.8 Treatment Effectiveness Report [WAC 173-303-806(4)(i)(iv)]

A treatment effectiveness report evaluating the performance of the miscellaneous treatment sub-systems, and their effectiveness in treating the LAW and HLW, will be located in DWP Operating Unit Group 10, Appendix 9 for LAW and Appendix 10 for HLW. The report ~~will~~ uses the results of the environmental performance demonstration and the risk assessment activities to document treatment effectiveness of miscellaneous treatment sub-systems.

~~4.3.10~~4.3.9 Approach to Risk Assessment [WAC 173-303-680(2)(c)(i) through (vii)]

A screening level risk assessment is being conducted to evaluate any possible human health and ecological risk posed by the thermal treatment of mixed wastes. The risk assessment ~~will~~ provides information about the potential terrestrial, aquatic, and food pathways for exposure of human and ecological receptors to dangerous waste constituents. This risk assessment ~~will~~ presents the quantitative methods, detailed assumptions, and numerical parameters that ~~will be~~are used to estimate the nature, extent, and magnitude of potential risks from operation of the WTP. The primary regulatory guidance followed for this risk assessment is found in the *Human Health Risk Assessment Protocol for Hazardous Waste Combustion Facilities* (EPA 1998a) and the *Screening-Level Ecological Risk Assessment Protocol for Hazardous Waste Combustion Facilities* (EPA 1999a)

Treated air emissions through the stack ~~will be~~are the only planned direct releases into the environment from the WTP. Other waste streams ~~will be~~are transferred to a permitted facility and ~~will~~ are not ~~be~~ released directly into the environment. Thus, the overall risk assessment process ~~will~~ focuses primarily on air emissions.

Major components of the human health and ecological risk assessment process for evaluating airborne emissions ~~will be~~are as follows:

- Risk assessment work plan
- Pre-demonstration test risk assessment
- Final risk assessment

The overall approach for the risk assessment ~~will be~~is to identify potential risks associated with various receptors, their locations, exposure pathways, and activity patterns in two broad exposure scenarios, as follows:

- Plausible exposure scenario
- Worst-case exposure scenario

The plausible exposure scenarios ~~will be~~are based on where potential receptors currently exist or may reasonably be expected to exist within the foreseeable future. The worst-case assumptions ~~will be~~are based on locations of maximum concentration even though it is not expected that such receptors will ever actually exist at these locations. Both scenarios will reflect current uses of the surrounding land and habitat and reasonable assumptions about future uses of the land and habitat.

During the environmental performance demonstration, emission samples ~~will be~~are collected and analyzed, and the data ~~will be~~ used to evaluate risk to the human population and ecological (such as wildlife) receptors. Operating conditions ~~will be~~are established for the WTP, which limit risks to human health and the environment to acceptable levels.

4.4 Other Waste Management Units

Sections 4.4.1 through 4.4.5 discuss the applicability of the requirements for waste management units that have not been discussed up to this point in the permit. Sections 4.4.6 through 4.4.9 describe the applicability of air emission controls, waste minimization, groundwater monitoring, and functional design requirements to the WTP. References to other sections of the permit are provided as appropriate.

4.4.1 Waste Piles

The operation of the WTP does not involve the placement of dangerous waste in waste piles. Therefore, the requirements of WAC 173-303-660, "Waste Piles", do not apply to the WTP.

4.4.2 Surface Impoundments

The operation of the WTP does not involve the placement of dangerous waste in surface impoundments. Therefore, the requirements of WAC 173-303-650, "Surface Impoundments", do not apply to the WTP.

4.4.3 Incinerators

The WTP does not include a dangerous waste incinerator. ~~Therefore,~~However, applicable sections of the incinerator requirements ~~of~~ in WAC 173-303-670, and 40 CFR Section 63.1203~~"Incinerators", do not~~ apply to the WTP.

4.4.4 Landfills

The operation of the WTP does not involve the placement of dangerous waste in landfills. Therefore, the requirements of WAC 173-303-665, "Landfills", do not apply to the WTP.

4.4.5 Land Treatment

The operation of the WTP does not involve the land treatment of dangerous waste. Therefore, the requirements of WAC 173-303-655, "Land Treatment", do not apply to the WTP.

4.4.6 Air Emissions Control

Information regarding air emissions control is provided in the following sections:

- Pretreatment ~~f~~Facility ~~v~~Vessel ~~v~~Vent ~~p~~Process and ~~e~~Exhaust ~~s~~System (PVP/ PVV) - ~~Appendix~~ Chapter 4D, Section 4D.4.2
- LAW ~~vitrification~~ Vitrification Facility offgas treatment system description - Chapter 4E, Section 4E.4.2
- ~~•~~ HLW Vitrification Facility offgas treatment system description - ~~Appendix 4E, Section 4E.4.2~~
- ~~HLW vitrification offgas treatment system description – Appendix~~ Chapter 4F, Section ~~4F.~~ 4.2
- Direct Feed LAW Effluent Management Facility Vessel Vent Process System (DVP) – Chapter 4G, Section 5.1
- Process vents (40 CFR 264 Subpart AA) - Section 4.2.10.2
- Equipment leaks (40 CFR 264 Subpart BB) - Section 4.2.10.3
- Tanks and containers (40 CFR 264 Subpart CC) - Section 4.2.10.4

4.4.7 Waste Minimization

Waste minimization information is presented in Operating Unit Group 10 of the permit.

4.4.8 Groundwater Monitoring for Land-Based Units

The groundwater monitoring requirements found in WAC 173-303-645, "Releases from regulated units", do not apply to the WTP, since it is not operated as a regulated dangerous waste surface impoundment, landfill, land treatment area or waste pile, as defined in WAC 173-303-040. Therefore, groundwater monitoring is not required.

4.4.9 Functional Design Requirements

The WTP will be designed to comply with applicable design codes and specifications. The documents referenced in this chapter, appendices and contained in DWP Operating Unit Group 10 identify the codes and standards to which the WTP system, structures, and components are being constructed.

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