November 10, 2020

20-ECD-0055

Ms. Stephanie N. Schleif
Acting Program Manager
Nuclear Waste Program
Washington State Department of Ecology
3100 Port of Benton Boulevard
Richland, Washington 99354

Dear Ms. Schlief:

SUBMITTAL OF 24590-WTP-PER-PR-03-001, REV 3, PREVENTION OF HYDROGEN ACCUMULATION IN WASTE TREATMENT AND IMMOBILIZATION PLANT TANK SYSTEMS AND MISCELLANEOUS TREATMENT UNIT SYSTEMS ISSUED FOR PERMITTING USE, TO THE HANFORD FACILITY RESOURCE CONSERVATION AND RECOVERY ACT ADMINISTRATIVE RECORD

References:

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

2. BNI letter from V. McCain to B. Vance, ORP, "Submittal of 24590-WTP-PER-PR-03-001, Rev 3, Prevention of Hydrogen Accumulation in WTP Tank Systems And Miscellaneous Treatment Unit Systems Issued for Permitting Use, to the Hanford Facility Resource Conservation and Recovery Act Administrative Record," CCN: 320185, dated October 19, 2020.

This letter transmits 24590-WTP-PER-PR-03-001, Rev. 3, Prevention of Hydrogen Accumulation in Waste Treatment and Immobilization Plant Tank Systems and Miscellaneous Treatment Unit Systems Issued for Permitting Use (attached) for incorporation into the Dangerous Waste Permit (DWP) (Reference 1) Administrative Record. This document is being submitted to replace Rev. 2, which was previously incorporated into the DWP Administrative Record during the Class 3 Modification for the Effluent Management Facility.

If you have any questions, please contact me, or your staff may contact Gae M. Neath, Environmental Compliance Division, Office of River Protection, on (509) 376-7828.

Sincerely,

Digitally signed by GLYN D. TRENCHARD
DN: c=us, o=u.s. government, ou=department of energy, ou=Energy IT Services, ou=Hanford Site, ou=People, cn=GLYN D. TRENCHARD
Date: 2020.11.10 13:03:32 -08'00'

Glyn D. Trenchard, Assistant Manager
Technical and Regulatory Support
Office of River Protection

ECD:GMN

Attachment

cc w/attach:
J. Cantu, Ecology
M. E. Jones, Ecology
J. K. Perry, MSA
Administrative Record (WTP H-0-8)
Environmental Portal

cc w/o attach:
J. Bell, NPT
L. Contreras, YN
S. L. Dahl, Ecology
D. McDonald, Ecology
M. Murphy, CTUIR
M. Woods, Oregon Energy

Attachment
20-ECD-0055

Hanford Facility RCRA Permit Modification Notification
Form 24590-WTP-PER-PR-03-001, Rev. 3

(16 Pages Including Cover Sheet)

Issued by
RPP-WTP PDC

Document title: **Prevention of Hydrogen Accumulation in WTP Tank Systems and Miscellaneous Treatment Unit Systems Issued for Permitting Use**

Document number: 24590-WTP-PER-PR-03-001, Rev 3

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Department: Engineering

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Approver's position: Process Engineering Group Supervisor

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Signature *Date*

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Notice

Please note that source, special nuclear, and byproduct materials, as defined in the Atomic Energy Act of 1954 (AEA), are regulated at the US Department of Energy (DOE) facilities exclusively by DOE acting pursuant to its AEA authority. DOE asserts, that pursuant to the AEA, it has sole and exclusive responsibility and authority to regulate source, special nuclear, and byproduct materials at DOE-owned nuclear facilities. Information contained herein on radionuclides is provided for process description purposes only.

History Sheet

Rev	Reason for revision	Revised by
0	Issued for Permitting use.	R. Peters
1	Issued for Permitting use & addressed DOE comments.	R. Peters
2	Issued for Permitting use & revised in its entirety to include Direct Feed LAW Operations	S. Schreiber
3	Issued for Permitting use & revised to update HLW facility information. Other sections and references also reviewed and updated as required.	R. Nowak

Contents

Acronyms

AEA	Atomic Energy Act of 1954
ASME	American Society of Mechanical Engineers
BEU	beyond extremely unlikely
BOF	Balance of Facilities
DBE	design basis event
DFLAW	Direct Feed LAW
DOE	US Department of Energy
DSA	Documented Safety Analysis
DWP	Dangerous Waste Permit
EMF	Effluent Management Facility
HEDTA	N-(2-Hydroxyethyl)ethylenediamine triacetic acid
HFP	HLW Melter Feed Process System
HLW	High-Level Waste Facility
HOP	HLW Melter Offgas Treatment Process System
ISA	instrument service air
LAB	Analytical Laboratory Facility
LAW	Low-Activity Waste Facility
LEL	lower explosive limit
LFL	lower flammability limit
MU	miscellaneous unit
NPH	natural phenomena hazard
PDSA	Preliminary Documented Safety Analysis
PJM	pulse jet mixer
PSA	plant service air
PTF	Pretreatment Facility
PVV	Process Vessel Vent Exhaust System
SSCs	structures, systems, and components
UBC	Uniform Building Code
WAC	Washington Administrative Code
WTP	Hanford Tank Waste Treatment and Immobilization Plant

1 Background

The Hanford Tank Waste Treatment and Immobilization Plant (WTP) is a complex of radioactive waste treatment processing facilities designed and constructed to process, or vitrify, the Hanford Site tank waste into a stable glass form. The Hanford Site tank waste consists of approximately 54 million gallons of mixed hazardous waste stored in underground storage tanks at the Hanford Site. The tank waste includes solids (sludge), liquids (supernatant), and salt cake (dried salts that will dissolve in water, forming supernatant).

The Washington Administrative Code (WAC) 173-303-340 requires that “Facilities must be designed, constructed, maintained and operated to minimize the possibility of fire, explosion, or any unplanned sudden or nonsudden release of dangerous waste or dangerous waste constituents to air, soil, or surface or ground water which could threaten the public health or the environment.”

The current WTP Dangerous Waste Permit (DWP) conditions are more specific and, in summary, state that, “Tank systems that have the potential for formation and accumulation of hydrogen gases must be operated to maintain hydrogen levels below the lower explosive limit.” (Reference 2.2, III.10.E.5.l)

This document describes the design and operating features that prevent hydrogen concentrations from exceeding the lower flammability limit (LFL)[1]. The following conditions of the DWP will be addressed in this document:

- Secondary containment and leak detection systems. DWP Conditions: III.10.E.9.b.viii, III.10.G.10.b.viii, III.10.H.5.b.viii, III.10.J.5.b.viii)
- Tanks/miscellaneous units
  (DWP Conditions: III.10.E.9.c.xi, III.10.G.10.c.x, III.10.G.10.d.xii)
- Ancillary equipment
  (DWP Conditions: III.10.E.9.d.xii)
- Sub-Systems
  (DWP Conditions: III.10.H.5.c.xii, III.10.H.5.d.xii, III.10.J.5.c.xii, III.10.J.5.d.xii)

These requirements apply to process vessels in the Pretreatment Facility (PTF), High Level Waste Facility (HLW), Low-Activity Waste Facility (LAW) including the Effluent Management Facility (EMF), Analytical Laboratory Facility (LAB), and Balance of Facilities (BOF). Throughout this document the term process vessels includes tanks, vessels, miscellaneous units (MU), secondary containment/leak detection systems, sub-systems, and ancillary equipment, such as piping and other in-line components. PTF is undergoing redesign activities so the information in sections for PTF has been removed and the sections are listed as RESERVED and will be updated in a future revision.

[1] Lower explosive limit (LEL) and LFL are different terms for the same concept. The term LFL is used throughout this document.

2 References

2.1 WAC 173-303, Dangerous Waste Regulations, 12/18/14.
2.2 WA7890008967, Dangerous Waste Portion of the Hanford Facility Resource Conservation and Recovery Act Permit for the Treatment, Storage, and Disposal of Dangerous Waste, Revision 8C, Part III, Operating Unit Group 10, Waste Treatment and Immobilization Plant.
2.3 24590-WTP-M4C-V11T-00011, Revised Calculation of Hydrogen Generation Rates and Times to Lower Flammability Limit for WTP, Revision C.
2.4 (RESERVED)
2.5 24590-WTP-PSAR-ESH-01-002-04, Preliminary Documented Safety Analysis to Support Construction Authorization; HLW Facility Specific Information, Revision 8.
2.6 Not Used
2.7 24590-WTP-PSAR-ESH-01-002-06, Preliminary Documented Safety Analysis to Support Construction Authorization; LAB Facility Specific Information, Revision 5c.
2.8 24590-WTP-PSAR-ESH-01-002-01, Preliminary Documented Safety Analysis to Support Construction Authorization; General Information, Revision 6D.
2.9 24590-WTP-SRD-ESH-01-001-02, Safety Requirements Document Volume II, Revision 10.
2.10 24590-BOF-M4C-V11T-00003, Calculation of Hydrogen Generation Rates and Times to Low Flammability Limit for EMF, Revision 0.
2.11 24590-LAW-DSA-NS-18-0001, Documented Safety Analysis for the Low-Activity Waste Facility, Revision 3.
2.12 24590-LAW-M4C-V11T-00003, Calculation of Hydrogen Generation Rates for LAW Process Feed Vessels, Revision 1.
2.13 24590-HLW-M4C-V11T-00005, Calculation of Hydrogen Generation Rates for HLW Melter Feed Vessels for a TFCOUP6 Feed Vector, Revision 0.

3 Scope

This document explains which facilities are affected by hydrogen gas, where hydrogen gas comes from, why it is a problem, the types of equipment at risk, and the design and operating features that prevent hydrogen gas from causing a release of dangerous waste to the environment. Information in this document applies to WTP systems that manage dangerous waste and also have the potential for the formation and accumulation of hydrogen gases during normal operation. This information does not necessarily include post-design basis events (DBE). Such systems include permitted tank and miscellaneous systems that contain tank waste from tank farms, but not vitrified waste. It also does not include offgas treatment equipment as both LAW and HLW continuously remove generated gases at levels below the hydrogen LFL.

WTP consists of the following five major facilities:

- High-Level Waste (HLW)
- Low-Activity Waste (LAW), including the Effluent Management Facility (EMF)[2]
- Pretreatment (PTF)

[2] Although EMF is permitted as a stand-alone facility and design documentation carries a BOF designator, it is described in this document in LAW subsections because it is included in the LAW Documented Safety Analysis (DSA).

- Analytical Laboratory (LAB)
- Balance of Facilities (BOF)

All the above major facilities, with the exception of BOF, manage waste and use equipment that has the potential for the formation and accumulation of hydrogen gas.

The processing of radioactive mixed dangerous waste results in hydrogen generation by several mechanisms including the following:

- Radiolysis of water. This can be viewed as radiation breaking apart a water molecule (H_2O), to form hydrogen (H_2), and oxygen (O_2) gasses.
- Radiolysis of organic compounds dissolved in the liquid. This can be viewed as radiation breaking apart organic molecules (e.g. HEDTA [$C_{10}H_{16}O_8N_2$]), to form e.g. hydrogen (H_2), carbon dioxide (CO_2), and oxygen (O_2) gasses.
- Thermolysis. Thermolysis can be viewed as thermal heat, breaking apart organic molecules, and forming hydrogen as a by-product.

The hydrogen gas naturally evolves from the waste in the vessels, ancillary vessels and piping, creating a flammable gas hazard that could, under certain circumstances result in a "hydrogen event." A hydrogen event is one where a deflagration, detonation, or similar event occurs after hydrogen gas levels exceed the LFL, in conjunction with other necessary conditions. A hydrogen event of sufficient magnitude could potentially cause equipment failure and release dangerous waste to secondary containment or the environment.

Section 4 describes the features for facilities in which design is complete (LAW, BOF and LAB) and operating
requirements for other facilities (HLW, PTF) used at WTP to prevent a hydrogen event.

4 Potential Control Strategies for Preventing Hydrogen Accumulation

To comply with WAC 173-303 (Reference 2.1), the requirements discussed in the following sections will be implemented. Throughout this section, potential strategies for controlling accumulation of hydrogen will be identified. The following criteria and strategies are the major elements for designing or mitigating the potential for hydrogen events and are supported by Engineering analysis for each major facility.

4.1 Controls

Hydrogen accumulation is minimized by either limiting the time that hydrogen can accumulate or limiting the amount of hydrogen that can accumulate. The time to accumulate is limited by process parameters such as the amount of time between transfers. The amount of hydrogen is controlled by either air flow to remove the hydrogen (i.e. vessel ventilation) or by mixing to prevent large releases of hydrogen within a vessel (i.e. pulse jet mixers [PJMs], agitators).

The process vessels that require controls for hydrogen removal (typically tanks, vessels, and MUs) will have mixing systems, purging, and/or dilution to prevent exceeding the LFL. In addition, the liquid level will be monitored to stay within normal operating range, thus maintaining an appropriate headspace volume that will prevent exceeding the LFL.

4.1.1 Mixing to Release Hydrogen

4.1.1.1 LAW, LAB, EMF and BOF

LAW, LAB, EMF, and BOF have not identified any vessels that require mixing to release hydrogen.

4.1.1.2 Mixing for the Release of Hydrogen in the PTF Facility

RESERVED for PTF.

4.1.1.3 Mixing for Release of Hydrogen in the HLW Facility

Mixing Vessel Waste by Mechanical Agitation
The agitators in melter feed preparation vessels (HFP-VSL-00001/5) and melter feed vessels (HFP-VSL-00002/6) in the HLW facility have a safety function to release trapped hydrogen and limit the accumulation of hydrogen (Reference 2.5, Sections 3.3.3.2.1, 4.4.2.6.1). The feed from PTF to HLW and its mixture with glass formers are non-Newtonian fluids.

4.1.2 Headspace Ventilation and Purge

Vessel headspace ventilation removes hydrogen gas before it reaches concentrations that could cause a hydrogen event by continuously drawing gases from the headspace of vessels through the vessel ventilation system. In addition to venting, some vessels also use purging where air is added to the headspace of the vessel. Vessel headspace purging or ventilation for the purpose of hydrogen dissipation is applied to vessels in LAW, EMF, HLW, and PTF.

Headspace purging is typically accomplished in the LAW vessels identified requiring headspace dilution using plant service air (PSA) purge flow set with flow restriction devices to provide required flow (Reference 2.11, Section 2.5.1.4.2.1). In the case of EMF, passive purge air flow where air is drawn from the building (C3 air) through the vessel by the exhaust fans (Reference 2.11, Section 2.6.2.1.2).

In HLW, instrument service air (ISA) is provided to dilute the headspace in HFP (Reference 2.5, Section 4.4.2.5.1). All HLW process vessels are vented through the PVV system.

PTF discussion is RESERVED.

The purge will have a minimum volumetric air flow rate of 100 times the maximum calculated hydrogen generation rate of each vessel to maintain a steady-state hydrogen concentration in the headspace lower than 25% of the LFL (which is 1.0 vol.%) (Reference 2.3, Page 23). The purge air flow will be adequate to provide for the hydrogen generation rate at the maximum sustained operating temperature of the waste contained in the vessel.

4.1.3 Headspace Volume

Vessel headspace volume will be adequate to ensure that the relationship between hydrogen generation rate and constant purge flow rate maintains the hydrogen concentration less than 25% of the LFL during normal operations. The headspace used in calculating times to LFL is assumed to be above the overflow level, however during normal operation, additional vessel headspace is maintained by ensuring liquid level is below the maximum operating level through monitoring and interlocks. The amount of vessel headspace can be compromised through allowing the vessel level to rise too far. The vessel liquid level will be monitored with instrumentation.

4.1.4 Flushing

Following waste transfers, the system is capable of being drained and flushed to minimize the buildup of waste material that could lead to plugging, thereby reducing the potential to produce and trap hydrogen.

4.2 System/Piping Design Features

It is important to design systems and piping such that the amount of waste that may become stagnant is minimized. This prevents pockets of waste from collecting, thus preventing hydrogen from being generated in the system. To that end, several design features should be considered for designs which have not been completed:

- Systems or portions of systems are designed to be self-draining.
- High points in process systems are avoided.
- Process lines filled with waste are designed so that they may be flushed or drained.
- Dead legs (where waste can remain stagnant during operations) are minimized.
- Use schedule 80 piping in black cell (BC) and hard-to-reach (HTR) locations as the preferred wall thickness for HPAV affected piping since it provides improved margin, particularly for high solids systems.

4.3 Secondary Containment

Secondary containment may include the process cells and sumps, pump and valve pits, double wall piping, feed line encasement assemblies, and encasement pipes of the transfer lines. Leak detection systems include the secondary containment sumps and transfer line leak detection system.

Hydrogen is not likely to accumulate in secondary containment because process vessels containing hydrogen generating waste are designed to maintain structural integrity during off-normal events and mitigate hydrogen accumulation during normal process operation through the vessel vent systems. Furthermore, the process vessels are designed for the removal of spilled waste and flushing of secondary containment in the event of a leak.

In the unlikely event that a vessel fails and vessel contents are released into secondary containment, the vessel contents will be dispersed over a broad area. This prevents hydrogen from being trapped to such a depth that it could result in accumulation in a solids layer that leads to an episodic release. The building ventilation systems provide a continuous air flow through the cell. In the case of a vessel spilling contents into the cell, this air flow provides dilution and mitigation of hydrogen.

5 Process Vessels

The process vessels listed in Section 5 require hydrogen purging and dilution to prevent hydrogen buildup. Hydrogen mitigation strategies were selected based on either the time to reach the LFL following a loss of hydrogen purging or the amount of suspended solids in the vessel contents that might trap and later release hydrogen gas.

All of the identified HLW, LAW, EMF, and LAB vessels have normal air purge, dilution, and/or mixing using components supplied with instrument air, plant air, or passive flow. In addition, the hydrogen mitigation purge and mixing structures, systems and components (SSCs) prevent hydrogen buildup in process vessels and other equipment to levels in excess of the LFL.

Newtonian fluids can release any generated hydrogen in a steady state manner since the shear stress of these fluids allow small bubbles of hydrogen to rise to the top of the vessel as they are generated.

5.1 PTF

RESERVED.

5.2 HLW

HLW is utilized in the normal WTP configuration. Hydrogen accumulation for the normal WTP configuration is described in the HLW PDSA (Reference 2.5).

5.2.1 Hydrogen Accumulation Prevention

For hydrogen gas accumulation in HLW feed vessels, the vessels of concern (Ref. 2.5, pg. 3.3-49) are the:

Melter Feed Preparation Vessels (MFPVs) - HFP-VSL-00001, HFP-VSL-00005

Melter Feed Vessels (MFVs) - HFP-VSL-00002 **-** HFP-VSL-00006

As discussed in Section 4.1.2, for the above vessels, the hydrogen accumulation prevention strategy for normal operation is to provide an adequate air purge through the vessel headspace. The agitators in the HLW facility feed vessels also have a safety function to release trapped hydrogen and limit the accumulation of hydrogen (Reference 2.5, Section 4.4.2.6.1). The feed from PTF to HLW and its mixture with glass formers are non-Newtonian fluids. The vessel agitators are designed to mix HFP vessel contents with a yield stress not exceeding 30 Pa, and a viscosity not exceed 40 cP (Reference 2.5, Section 4.4.2.6.4). The agitators are required to operation at greater than 80 rpm and provide an alarm if this speed is not achieved (Reference 2.5, Section 4.4.2.6.4). In addition, the vessel agitators can operate intermittently as required on a backup power source during loss-of-site-power events (Reference 2.5, Section 4.4.2.6.4).

Thus, mixing prevents hydrogen accumulation in the vessel fluids, and the vessel headspace ventilation dilutes hydrogen as it is removed from the vessel. For the HFP vessels, dilution air (ISA) is supplied at a flow rate equal to or exceeding 2 scfm, including during and after NPH events (Reference 2.5, Section 4.4.2.5.4), This is roughly 200 times the hydrogen generation rate. Venting to the PVV/HOP systems is the credited exhaust path for the removal of hydrogen (Reference 2.5, Section 4.4.2.5.4). The HFP vessel overflows are credited as the alternate path (Reference 2.5, Section 4.4.2.5.4). The PVV system provides the vent path for the major vessels in HLW (HFP-VSL-00001/2/5/6, RLD-VSL-00007/8, HDH-VSL-00003) (Reference 2.5, Section 2.5.7). Ventilation air from the PVV system is processed by the HOP system.

The "Plant wash and Drains Vessel", RLD-VSL-00008, is an intermediate holding vessel for residual fluid from cleaning, water recycling and drainage operations. Normal operations of this vessel do not possess any hydrogen issues.

5.2.2 Agitator/Purge/Vessel Functional Requirements

The HFP vessel agitators are capable of mixing the waste to release hydrogen so that the vessel headspace hydrogen concentration level can be maintained below 25% of the LFL during normal operation and below LFL during a loss-of-site-power event, and up to an SC-III seismic event (Reference 2.5, Section 4.4.2.6.3). The HFP vessel agitators shall provide positive indication of adequate mixing (Reference 2.5, Section 4.4.2.6.3).

HFP vessel purge provides air through the vessel to dilute the headspace below the hydrogen lower flammability limit (Reference 2.5, Section 4.4.2.5.3). HFP vessels provide flow path sufficient to vent generated hydrogen and purge air from vessel headspace (Reference 2.5, Section 4.4.2.3.3).

The functional requirements for the hydrogen mitigation purge system are to maintain the hydrogen concentrations in the vessel headspaces and lines to less than 1 % by volume hydrogen (25 percent of the LFL) during normal operations (Reference 2.9, Page C-164).

5.2.3 Air Supply

The HLW ISA supply must be capable of simultaneously servicing purge air flow to HFP-VSL-00001/2/5/6. As discussed in Section 5.2.1, dilution is supplied at a flow rate equal to or exceeding 2 scfm, including during and after NPH events.

5.2.3.1 Air Supply Functional Requirements

The HLW ISA system must provide a enough capacity and quality of air to identified SSCs.

5.3 LAW

LAW can be operated in two configurations. The normal configuration utilizes LAW process vessels for the receipt of feed from PTF, preparation and feeding of waste to the melters, offgas, and the return of effluent to PTF.. The second configuration (Direct Feed LAW [DFLAW]) the LAW facility receives feed from Tank Farms and also utilizes vessels in the EMF. Both operational configurations are described in the LAW DSA.

5.3.1 Hydrogen Accumulation Prevention

For flammable gas accumulation using the normal LAW configuration, the hydrogen accumulation prevention strategy is to provide an adequate air purge through the vessels of concern; RLD-VSL-00004, LCP-VSL-00001/00002 and LFP-VSL-00001/2/3/4 (Reference 2.11, Section 2.5.1.4.2.1).The PSA purge of these vessels provides this function, in conjunction with instrumentation to monitor purge airflows to each vessel and alarm on low flow conditions. There are no engineered components for hydrogen mitigation in the primary and secondary offgas system MUs because air dilution prevents the generation of flammable gas to concentrations that exceed the LFL. (Reference 2.11, Section 2.6.1.4)

For flammable gas accumulation using the DFLAW configuration, in addition to the vessels described for

LAW above, the hydrogen accumulation prevention strategy in the EMF is to provide an adequate passive air purge through the vessels of concern (DEP-VSL-00001, DEP-VSL-00002, DEP-VSL-0003A/B/C, DEP-VSL-00004A/B, DEP-VSL-00005A/B, and DEP-EVAP-00001) (Reference 2.11, Section 2.6.2.1.2).

5.3.2 Functional Requirements

The functional requirements for the hydrogen mitigation purge system are to maintain the hydrogen concentrations in the vessel headspaces and lines to less than 1 % by volume hydrogen (25 percent of the LFL) during normal operations (Reference 2.9, Page C-164).

5.3.3 Air Supply SSCs

5.3.3.1 Plant Service Air Header Flow Restriction Device

The function of the plant service air header flow restriction device is to limit the maximum purge flowrate to the LAW vessels receiving plant service air for hydrogen mitigation. This serves to protect the melter offgas system to confine offgas and direct flows to the exhaust stack.

5.3.3.2 Functional Requirements

The flow restriction device is designed such that it limits the flowrate to the LAW vessels receiving plant service air to a predetermined level that ensures that melter offgas confinement is not compromised during normal, abnormal, and accident conditions.

5.3.3.3 Standards

The flow restriction device will be designed in accordance with American Society of Mechanical Engineers (ASME B31.3). The Uniform Building Code (UBC) applies to the flow restriction device to ensure that it can provide its safety function throughout applicable natural phenomena hazards.

5.4 Lab

5.4.1 Hydrogen Accumulation Prevention

A hydrogen explosion in LAB from the accumulation of hydrogen in the C5 vessel (RLD-VSL-00165) but is considered Beyond Extremely Unlikely (BEU) because the time to reach the LFL is extremely long (Reference 2.7, Section 3.3.3.7) and the vessel headspace is vented to the C5 ventilation system. To protect an initial condition assumption in the calculation of the time to reach the LFL, administrative controls for hot cell drain collection vessel (RLD-VSL-00165) inventory limits are adopted (Reference 2.7, Section 3.3.3.7). The risk of a hydrogen event is minimized by limiting the organics allowed in the vessel to within the analyzed bounds, thus, ensuring the time to reach LFL is not minimized. During DFLAW operation this vessel is not in use.

5.4.2 Functional Requirements

The functional requirements for the hydrogen mitigation purge system are to maintain the hydrogen concentrations in the vessel headspaces and lines to less than 1 % by volume hydrogen (25 percent of the LFL) during normal operations (Reference 2.9, Page C-164).

5.5 BOF

The BOF is primarily comprised of facilities that supply chemical and process services, and provides infrastructure support services and utilities for the WTP site (Reference 2.8, Page ES-3). During normal operation, none of its facilities include equipment that is permitted and has the potential for the formation and accumulation of hydrogen gas.

6 Summary

Implementation of these requirements ensure WTP facilities are "designed, constructed, maintained and operated to minimize the possibility of fire, explosion, or any unplanned sudden or non-sudden release of dangerous waste or dangerous waste constituents to air, soil, or surface or ground water which could threaten the public health or the environment."

PTF is undergoing redesign activities so the information in sections for PTF has been removed and these sections are listed as RESERVED and will be updated in a future revision.

6.1 Functional Requirements

To demonstrate compliance with WAC 173-303 (Reference 2.1) the requirements discussed below and in the following sections will be implemented, which includes revising the existing WTP DWP (Reference 2.2). Throughout this document, control strategies are identified for controlling accumulation of hydrogen. The following criteria and strategies are the major elements for designing or mitigating the potential for hydrogen events and are supported by Engineering analysis for each facility:

1. Hydrogen Generation Rate
a. Calculations will show the maximum hydrogen generation rate for vessels (References 2.3, 2.10, 2.12 and Reference 2.13)
2. Controls (Section 4.1)
a. Mixing to Release Hydrogen (Section 4.1.1) - The agitators in melter feed preparation vessels (HFP-VSL-00001/5) and melter feed vessels (HFP-VSL-00002/6) in the HLW facility have a safety function to release trapped hydrogen and limit the accumulation of hydrogen. (Section 4.1.1.1 is RESERVED for PTF)
b. Headspace Ventilation and Purge (Section 4.1.2) - Hydrogen concentrations in the vessel headspace will be maintained below 1 % by volume (25 % of the LFL) during normal operations.
c. Headspace Volume (Section 4.1.3) - To support solids mixing and vessel headspace purge strategies, the vessel headspace will maintain an adequate volume to ensure hydrogen purge can occur within the calculated time to reach LFL concentrations.
d. Flushing (Section 4.1.4) - Following waste transfers, the system is capable of being drained and flushed after each use to minimize the buildup of waste material, thereby reducing the potential to produce hydrogen.

3. System/Piping Design Features (Section 4.2) - It is important to design systems and piping such that the amount of waste that may become stagnant is minimized. This prevents pockets of waste from collecting, thus preventing hydrogen from being generated in the system or piping.

4. Secondary Containment (Section 4.3) - In the unlikely event that a vessel fails and vessel contents are released into secondary containment, the vessel contents will be dispersed over a broad area.
This prevents hydrogen from being trapped and thus avoids hydrogen accumulation. The building ventilation systems provide a continuous air flow through the cell. In the case of a vessel spilling contents into the cell, this air flow provides dilution and mitigation of hydrogen.

6.2 Process Vessels

As described in Section 5, the mitigating features of the process vessels and MUs in secondary containment, facility tank systems, and MU system equipment prevent hydrogen accumulation, thus alleviating a potential hazard.

The LAB and BOF process vessels do not possess controls that serve the purpose of mitigating hydrogen due to the fact that the contents contained in these units do not generate hydrogen gas.
However, they do utilize passive purge to facilitate normal filling and emptying operation (i.e. tank level fluctuations, not hydrogen mitigation) and follow the same aspects of design related to component design, such as double contained pipe monitoring, pipe slopes, flush lines, etc.