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BNFL

CSTF Flammability Control Program

Program Description Document

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Summary of Revisions

2/21/03 Revision 0, Initial Issue

3/27/03 Revision 1, With Revision Bars;
Released hold on Section 5.2, Seismic Flammability Control Program
Expanded discussion for Seismic Quiescent Time Methodology
Provided clarification for Section 5.5, Tank Fill Limits

8/21/03 Revision 2, With Revision Bars;
Eqs. # 6, # 8, and # 13 specify that dividing by the C_{LFL} gives units of % LFL, or can be expressed in % hydrogen if not divided by the C_{LFL}.
Variable V_V in sections 5.3.1, 5.3.3, 5.4.1 and 5.4.3 were updated to specify that once in Gas Release Mode, the actual vapor space is credited in flammability evaluations (to determine if in Gas Release Mode the HLLCP is used to protect the vapor space)
Updated references for interstitial liquid removal and salt dissolution activities in section 5.4.3
Added discussion on salt-out potential to section 5.5
Added implementation actions to section 5.5.1 to document a 6-month transfer plan, which includes solubility / temperature projections, and use this input, as well as Canyon projections, to evaluate the potential need to adjust the HLLCP to maintain tank classification
Added implementation action to section 5.5.1 to state that waste tank to waste tank transfers shall be pre-evaluated in the SW11.1-WTS to ensure the proposed transfer has been evaluated in the 6-month plan and that the inputs remain valid
Revised Output Documentation section to permit the use of Type I and Type II calculations in compliance with the E7 manual

12/05/03 Revision 3, Added programmatic controls to Sec. 3.2 to ensure that only 7 tanks can become flammable in less than 24 hours and only 14 tanks can become flammable in less than 7 days following a seismic event
Provided option to perform 12 vapor space turnovers or measure hydrogen in vapor space with LFL monitor (Sec. 3.3, 3.4, 5.3.1, 5.3.4, 5.4.1)
In section 5.1.1 under the heading labeled "Variable Q_{H2}", an option is provided to perform an engineering evaluation to set maximum temperature limits as opposed to using supernate temperature designated by the Corrosion Control Program
Definition of very slow generation tanks is changed in Sec. 5.1.2 to state that removal of free supernate over saltcake and settled sludge may cause very slow generation tanks to reach 100% LFL
Changed wording in Sec. 5.2.2 to allow empirical data to permit operation of less than four slurry pumps/mixing devices and still claim adequate mixing occurs to deplete the tank's trapped hydrogen inventory

In Sec. 5.3, added wording to recognize that trapped hydrogen is released from sludge during free supernate removal and added section on free supernate removal
Added implementation action numbers 4 and 5, which address free supernate removal from settled sludge tanks to Sec. 5.3.4
In Secs. 5.3.3 and 5.4.3, added requirement to ensure 25% LFL is not exceeded during stepwise hydrogen release activities assuming loss of ventilation
In Sec. 5.4 added wording to recognize that trapped hydrogen is released from salt during free supernate removal and added section on free supernate removal
Removed transfers out of salt tanks (where final transfer level maintains supernate layer covering bulk saltcake) as insignificant activity from Sec. 5.4
Removed implementation action number 5 from Sec. 5.4.4
Added implementation action numbers 5 and 6, which address free supernate removal from salt tanks to Sec. 5.4.4
Changed reference 26 in Sec. 5.5
In Sec. 5.5.1, modified implementation actions number 6 and 8 to state that waste tank to waste tank transfers are only evaluated in the waste transfer evaluation and approval procedure and deleted wording in number 6 that referred to the solubility model not being validated
Elaborated on discussion of Removed from Service tanks in Sec. 5.6
Changed all references of SW11.1-WTS to waste transfer evaluation and approval procedure

3/2/04 Revision 4, In Sec 5.1.1 under the heading labeled "Variable Q_{H2}", added discussion on using dip samples for NO_{eff} values when applied to supernate, sludge, and salt layers to satisfy both corrosion and flammability purposes

Also added a discussion stating that all hydrogen generated is assumed released to tank's vapor space for time to LFL evaluation in Sec 5.1.1

Added an assumption to the Seismic Time to LFL Methodology stating that post seismic trapped gas release assumes no gas retention for settled sludge and salt cake tanks (Sec 5.2.1)

Added an assumption to the Seismic Quiescent Time Program stating that in slurried sludge tanks all hydrogen generated is released during the seven days into the waste tank vapor space after sludge agitation is stopped (Sec 5.2.2)

12 vapor space turnovers or measuring H_2 in vapor space with LFL monitors are not needed for insignificant sludge mixing activities. Therefore for evaluations which protect 25% LFL, 12 vapor space turnovers would reduce hydrogen concentration to 2.5% LFL (Sec 5.3.2, 5.4.2)

	Hydrogen may be retained in the entire amount of slurried sludge between pump operations (Sec 5.2.1, 5.3.1, 5.3.3)
	For waste tank with ≤ 90 inches of slurried sludge depth, 50% of the hydrogen generated is retained in the sludge. For waste tanks with > 90 inches of slurried sludge depth, 100% of the hydrogen generated is retained in the sludge (Sec 5.2.2, 5.2.2.1). Added reference 28 to Sec 6.0
	While in the Pump Run Program an actual hydrogen retention rate can be calculated using a second order polynomial equation (Sec 5.3.3)
	Included siphon potential waste transfers associated with free supernate removal (Sec 5.3, Sec 5.4)
	In Sec 5.5 changed the numbering of the Flammability Level Equation from 15 to 16
	Added implementation action to section 5.5.1 to state that for all waste tanks the Waste Tank Structural Integrity Cog Engineering function shall maintain a reference document(s) of current overflow limits, structural integrity limits, and lowest known leak sites (only for single wall tanks)
	Added reference 29 to section 6.0
	Updated reference 1 in section 6.0
11/30/04 Revision 5,	Added Section 5.7 to describe the Compressor Lube Oil Program, added reference 30
	Added implementation item #8 to Section 5.1.3 to detail the periodic updates made to the facility regarding flammability status
12/13/04 Revision 6,	Revised for 60% Gas Release Mode DSA/TSR change package
	In Section 6.1.1, Variable Q_{H2}, sample frequency and grace period for variable depth samples is same as Corrosion Control Program
	Added last sentence in Section 6.1.2 to state that if Tank 15 is re-wet, tank classification must be revised
	In Section 6.5.1, changed #7 to read Tank Farm influents shall be updated monthly...
	Added Section 7.0, entitled "Gas Release Mode Best Management Practice"
	Added reference for portable and installed hydrogen monitors

Added discussion in Sections 4.3 and 6.3.3 of controlling a self-propagating release of hydrogen from the sludge during gas release mode pump run controls, added reference 36

Clarified Section 4.3 concerning GRM pump runs and which limits (TSR or SAV) they protect

1.0 SAFETY FUNCTION

The safety function of the Concentration, Storage and Transfer Facilities (CSTF) Flammability Control Program is to protect the anticipated times to reach the Lower Flammability Limit (LFL) in individual waste tanks, thereby preventing waste tank explosions.

2.0 PURPOSE

This Program Description Document (PDD) describes the implementation plan for the CSTF Flammability Control Program, including the following ancillary programs provided for by the CSTF Documented Safety Analysis (DSA)[1]:

Waste Tank Quiescent Time Program,

Pump Run Program,

Salt Dissolution/Interstitial Liquid Removal Program, and

Tank Fill Limits

Compressor Lube Oil Program

Additional controls deemed necessary by program management are also described.

This PDD provides background information and describes attributes of the Flammability Control Program in sufficient detail such that procedures implementing flammability control can be developed.

3.0 TSR HYDROGEN CONCENTRATION LIMIT

For activities where entry into Gas Release Mode is required (refer to Sections 6.3.1 and 6.4.1), the TSR hydrogen concentration limits (considering only radiolytic hydrogen generation) shall be established by the Flammability Control Program and shall ensure the minimum time to LFL, defined by the tank classification, is maintained[2]. TSR hydrogen concentration limits are established by the Flammability Control Program according to the safety analysis value designation of a given tank. Safety analysis values cannot be less than 25% LFL and cannot exceed 60% LFL. In order to determine the TSR hydrogen concentration limit, which shall be documented in the ERD, the designated safety analysis value is reduced to account for potential organics and instrument uncertainty. Additionally, for tanks that require entry into Gas Release Mode, an alarm setpoint will be required to ensure the TSR hydrogen concentration limit is not exceeded[2,3]. The TSR hydrogen concentration limit will be designated in the ERD. Once the ERD is approved, this will drive the revision of the Instrument Scaling and Setpoint Document, which will allow implementation of the required indicated hydrogen concentration reading and/or alarm setpoint in the facility. References 4, 5, and 6 provide instrument uncertainty values for a range in various safety analysis values, which are employed to determine the TSR hydrogen concentration limit (i.e., indicated hydrogen reading) and/or alarm setpoint. The Flammability Control Program shall establish the TSR hydrogen concentration limit based on the vapor space volume protected by the waste tank HLLCP[2]. The TSR hydrogen concentration limits shall be on an individual tank basis and shall consider any proposed activities having the potential to release trapped gas (e.g., sludge agitation, salt dissolution, interstitial liquid removal)[2].

4.0 BACKGROUND

The CSTF Flammability Control Program applies to all waste storage tanks due to the presence of hydrogen and potentially flammable organic vapors. Tank 48, which is outside the scope of the flammability program, and tanks Removed from Service[7], deactivated (e.g., Tank 16) or closed (e.g., Tanks 17 and 20) are excluded from the program. The criteria for meeting the flammability requirements of the Removed from Service Mode are described in this PDD.

Administrative controls will be implemented through this program to control mixing devices, salt dissolution, interstitial liquid removal, and free supernate removal operations to limit hydrogen releases into a tank vapor space. The control requirements are separated into the following general categories:

- Loss of Ventilation Flammability Control Program
- Seismic Flammability Control Program
- Sludge Hydrogen Release Activities
- Salt Removal Activities
- Tank Fill Limits
- Waste Tank Removed from Service Flammability Requirements

The following sections describe the program attributes for the general categories provide the Technical Safety Requirement (TSR)[7] and DSA Chapter 5 Administrative Control (AC) references, where applicable.

4.1 LOSS OF VENTILATION FLAMMABILITY CONTROL PROGRAM

A Flammability Control Program addressing loss of ventilation shall be established. The program shall include the following minimum attributes:

- Programmatic controls shall be established to ensure that it takes a minimum of seven days upon loss of waste tank forced ventilation for any tank vapor space to increase from 25% to 100% LFL due to radiolytic hydrogen generation. (TSR AC 5.8.2.27)
- The Flammability Control Program shall determine and track the time to LFL in each waste tank in order to determine the individual waste tank flammability classification (Rapid/Slow/Very Slow). (DSA Section 5.5.4.2.27).

4.2 SEISMIC FLAMMABILITY CONTROL PROGRAM

The Flammability Control Program is credited with tracking the time to reach LFL following a seismic event. The program shall include the following attributes:

- Determine and track which waste tanks may become flammable (i.e., increase from 25% to 100% LFL), due to the contribution from trapped gas and radiolytic release, in less than seven days upon loss of waste tank forced ventilation (post seismic). (TSR AC 5.8.2.27)
- Programmatic controls shall be established to ensure that only 7 tanks can become flammable in less than 24 hours following a seismic event (assuming no ventilation and including the effects of post seismic trapped gas release). (TSR AC 5.8.2.27)
- Programmatic controls shall be established to ensure that only 14 tanks can become flammable in less than seven days following a seismic event (assuming no ventilation and including the effects of post seismic trapped gas release). (TSR AC 5.8.2.27)
- Programmatic controls shall be established to ensure a path forward is provided to DOE (addressing the additional risk and recovery time) if a transfer required to mitigate a tank leak causes additional tanks to have the potential to become flammable in less than seven days following a seismic event. Submittal of the path forward is not required prior to initiating the transfer. (TSR AC 5.8.2.27).
- Programmatic controls shall be implemented to periodically operate waste tank mixing devices to limit the amount of trapped gas that could be released during a seismic event, such that the waste tank does not become flammable in less than seven days following a seismic event. These controls shall be applicable to a waste tank following the initial depletion of trapped gas from the waste as a result of mixing operations. (TSR AC 5.8.2.28)

The program shall determine the quiescent period and shall be based on the hydrogen retention/release methodology discussed in the DSA, Section 3.4.2.11.1. The program shall also address the requirements for declaring hydrogen depletion success for a given tank quadrant (e.g., slurry pump run times and speeds, number of pumps required to perform the safety function).

4.3 SLUDGE HYDROGEN RELEASE ACTIVITIES

Programmatic controls shall be implemented to ensure that:

- The waste tank vapor space hydrogen concentration is less than or equal to the initial value assumed in the hydrogen release Engineering Evaluation prior to initiating mixing activities. This may be achieved by an adequate number of vapor space turnovers and/or by comparing the tank LFL reading to a reading obtained using a known LFL concentration. If the flammable vapor concentration method is implemented, the methodology used to determine the flammable vapor concentration shall be consistent with the requirements of Reference 8. (TSR AC 5.8.2.29)

- When a tank is in Gas Release Mode, the operation of waste tank mixing devices limits the planned release of trapped hydrogen such that the vapor space hydrogen concentration does not exceed the hydrogen concentration safety analysis value. (TSR AC 5.8.2.29)
- When a tank is in Gas Release Mode, the operation of waste tank mixing devices will prevent a buildup of gas within the sludge so that a self-propagating release of gas does not occur within the sludge.
- The waste tank TSR hydrogen concentration limit and/or alarm setpoint are documented in the ERD[3]. The safety analysis value shall protect the tank's classification (Rapid, Slow, or Very Slow) time to LFL, but not to exceed 60% of the LFL. The documented TSR hydrogen concentration limit shall account for potential organics, alarm setpoint increment limitations, and instrument uncertainties. (TSR AC 5.8.2.27)

4.4 SALT REMOVAL ACTIVITIES

Programmatic controls shall be implemented to ensure that:

- The waste tank vapor space hydrogen concentration is less than or equal to the initial value assumed in the hydrogen release Engineering Evaluation prior to initiating salt removal activities. This may be achieved by an adequate number of vapor space turnovers and/or by comparing the tank LFL reading to a reading obtained using a known LFL concentration. If the flammable vapor concentration method is implemented, the methodology used to determine the flammable vapor concentration shall be consistent with the requirements of Reference 8. (TSR AC 5.8.2.30)
- When a tank is in Gas Release Mode, the rate at which salt is dissolved or interstitial liquid is removed from saltcake does not result in exceeding the hydrogen concentration safety analysis value. (TSR AC 5.8.2.30)
- The waste tank TSR hydrogen concentration limit is documented in the ERD[3]. The safety analysis value shall protect the tank's classification (Rapid, Slow, or Very Slow) time to LFL, but not to exceed 60% of the LFL. The documented TSR hydrogen concentration limit shall account for potential organics, instrument uncertainties, and alarm setpoint increment limitations. (TSR AC 5.8.2.27)

4.5 TANK FILL LIMITS

Programmatic controls shall be implemented to ensure that:

- Engineering shall determine the HLLCP setpoint for each waste tank and document the values in the High Level Waste Emergency Response Data and Waste Tank Status Data (ERD)[3]. The values stated in the ERD shall account for instrument uncertainties and the maximum volume associated with a transfer error event. (TSR AC 5.8.2.44)

The HLLCP setpoint for each waste tank shall be determined and subsequently documented in the ERD. The published value shall protect the most conservative of the following (accounting for the maximum amount of waste associated with a transfer error event [i.e., 15,000 gallons] and instrument uncertainties):

- Overflow Limit
- Tank Classification Level (used for time to LFL calculations)
- Siphon Limits for Tanks 1 and 2
- Structural Integrity Limit
- Lowest Leak Site for Single-Wall Tanks
- Flammable Transient Limits Due to Trapped Gas Release

4.6 WASTE TANK REMOVED FROM SERVICE MODE

The parameters defining the Removed from Service Mode are documented in Chapter 5 of the DSA. This PDD describes the criteria for meeting the flammability requirements of the Removed from Service mode.

5.0 INPUTS

The inputs used for the CSTF Flammability Control Program include the following:

- Vapor space and trapped gas temperature limits used in the flammability calculations are imposed by the supernate temperature limits in the Corrosion Control Program[9]. As an alternative to using the corrosion control supernate temperature limits, an engineering evaluation may be performed to set maximum flammability temperature limits (refer to Reference 10). These temperature limits are used to correct the flammability calculations to account for temperature variations. For tanks with no specified supernate temperature limit, a maximum temperature limit of 50°C shall be used for the flammability calculations.
- Unless otherwise noted, dissolved hydrogen contributions are not considered because of the following:
    - Typical of waste tanks, small temperature increases correspond to insignificant amounts of dissolved hydrogen released.
    - Waste agitation from seismic motion will release insignificant, if any, quantities of dissolved hydrogen, per the DSA, Section 3.4.1.5.3.
    - Dissolved hydrogen release due to mixer operation is not a prompt release, per the DSA, Section 3.4.1.5.3.

- Organic flammability contributions are considered bounded by 5% of the LFL, except for Tank 50H, which is governed by its JCO (WSRC-TR-2003-00083). The Waste Acceptance Criteria Program (TSR AC 5.8.2.15) shall control the flammability contribution of organics received into CSTF locations. The organic contribution is accounted for in the time to LFL calculations. Within CSTF, very minor, if any, organics are added (e.g., defoamers for evaporators) and are fully covered by the 5% LFL assigned for organics by the following programs:
  - The Chemical Inventory Control Program shall provide control over new materials brought into the facility. (TSR AC 5.8.2.17)
  - The Compressor Lube Oil Control Program shall prevent the introduction (via air compressors) of significant flammable vapors into analyzed spaces (e.g., evaporator pots, evaporator cells, transfer facilities, waste tanks, and waste tank annuli). (TSR AC 5.8.2.45). This program is described in Section 6.7.
- Flammability calculation inputs are dependent on the Waste Characterization System Administrative Program[11]. The input parameters and corresponding outputs for the flammability control program calculations are revised at the frequency that the Waste Characterization System is updated. Such updates capture the Flammability Control Program requirements through the ERD linking procedure (SW11.6-SVP-ERD).

6.0 PROGRAM DESCRIPTION

6.1 LOSS OF VENTILATION FLAMMABILITY CONTROL PROGRAM

The objective of this section is to describe the administrative control requirements to evaluate the mixture of flammable gases in the waste tank vapor space such that, upon loss of ventilation, at least seven days are available before the waste tank reaches 100% LFL, considering only radiolytic hydrogen generation.[1] The Flammability Control Program shall provide administrative controls to determine and track the time to LFL for each waste tank, including administrative control of tank contents and operations. Rapid and Slow flammability classifications are designated according to the time it takes to go from 25% to 100% of the LFL. A Very Slow Generation flammability classification designates tanks that reach their equilibrium concentration at less than 100% LFL; therefore, the times to LFL are infinite and Very Slow Generation Tanks are exempt from ventilation requirements (except for best management practice as discussed in Section 6.1.2). However, during free supernate removal in Very Slow Generation Tanks, specific volumes of saltcake/settled sludge will cause the vapor space to reach 100% LFL; therefore, free supernate removal is prohibited from these tanks.

Dissolved gas releases from jetted transfers and free liquid removal are not considered in the loss of ventilation time to LFL.

Hydrogen is naturally buoyant in air and diffuses readily; therefore, hydrogen released to vapor spaces from radiolytic decomposition is assumed to be well mixed (i.e., no hydrogen layering) and only bulk hydrogen concentrations are considered.

6.1.1 TIME TO LFL METHODOLOGY

The DSA recognizes atmospheric breathing as a realistic transport mechanism for flammable vapors in the loss of normal tank ventilation. The following derivation (Ref. 12) provides the Flammability Control Program time to LFL equation which accounts for the effects of atmospheric breathing:

Eq. # 1

$$\text{Time to LFL} = \frac{-\ln\left[\dfrac{C_{LFL} - \dfrac{Q_{H2}}{Q_{H2}+Q}}{y_0 - \dfrac{Q_{H2}}{Q_{H2}+Q}}\right]}{\dfrac{Q_{H2}+Q}{V_v}}$$

Where,

C_{LFL}	=	corrected hydrogen concentration at 100% LFL (see Eq. # 2)
y_0	=	initial hydrogen concentration (defined by the designated tank specific safety analysis value), including temperature and organic corrections (see Eq. # 3)
Q_{H2}	=	temperature corrected hydrogen generation rate, ft^3/hr
Q	=	atmospheric breathing rate, ft^3/hr (see Eq. # 4)
Vv	=	vapor space volume, ft^3 (see Eq. # 5)

VARIABLE C_{LFL} CALCULATION (USED IN EQ #1)

The LFL for hydrogen is 4.0% by volume (0.04-volume fraction) at room temperature conditions (i.e., 25°C). Since the LFL is temperature dependent, the LFL is adjusted for the various temperature conditions found in the CSTF using the Burgess – Wheeler Law.[!] The Burgess-Wheeler Law provides an empirical correlation to correct the LFL to account for temperature variations. The Burgess – Wheeler correlation is documented in Section 3.4.1.1.2 of the DSA.

The organic LFL contribution required by the DSA is 5% of LFL equivalent hydrogen concentration. The LFL is 4.0% at ambient conditions; therefore the equivalent hydrogen concentration for the organic contribution would be 0.2% (0.002-volume fraction). This correction factor is used to account for trace organics found in a waste tank. The LFL, corrected for organic and temperature, is determined by using the Burgess – Wheeler correlation and subtracting the organic contribution, as follows:

Eq. # 2 $C_{LFL} = LFL_{25C} * [1 - A (T - 25)] - OC$

Where,

LFL_{25C} = LFL at 25°C, (i.e., 4.0% by volume)

A = empirical coefficient (Zabetakis attenuation factor), (i.e., 0.0011 per Ref. 1)

T = temperature at which LFL is to be evaluated in °C

OC = the organic contribution equivalent hydrogen concentration (i.e., 5 % of LFL_{25C})

The values used in the temperature correction calculations are the supernate temperature limits designated by the Corrosion Control Program[9]. As an alternative to using supernate temperature limits, an engineering evaluation may be performed to set maximum temperature limits (refer to Reference 10). The vapor space temperature is assumed to be the same as the liquid surface.

VARIABLE y_0 CALCULATION (USED IN EQ #1)

Using the same basis as the C_{LFL} calculation (Eq. #2) for temperature and organic correction, the corrected initial hydrogen concentration is:

Eq. # 3 $y_0 = y_{0(25C)} * [1 - A (T - 25)] - OC$

Where,

$y_{0(25C)}$ = initial hydrogen concentration at 25°C,

A, T, and OC are as in Eq. # 2.

VARIABLE Q_{H2} (USED IN EQ #1)

Many of the accidents are assumed to occur at elevated temperatures; therefore, the hydrogen generation rate is corrected for the higher temperatures using the Temperature Corrected Hydrogen Generation Rate methodology in Section 3.4.1.1.2 of the DSA. The values used in the temperature correction calculations are the supernate temperature limits designated by the Corrosion Control Program[9]. As an alternative to using supernate temperature limits, an engineering evaluation may be performed to set maximum temperature limits (refer to Reference 10). The effective ion concentration (NO_{eff}) of the tank supernate is equal to the nitrate concentration plus one-half of the nitrite concentration. To address the potential for unevaluated additions to the tanks, the NO_{eff} is diluted by the addition of 15,000 gallons of uninhibited water to account for maximum missing waste. This application of maximum missing waste bounds minor facility operations. Operational processes include occasional small volume water additions to the waste tanks. Sources of these additions include rainwater, sump solutions, equipment flushes, and decontamination solutions. These additions do not significantly alter the bulk chemistry of the waste already present in the tank. Water additions exceeding 3,000 gallons will require an engineering evaluation for flammability impact prior to the addition.

Time to LFL evaluations assumes that the waste is at equilibrium for hydrogen retention, therefore all the hydrogen generated is assumed to be released into the waste tank vapor space.

Application of the Corrosion Control Program dip sample analysis for the effective ion concentration (NO_{eff}) values applied to supernate, sludge, and salt layers is a conservative practice, which minimizes the number of samples required to satisfy both Corrosion and Flammability Control Programs. Alternatively, variable depth samples offer a more representative analysis of NO_{eff} for flammability purposes and are acceptable for use in the Flammability Control Program evaluations in lieu of dip sample analysis. This will be especially true of waste tanks where supernate stratification is suspected (e.g. evaporator feed tanks, drop and vent tanks, low density transfer into high density waste tanks, and rainwater in-leakage into waste tanks). The variable depth samples used in flammability calculations will be subject to the same requirements (i.e., sample frequency and grace period) as the dip sample analysis in the Corrosion Control Program (refer to Reference 9).

For sludge waste without a supernate cover, the scavenger concentrations used are minimum values based on joint solubility. The NO_{eff} term for these tanks is conservatively assumed to be 1.45M.[13]

The scavenger concentration, NO_{eff}, used in dry salt tanks is based on the most recent sample results. As the evaporation process occurs in a salt tank, the supernate layer above the salt increases in salt concentration as the liquid level recedes into the salt phase as interstitial liquid. Evaporation tends to increase NO_{eff} in the remaining liquid. Therefore, using the latest sample results is conservative.

The calculated hydrogen generation rate is for standard temperature and pressure (STP: 0°C and 1 atm).

VARIABLE Q CALCULATION (USED IN EQ #1)

Atmospheric breathing reduces the hydrogen buildup in the vapor space and is therefore credited in this program. No specific controls for atmospheric breathing are required, since the design of the cell covers, penetrations, riser plugs, etc., is such that the locations crediting atmospheric breathing will have more than enough of such extremely small openings.[1] The atmospheric breathing assumptions and methodology are established in the DSA, Section 3.4.1.5.5. The correlation for atmospheric breathing rate is determined using the following equation:

Eq. # 4 $$Q = \left[\frac{(\text{mean atm. Fluctuation})}{(1013 \text{ mbar})}\right] * \frac{V_v}{(24 \text{ hrs/day})}$$

Where,

mean atm. Fluctuation = mean pressure fluctuation, mbar/day (i.e., 5 mbar/day)

Vv = vapor space volume, ft^3

VARIABLE Vv CALCULATION (USED IN EQ #1 & EQ #4)

The High Liquid Level Conductivity Probe (HLLCP) setpoint is credited for protecting the vapor space volume used to determine loss of ventilation time to LFL and flammability classifications. Although the actual waste level will be less than the HLLCP, its use provides a conservative basis utilizing credited level detection equipment. The following equation is the vapor space volume calculation, in cubic feet:

Eq. # 5 $$V_V = [V_T - (\text{Flammability Level} * Ff)] * 0.1336 \text{ ft}^3 / \text{gal}$$

Where,

V_T = total Tank Vapor Space Volume (empty tank), gal

Flammability Level = establishes the credited vapor volume used to protect the Tank Classification, in (see Eq. # 16)

Ff = fill factor, gal/in

The adjusted fill factor is applied as an algorithm to reflect varying fill factors that adjust the established tank calibrations as a result of the displaced volume of the support cone in the upper part of the tank, as applicable.[14,15] The nominal fill factor (Ref. 1) may be used to calculate the waste volume. Application of the nominal fill factor in this way is conservative because the fill factor overestimates the waste volume. The Flammability Level accounts for maximum missing waste volume and instrument uncertainty. The instrument uncertainty values are based on conductivity probe uncertainty calculations (Ref. 16, 17, 18, 19, 20).

6.1.2 FLAMMABILITY CLASSIFICATION METHODOLOGY

The flammability classifications are designated according to the time it takes to go from 25% to 100% of the LFL following a loss of ventilation:

- Rapid Generation Tanks - Waste storage tanks that have been determined to go from 25% to 100% of the LFL in less than 28 days following a loss of ventilation.

- Slow Generation Tanks - Waste storage tanks that have been determined to go from 25% to 100% of the LFL in greater than or equal to 28 days following a loss of ventilation.
- Very Slow Generation Tanks - Waste storage tanks that have been determined to never reach 100% of the LFL, considering atmospheric breathing.

The above classifications only pertain to tanks where there is no sludge agitation and/or salt removal activities taking place (i.e., tanks not in Gas Release Mode). For tanks where sludge agitation and/or salt removal activities are planned, flammability classifications are designated as the time it takes to go from the safety analysis value to 100% LFL. All flammability classifications are based on the time to LFL calculations using Eq. # 1.

VERY SLOW GENERATION TANKS

Very Slow Generation Tanks are shown by calculation to never reach 100% of the LFL. However, during free supernate removal in Very Slow Generation Tanks, specific volumes of saltcake/settled sludge will cause the vapor space to reach 100% LFL; therefore, free supernate removal is prohibited from the tanks that contain greater than these specified volumes of saltcake/settled sludge. The hydrogen concentration at equilibrium conditions with radiolytic production is represented in the following equation:

Eq. # 6 $$\text{Equil. Conc.} = \frac{Q_{H2}}{Q_{H2} + Q} / C_{LFL}$$

Where,

C_{LFL} = corrected hydrogen concentration at 100% LFL (see Eq. # 2)

Q_{H2} = temperature corrected hydrogen generation rate, ft^3/hr

Q = atmospheric breathing rate, ft^3/hr (see Eq. # 4) [By substituting ventilation flow rate for Q, the hydrogen concentration at steady state equilibrium is determined for Slow and Rapid Generation Tanks when accounting for ventilation.]

Equation # 6 is expressed in units of % LFL, or can be expressed in % hydrogen if the equation is not divided by the C_{LFL}.

No forced ventilation is required by the DSA. National Fire Protection Association (NFPA), National Fire Code 69[21] requirements do not apply if 100% of the LFL cannot be reached. Normal tank breathing will prevent the tank vapor space from reaching a deflagrable condition.

Best management practice will be to require ventilation (installed or portable) to operate on Very Slow Generation Tanks undergoing jetted transfer receipts (due to steam used in a steam jet transfer) because of the potential of dissolved hydrogen contributions above the hydrogen equilibrium to result in greater than, or equal to, 100% of LFL. The exhaust fan shall be operating and aligned for the duration of the transfer.

The calculated hydrogen concentration shall reach equilibrium conditions for Very Slow Generation Tanks at less than 100% of the LFL, by definition. However, during free supernate removal in Very Slow Generation Tanks, specific volumes of saltcake/settled sludge will cause the vapor space to reach 100% LFL; therefore, free supernate removal from the tanks that contain greater than these specified volumes of saltcake/settled sludge is prohibited. Best management practice will be to limit the Very Slow Generation designation to tanks that reach equilibrium at less than 95 % of the LFL. Additionally, tanks reaching hydrogen equilibrium at greater than 60% of LFL shall undergo annual periodic ventilation operation using an installed or portable ventilation system (i.e., for a duration of 12 vapor space turnovers with downtime not exceeding 12 cumulative hours from start to completion).

Dry sludge Tank 15H was evaluated based on empirical data and determined to not be able to accumulate sufficient amounts of flammable gas to pose a safety risk.[22] Therefore, Tank 15 is classified as Very Slow Generation Tanks as long as it remains dry. If Tank 15 is re-wet, the tank classification must be re-evaluated.

6.1.3 Implementation Actions

1. The loss of ventilation time to LFL Tank Classification shall be determined in an engineering evaluation or in the Waste Characterization System governed by the Waste Characterization System Administrative Program.
2. The waste Tank Classifications shall be documented in the High Level Waste Emergency Response Data and Waste Tank Status Data (ERD)[3].
3. Planned operations (e.g., waste tank to waste tank transfers) shall be pre-evaluated to determine the impact on the time to LFL and Tank Classification for the affected process areas (e.g., sending and receiving tanks) in the Waste Transfer Evaluation and Approval procedure.
4. If the evaluated activity results in a Tank Classification change to a more restrictive status (SLOW to RAPID, VERY SLOW to RAPID, VERY SLOW to SLOW), then the status will be updated in the ERD and implemented in the facility via the ERD linking procedure (SW11.6-SVP-ERD) prior to initiation of the planned activity.
5. If the projected time to LFL results in less than seven days, then the evaluated activity shall not be performed.
6. Small volume water additions greater than 3,000 gallons shall be evaluated and documented prior to introduction into the waste tank.
7. Ventilation shall be required during jetted transfer receipts for Very Slow Generation Tanks in the Waste Transfer Evaluation and Approval procedure.
8. Periodically, the classifications of all waste tanks will be reviewed to determine if any are at risk of an unexpected classification change due to

fluctuations in sample results. If a tank is identified by this review, recommendations (e.g., chemical additions, lowering probe heights, etc.) shall be provided to the facility to avoid this risk.

9. The hydrogen equilibrium concentration for Very Slow Generation Tanks shall be determined in an engineering evaluation or in the Waste Characterization System. Very Slow Generation Tanks with a calculated hydrogen equilibrium concentration greater than 60% LFL shall be identified in the ERD or in an engineering evaluation.

10. Very Slow Generation Tanks identified to have a calculated hydrogen equilibrium concentration greater than 60% LFL shall undergo periodic ventilation operation.

6.2 Seismic Flammability Control Program

The Flammability Control Program shall provide administrative controls to determine and track the seismic time to LFL for each waste tank, including administrative control of tank contents and operations. Programmatic controls shall be established to ensure that the number of tanks capable of becoming flammable following a seismic event (including the effects of post seismic trapped gas release) within specified time periods shall be within the restrictions of the TSR/DSA[1,23]. Programmatic controls shall be established to ensure a path forward is provided to DOE (addressing the additional risk and recovery time) if a transfer required to mitigate a tank leak causes additional tanks to have the potential to become flammable in less than seven days following a seismic event. Because the transfer is mitigating a degraded condition (i.e., placing the facility in a safer condition), submittal of the path forward is not required prior to initiating the transfer.

6.2.1 Seismic Time to LFL Methodology

The methodology for determining the seismic time to LFL is consistent with the methodology presented in the Time to LFL Methodology (Eq. # 1), with the exception of the following assumptions:

- The initial concentration, y_0, shall be the steady state hydrogen equilibrium concentration including the effects of post seismic trapped gas release and shall be designated by the term y_0(Seismic) (see Eq. # 7)
- The vapor space volume, Vv, shall be dependent on the actual or projected tank fill level, Vv' (see Eq.# 10)
- 15,000 gallons of maximum missing waste shall be evaluated for the transfer receipt tank prior to transfers (assuming the maximum missing waste is the transfer material)
- Post seismic trapped gas release assumes no gas retention (the hydrogen generated is equal to the hydrogen released into the waste tank's vapor space). The methodology is limited to settled sludge and saltcake waste

tanks. Seismic Time to LFL Methodology for slurried tanks is governed by the Seismic Quiescent Time Program specified in section 6.2.2.

VARIABLE y_0 (SEISMIC) CALCULATION (USED IN EQ #1)

The initial concentration used in the seismic time to LFL equation shall include the steady state hydrogen equilibrium concentration accounting for ventilation, (except for Very Slow Generation Tanks, which shall assume the hydrogen equilibrium without ventilation) and the effects of post seismic trapped gas release. Free release is inherently accounted for in the seismic time to LFL calculation based on the inclusion of the hydrogen generation rate term.

Eq. # 7 $\quad y_0(\text{Seismic}) = \text{Equil. Conc.} + TG$

Where,

Equil. Conc. = initial concentration at steady state hydrogen equilibrium (i.e., 2.5% LFL or as specified in engineering evaluation; refer to Section 6.3.2)

TG = hydrogen concentration due to trapped gas release (see Eq. # 8)

VARIABLE EQUIL. CONC. CALCULATION (USED IN EQ #7)

For Rapid and Slow Generation Tanks, the initial hydrogen concentration after a seismic event is assumed to be at steady state hydrogen equilibrium accounting for ventilation. The initial hydrogen concentration is calculated using Equation 6, substituting the atmospheric breathing term, Q, with the DSA purge ventilation flow rate. For Very Slow Generation Tanks, the initial hydrogen concentration after a seismic event is assumed to be at steady state hydrogen equilibrium accounting for atmospheric breathing (Eq. # 6).

VARIABLE TG CALCULATION (USED IN EQ #7)

The contribution of post seismic trapped gas from salt and sludge is additive. The following equation (Ref. 23) is used to determine the vapor space hydrogen concentration due to trapped gas release from sludge or salt under post seismic conditions. Each contributing phase shall be added together to determine the total seismic initial concentration:

Eq. # 8
$$TG = \frac{V_{solids} * G_s * H * C * F_R}{Vv'} / C_{LFL}$$

Where,

V_{solids} = volume of sludge or salt in the tank, ft^3

G_s = fraction trapped bubble gas

H = hydrogen fraction in trapped gas

C = pressure correction (see Eq. # 9)

F_R = trapped gas release fraction

V_V' = vapor space volume, ft^3 (see Eq. # 10)

C_{LFL} = corrected hydrogen concentration at 100% LFL (see Eq. # 2)

TG is expressed in units of % LFL, or can be expressed in % hydrogen if Equation # 8 is not divided by the C_{LFL}.

VARIABLE V_{SOLIDS} (USED IN EQ #8)

All insoluble solids are considered to be sludge for the purposes of trapped gas retention. The DSA, Section 3.4.1.5.3, establishes the following input for determining the volume of sludge or salt affected due to seismic agitation:

- For tanks not under a quiescent time program, the tank sludge is assumed to be settled sludge, and therefore the entire sludge volume is used
- For tanks under a quiescent time program, the sludge is slurried sludge and the entire sludge volume is included in releasing hydrogen during a seismic event
- For salt tanks, the volume of salt available to liberate hydrogen is equal to the least of the following: the salt depth, the free liquid depth (depth of liquid above salt) or 40 inches. If there is no free liquid above the salt layer, no trapped gas is released from salt

VARIABLE G_S (USED IN EQ #8)

The DSA, Section 3.4.1.5.3, establishes the following input for determining the percent of trapped bubble gas released due to seismic agitation:

- For sludge tanks under a Quiescent Time Program, the trapped bubble gas percent is 20%
- For sludge tanks not under a Quiescent Time Program, the trapped bubble gas percent is 10%
- For salt tanks, the trapped bubble gas percent is 11%

VARIABLE H (USED IN EQ #8)

The percent hydrogen in trapped gas is calculated using the DSA, Section 3.4.1.5.3 equations which relate empirical data (i.e., nitrite and nitrate concentrations) to the radiolytic decay heat or determined using DSA values for tanks with unknown chemistry and heat loads.

VARIABLE C CALCULATION (USED IN EQ #8)

The expansion factor is used for predicting the effect of pressure on trapped bubble gas release due to agitation. The relationship between the expansion factor and the head pressure is linear ($C = P_{avg}/P_{atm}$). The expansion correction is determined from the following head pressure equation (Ref. 23):

Eq. # 9 $$P_{avg} = \sum_{a=2}^{n} \frac{\rho_a g h_a}{X} + \frac{1}{2}\frac{\rho_1 g h_1}{X} + p_0$$

Where,

n = number of layers in the waste tank, excluding bottom layer

ρ = density of layer material, kg/m^3

ρ_1 = density of the bottom layer material, kg/m^3

h = height of layer, m

h_1 = height of the bottom layer, m

g = gravitational force, m/s^2

p_0 = atmospheric pressure, atm

X = 101325, Pa/atm

VARIABLE F_R CALCULATION (USED IN EQ #8)

The DSA, Section 3.4.1.5.3, establishes the following input for determining the release percentage due to seismic agitation:

- The trapped hydrogen release percentage from waste tank settled sludge (i.e., tanks not under a quiescent time program) after a seismic event is equal to the following equation:

$$\frac{\text{total waste level (in)}}{400} * 50\%$$

- The trapped hydrogen release percentage from waste tank slurried sludge (i.e., tanks under a quiescent time program) after a seismic event is 100%
- The trapped hydrogen release percentage from waste tank salt after a seismic event is 50%

VARIABLE Vv' CALCULATION (USED IN EQ #8)

The vapor space volume used to calculate the seismic time to LFL is based on the actual waste level. The calculations account for the maximum missing waste volume only when pre-evaluating a waste transfer. This is accomplished by reducing the vapor space volume and adjusting the chemistry by 15,000 gallons (assuming the maximum missing waste is the material to be transferred). The following equation is the vapor space volume calculation, in cubic feet:

Eq. # 10 $$Vv' = [V_T - (Level_A * Ff + MMW)] * 0.1336\ ft^3/gal$$

Where,

V_T	=	total Tank Vapor Space Volume (empty tank), gal
$Level_A$	=	actual or projected waste level, in
MMW	=	maximum missing waste volume, gal (pre-evaluated to be accounted for in the receipt tank during a transfer)
Ff	=	fill factor, gal/in

The adjusted fill factor is applied as an algorithm to reflect varying fill factors that adjust the established tank calibrations as a result of the displaced volume of the support cone in the upper part of the tank, as applicable.[14,15] The nominal fill factor (Ref. 1) may be used to calculate the waste volume. Application of the nominal fill factor in this way is conservative because the fill factor overestimates the waste volume.

6.2.2 Seismic Quiescent Time Program

The Quiescent Time Program is a periodic pump/mixer run program required to safely manage the trapped hydrogen that may be retained within the sludge of some tanks. Tanks are placed under a Quiescent Time Program after successful initial sludge mixing (i.e., hydrogen depletion) is accomplished. Initial sludge mixing is achieved upon completion of four fully inserted slurry pumps or one fully inserted ADMP in a Type IV tank running non-indexed or turntable operating for a cumulative period of ten days[24]. At this point, operation of the slurry pumps will not achieve any additional trapped hydrogen release from settled sludge disturbance. Operation of the pump/mixer liberates hydrogen retained within the waste resulting in elevated flammable vapor concentrations in the vapor space. A periodic slurry pump run program has been implemented to safely manage the inventory of flammable vapors that may be retained within the waste. An integral part of this program is to determine the maximum time that a tank can remain undisturbed and still not retain sufficient hydrogen to cause the tank's vapor space to reach the LFL within seven days if a hydrogen release event were to occur. This time, referred to as the seismic quiescent time, is calculated based upon the following conservative inputs and assumptions:

- The hydrogen generation rate equations in the DSA, Section 3.4.1.1.2 are used to determine the amount of hydrogen generated during the seismic quiescent period.
- The seismic quiescent time is the allowable time between tank agitation such that the hydrogen released during a seismic event does not cause the waste tank vapor space to reach the LFL within seven days (radiolytic hydrogen generation and trapped hydrogen release) assuming the vapor space is initially at 25% LFL for Rapid and Slow Generation Tanks or at the higher of 25% LFL or equilibrium for Very Slow Generation Tanks.
- The amount of hydrogen retained in the slurried sludge layer during the quiescent period is dependent upon the depth of the sludge layer. For waste tanks with a slurried sludge depth of less than or equal to 90 inches, 50% of the hydrogen generated is retained in the sludge. For waste tanks

with a slurried sludge depth greater than 90 inches, 100% of the hydrogen generated is retained in the sludge[7].

- Post seismic trapped gas release time to LFL portion of seismic calculation release percentage is assumed to be 100%. The methodology is limited to a release period of seven days.

After initially slurrying the entire inventory of sludge in a waste tank, the Seismic Quiescent Time Program will be applied to that tank. Operational experiences have demonstrated that retained gas is released when adequate mixing occurs (i.e., after successful completion of an 8 hour pump/mixer run at maximum allowable speed with evidence of adequate sludge mixing [e.g., camera inspection, motor loading with acceptable ranges, etc.]). For a waste tank, it has been demonstrated that a single slurry pump is capable of depleting at least 25% of the tank's retained hydrogen inventory. Thus, the tank's trapped gas inventory can be removed with four pumps operating in a manner that ensures adequate mixing. Likewise, the effect of a non-operational pump is that it could leave up to 25% of the tank' content inadequately mixed, retaining the trapped gas inventory. Empirical trapped gas release data, which is baselined with a 4 pump run for 8 hours, from the tank under consideration may be evaluated to permit operation of less than four slurry pumps/mixing devices and still claim adequate mixing occurs to deplete the tank's trapped hydrogen inventory.

6.2.2.1 Seismic Quiescent Time Methodology

The methodology for determining the seismic quiescent time is consistent with the methodology presented in the Seismic Time to LFL Methodology, with the exception of the following assumptions:

- The initial concentration, y_0, shall be the initial hydrogen concentration (or 25% LFL) including the effects of post seismic trapped gas release and shall be designated by the variable name, y_0(Seismic)' (see Eq. # 11)
- The trapped gas contribution, TG, shall be a function of time (see Eq. # 13)

Variable y_0(Seismic)' Calculation (Used in Eq # 1)

The initial hydrogen concentration (y_o) is added to the trapped gas contribution (TG) to determine the post seismic initial hydrogen concentration, y_0(Seismic)':

Eq. # 11 $y_0(\text{Seismic})' = y_0 + TG$

y_0 shall be calculated using Equation # 3. y_0(Seismic)' shall be substituted into Equation # 1 to determine the time to LFL. The time to LFL shall be greater than or equal to seven days to satisfy the requirement inherent to the purpose of determining the quiescent time.

VARIABLE TG CALCULATION (USED IN EQ # 11)

Upon depletion of the hydrogen inventory due to pump agitation, the trapped gas inventory is a function of time (i.e., at time equal zero, the trapped gas inventory equals zero) until the maximum inventory is retained per the trapped gas methodology in the DSA, Section 3.4.1.5.3.

The following equation demonstrates the time dependence of the trapped hydrogen inventory:

Eq. # 12 $$G_s * H * C = \frac{(H_R/100) * Q_{H2} * t}{V_{solids}}$$

Where t = time (in hours), Q_{H2} is the temperature corrected hydrogen generation rate defined in Section 6.1.1 and all other variables are defined in Section 6.2.1. H_R is the percentage of hydrogen generated that is retained in slurried sludge and is consistent with the methodology presented in Reference 2. For waste tanks with slurried sludge depth greater than 90 inches H_R is 100%. For waste tanks with slurried sludge depth less than or equal to 90 inches H_R is 50%. The pressure correction, C, is included in the time dependent hydrogen inventory equation because the hydrogen generation rate already calculates the ambient pressure effects due to the application of the ideal gas law in Section 3.4.1.1.2 of the DSA.

The trapped gas contribution to LFL (Equation # 13) shall then be calculated by substituting Equation # 12 for the hydrogen inventory, $G_s * H * C$.

The following equation is used to determine the vapor space hydrogen concentration as a function of time due to trapped gas release from sludge under post seismic conditions:

Eq. # 13 $$TG = \frac{V_{solids} * \left(\frac{(H_R/100) * Q_{H2} * t}{V_{solids}} \right) * F_R}{Vv'} / C_{LFL}$$

Equation # 13 is substituted into Equation # 11, which provides the initial hydrogen concentration, y_0, for Equation # 1, where Time to LFL shall be greater than, or equal to, seven days. The equations may be rearranged to solve for quiescent time, t, since all other variables are known. TG is expressed in units of % LFL in Equation 13, but may be expressed in units of % hydrogen if Equation 13 is not divided by the C_{LFL}.

6.2.3 Implementation Actions

1. The seismic time to LFL shall be determined using an engineering evaluation or the Waste Characterization System database governed by the Waste Characterization System Administrative Program[11].
2. Planned operations (e.g., waste tank to waste tank transfers) shall be pre-evaluated to determine the impact on the seismic time to LFL for the affected process areas (e.g., sending and receiving tanks) using the Waste Transfer Evaluation and Approval procedure.
3. If the projected numbers of tanks capable of becoming flammable following a seismic event (including the effects of post seismic trapped gas release) within specified time periods are not within the restrictions of the TSR, then the evaluated activity shall not be performed.
4. Small volume water additions greater than 3,000 gallons shall be evaluated and documented prior to introduction into the waste tank.
5. A path forward shall be provided to DOE (addressing the additional risk and recovery time) if a transfer required to mitigate a tank leak causes additional tanks to have the potential to become flammable in less than seven days following a seismic event. Submittal of the path forward is not required prior to initiating the transfer.
6. The Quiescent Time Program quiescent time shall be determined using an engineering evaluation or the Waste Characterization System database to ensure that waste tank mixing devices will be periodically operated to limit the amount of trapped gas that could be released during a seismic event.
7. The Quiescent Time Program quiescent time shall be tracked by Operations to ensure that waste tank mixing devices will be periodically operated to limit the amount of trapped gas that could be released during a seismic event.

6.3 Sludge Hydrogen Release Activities

Hydrogen bubbles can become trapped in the sludge layer over time and subsequently released. The amount of hydrogen released is dependent on the characteristics of the sludge and the release initiator (i.e., agitation source). Trapped hydrogen is assumed to be released from sludge when the sludge is agitated (e.g., slurry pump/mixer operation, seismic event) or from the reduction in static pressure (e.g., free supernate removal).

Insignificant Sludge Mixing Activities

Some activities in waste storage tanks have the potential to disturb limited quantities of sludge. These activities are not considered to result in significant sludge mixing. Examples of these activities are provided in the DSA, Section 3.4.2.11.1, and include the following:

- Rotation of slurry pump turntables
- Sludge sampling
- Inserting tank components below the sludge layer (e.g., riser mining tools, pumps, caissons, etc.)
- Removing tank components from below the sludge layer
- Air blowing transfer jets that have a suction below the sludge layer
- Operating transfer pumps or jets that have a suction below the sludge layer
- Transfers into the waste tank (regardless of downcomer location)
- Flushing of transfer pumps or jets

In general, if activities in waste storage tanks are physically limited by design to disturb a localized region of sludge (i.e., not assumed to release significant quantities of trapped gas), then these activities are judged to involve insignificant sludge mixing.

Air or Steam Sparging

Air or steam sparging activities do not require additional sludge agitation evaluation per the DSA, Section 3.4.1.5.3, because the action that causes the release also serves to mitigate the release (through dilution or purging) and the net effect is insignificant in comparison to other hydrogen release mechanisms.

Free Supernate Removal

Aged settled sludge in waste tanks accumulates radiolytic gas bubbles, which connect into networks as they mature. Ordinarily, these networks release gas slowly by percolation. However, removing free liquid reduces the hydrostatic head, causing the bubbles to expand and release at a rate proportional to the liquid removal rate.

Based on the hydrogen release rates in Reference 1 and Reference 25 and a maximum transfer rate of 250 gpm, the following free supernate removal activities are prohibited [1]:

- Waste transfers (including siphon potential) associated with free supernate removal from a Type III/IIIA settled sludge tank with a sludge –inventory greater than 250 inches when the tank is classified as a Slow Generation Tank.

- Waste transfers (including siphon potential) associated with free supernate removal from a settled sludge tank with a sludge inventory greater than 80 inches when the tank is classified as a Very-Slow Generation Tank.

6.3.1 Sludge Agitation Gas Release Mode Evaluation

Prior to planned sludge agitation, an initial evaluation shall be performed to determine whether entry into the Gas Release mode will be required. When this initial evaluation shows that the release of hydrogen due to agitation will not cause the vapor space to exceed the following gas release criteria (assuming all trapped gas in the tank sludge is released and accounting for atmospheric breathing only), no specific controls regarding planned sludge agitation are required (other than Routine Flammability Controls)[2]:

- Become flammable in less than 7 days for a tank classified as a Rapid Generation Tank (due to trapped gas release plus radiolytic hydrogen generation)
- Become flammable in less than 28 days for a tank classified as a Slow Generation Tank (due to trapped gas release plus radiolytic hydrogen generation)
- Become flammable for a tank classified as a Very-Slow Generation Tank (due to trapped gas release plus radiolytic hydrogen generation)
- Exceed 60% of the LFL (due only to trapped gas release)

Tanks may be reclassified, based on the engineering evaluation, to meet the above criteria[2]. For example, an evaluation determines that, for a Slow Generation Tank, the assumed trapped gas release from the planned sludge agitation results in reaching 50% of the LFL and the subsequent radiolytic hydrogen production causes the tank to reach the LFL in 25 days. This tank would be required to have Gas Release Mode controls (e.g., interlocks, etc.) unless it is reclassified as a Rapid Generation Tank (with the associated Routine Flammability Controls).

The hydrogen concentration due to trapped gas release is added to the initial concentration to determine the total hydrogen concentration, H_2Total, in the waste tank vapor space due to non seismic agitation:

Eq. # 14 $$H_2Total = H_2Initial + TG$$

Where,

$H_2Initial$ = initial concentration accounting for an adequate number of vapor space turnovers and/or by comparing the tank LFL reading to a reading obtained using a known LFL concentration (see Section 6.3.2)

TG = hydrogen concentration due to trapped gas release (Using Eq. # 8 or Eq. # 13 and inputs provided below)

VARIABLE H_2INITIAL CALCULATION (USED IN EQ # 14)

An adequate number of vapor space turnovers (and/or comparing the tank LFL reading to a reading obtained using a known LFL concentration) establishes the initial hydrogen concentration in the tank vapor space as low as practical (refer to Reference 27 for combination method example). This assumes that the tank is under conditions that do not cause significant hydrogen release (e.g., no incoming jetted transfers or sludge agitation activities) and accounts for only radiolytic generation. Vapor space turnovers (and/or comparing the tank LFL reading to a reading obtained using a known LFL concentration) are not required for the insignificant sludge mixing activities listed in Section 6.3. The time to complete an adequate number of vapor space turnovers is determined based on the best estimate of the actual vapor space volume. The ventilation shall be operable to perform an adequate number of vapor space turnovers with downtime not exceeding 12 cumulative hours from start to completion. A 12 hour downtime will not significantly impact this initial concentration prior to sludge agitation activities because of the conservative assumptions used in the vapor space calculations (e.g., low mixing efficiency, high initial hydrogen concentration). Flammability evaluations should use 2.5% LFL as the initial condition where vapor space turnovers are employed. The required number of vapor space turnovers for each tank will be documented in the ERD[3]. In order to determine the adequate number of vapor space turnovers required to reduce the initial concentration (defined by the safety analysis value) to 2.5% LFL, the methodology of Reference 26 shall be employed (assuming a mixing efficiency of 0.2). However, if additional Facility Manager approval is obtained, vapor space turnovers and/or comparing the tank LFL reading to a reading obtained using a known LFL concentration can be employed to reduce the initial concentration below 2.5% LFL (this will affect the seismic time to LFL and Gas Release Mode evaluation). If the later option is used, the methodology used to determine the flammable vapor concentration shall be consistent with the requirements of Reference 8.

VARIABLE TG CALCULATION (USED IN EQ # 14)

The methodology for determining the vapor space hydrogen concentration due to trapped gas release from sludge under non-seismic conditions is consistent with the methodology presented in the Seismic Flammability Control Program (Eq. # 8 or Eq. # 13). The trapped gas calculation evaluated under equilibrium conditions shall utilize the trapped bubble gas and the hydrogen percent assumptions from Equation # 8 and the Seismic Time to LFL Methodology in Section 6.2.1. For tanks under a quiescent time, the trapped hydrogen inventory is time dependent and can utilize

Equation # 13 and the Seismic Quiescent Time Methodology in Section 6.2.2.

For sludge tanks where water or inhibitor is added, the time for the water or inhibitor to diffuse into the interstitial liquid (5-10 years depending on particle size, density gradients and temperature gradients) is considered so long that the percent hydrogen in trapped gas is assumed to be unchanged; therefore, current chemistry (i.e., chemistry prior to the water/inhibitor addition) may be used to determine the hydrogen concentration in trapped gas for Sludge Agitation Gas Release Mode evaluations.[28]

VARIABLE V_{SOLIDS} (USED IN EQ # 8 OR EQ # 13)

All insoluble solids are considered to be sludge for the purposes of trapped gas retention. The DSA, Section 3.4.1.5.3 and Reference 23 establish the following input for determining the volume of sludge affected due to non seismic agitation:

- All trapped gas in the tank sludge is assumed to be affected during agitation.
- For tanks under a quiescent time program, the sludge is slurried sludge and the entire sludge volume is included in releasing hydrogen.

VARIABLE F_R (USED IN EQ # 8 OR EQ # 13)

For the purposes of initially determining if the sludge agitation activity requires Gas Release Mode controls, the release percentage is assumed to be 100%, per the DSA, Section 3.4.1.5.3.

VARIABLE VV CALCULATION (USED IN EQ # 8 OR EQ # 13)

The HLLCP shall be used to protect the vapor space volume in the initial sludge agitation evaluations to determine if entry into Gas Release Mode will be required (see Eq. # 5).

6.3.2 GAS RELEASE MODE PUMP RUN PROGRAM

For planned sludge agitation activities where the percent LFL could exceed 60% or the minimum time to LFL is not met for the tank classification, based on the guidelines presented for the initial evaluation, the waste tank Gas Release mode shall be declared prior to agitation. Once it is determined that a tank will enter Gas Release Mode, programmatic controls shall be established to ensure that operation of waste tank mixing devices limit the planned release of trapped gases such that the vapor space does not exceed the safety analysis value as designated by the Flammability Control Program. Requirements during slurry pump operation associated with Gas Release mode are documented in Section 3.4.2.11.1 of the DSA.

If the hydrogen inventory accumulated in the sludge between hydrogen depletion activities provides the potential to exceed 60% LFL (or the safety analysis value) upon instantaneous release, a tank must enter gas release mode prior to the hydrogen depletion activity. The ERD shall report the time allowed between hydrogen depletion activities such that gas release mode would not have to be entered. However, once gas release mode is entered, a pump run time will be reported in the ERD so that when pumps are run 60% LFL (or the safety analysis value) will not be exceeded, crediting actual tank conditions. This pump run time can be extended such that it is equal with the seismic q-time, if an evaluation is performed which credits the operational attributes listed in Section 8.0 (all or some combination) to limit hydrogen releases such that the TSR hydrogen concentration limit is not exceeded in the vapor space at any time during the agitation activity. In order to protect the credited slurry pump interlock response to stop the trapped gas release on loss of ventilation in GRM, this evaluation must also limit the pump quiescent time such that a self-propagating trapped gas release will not occur before the seismic quiescent time is reached. This is done by maintaining the gas fraction in sludge to a value less than that retained by Tank 40 prior to a pump-induced self-propagating gas release.[36]

The Gas Release Mode Pump Run Program shall document an evaluation using a similar methodology to the Sludge Agitation Gas Release Mode evaluation (refer to Section 6.3.1); however, several assumptions may be modified once Gas Release Mode is declared; examples are:

- Historical actual hydrogen release rates may be credited
- Actual ventilation may be credited if it is verified in the facility; otherwise, TSR- credited ventilation shall be credited
- Actual vapor space may be credited
- Stepwise hydrogen release may be considered depending on the operational attributes from Section 8.0 (e.g., number of pumps run, pump rotation, pump insertion/disturbance depth, pump speeds and hold times)
- Actual waste temperature may be credited
- Gas retention rates described in Reference 35 may also be credited

6.3.3 Implementation Actions

1. Operation procedures shall address the requirement to perform an adequate number of vapor space turnovers and/or to compare the tank LFL reading to a reading obtained using a known LFL concentration prior to sludge agitation activities.
2. Prior to sludge agitation, an engineering evaluation in WCS shall be performed to determine if Gas Release Mode controls are required.
3. If required, the Gas Release Mode Pump Run Program is implemented to limit the vapor space hydrogen concentration.
4. Prior to free supernate removal from a Type III/IIIA Slow Generation Tank, it shall be verified that the tank does not contain a settled sludge inventory

greater than 250 inches in the Waste Transfer Evaluation and Approval procedure.

5. Prior to free supernate removal from a Very Slow Generation Tank, it shall be verified that the tank does not contain a settled sludge inventory greater than 80 inches in the Waste Transfer Evaluation and Approval procedure.

6.4 Salt Removal Activities

Trapped hydrogen is assumed to be released from salt during salt dissolution, interstitial liquid removal, agitation (e.g., seismic event, slurry pump/mixer operation), or from the reduction in static pressure (e.g., free supernate removal). Salt dissolution is the process of dissolving salt by adding liquid to the tank. Salt dissolution is typically performed by liquid addition alone, although in some cases the liquid addition may be accompanied by slurry pump/mixer operation[2]. Interstitial liquid removal from bulk saltcake is performed by pumping liquid from a well in the saltcake. Removing interstitial liquid will release hydrogen from the saltcake where the interstitial liquid is removed.

Salt removal activities include salt well mining. Salt well mining is the dissolving of a limited amount of salt, usually to allow insertion of equipment such as a pump for interstitial liquid removal. The volume of the well to be mined will determine the amount of hydrogen that can be released. The controls specified for waste tanks undergoing planned salt dissolution also apply to salt well mining.

Insignificant Salt Removal Activities

Some activities in waste storage tanks have the potential to release limited quantities of hydrogen. These activities are not considered to result in significant hydrogen release. Examples of these activities include the following:

- Salt sampling
- Removing tank components from below the salt layer
- Air blowing transfer jets that have a suction below the salt layer
- Transfers into salt tanks with small exposed salt peaks (height and base in inches not feet) / exposed salt on cooling coils and tank wall
- Dilute liquid additions to free supernate over salt cake
- Flushing of equipment in a salt tank including vent demister and reheater
- Lancing
- Sample rinsing
- Filling purge condenser seal leg
- Routine evaporator operations

In general, if activities in waste storage tanks are limited to disturb a limited quantity of salt (e.g., small salt peaks) or dissolve salt with a limited ability to retain hydrogen (e.g., surface salt on cooling coils), then these activities are judged as insignificant salt removal activities.

AIR OR STEAM SPARGING

Air or steam sparging activities do not require additional salt dissolution/ interstitial liquid removal evaluation per the DSA, Section 3.4.1.5.3, because the action that causes the release also serves to mitigate the release (through dilution or purging) and the net effect is insignificant in comparison to other hydrogen release mechanisms.

FREE SUPERNATE REMOVAL

Submerged saltcake in waste tanks accumulate radiolytic gas bubbles, which connect into networks as they mature. Ordinarily these networks release gas slowly by percolation. However, removing free liquid reduces the hydrostatic head, causing the bubbles to expand and release at a rate proportional to the liquid removal rate. At the same time, the tank vapor space volume is increasing due to liquid removal.

Based on the hydrogen release rates in Reference 1 and Reference 25 and a maximum transfer rate of 250 gpm, the following free supernate removal activities are prohibited [1]:

- Waste transfers (including siphon potential) associated with free supernate removal from a Type III/IIIA salt tank with an equivalent saltcake inventory greater than 330 inches when the tank is classified as a Slow Generation Tank.

- Waste transfers (including siphon potential) associated with free supernate removal from a salt tank with an equivalent saltcake inventory greater than 150 inches when the tank is classified as a Very-Slow Generation Tank.

With the exception of the above prohibitions, the minimum time to reach the LFL defined by the tank flammability classification is not impacted as free supernate is removed; therefore, no specific controls (other than the Routine Flammability Controls in DSA Section 3.4.2.11.1) are required during free supernate removal over saltcake[2].

6.4.1 SALT REMOVAL GAS RELEASE MODE EVALUATION

Prior to planned salt removal activities (e.g., salt dissolution with or without agitation, salt mining, interstitial liquid removal), an initial evaluation shall be performed to determine whether entry into the Gas Release mode will be required. When this initial evaluation shows that the release of hydrogen due to salt removal activities will not cause the vapor space to exceed the following gas release criteria (accounting for atmospheric breathing only), no specific controls regarding planned salt removal activities are required (other than Routine Flammability Controls)[2].

- Become flammable in less than 7 days for a tank classified as a Rapid Generation Tank (due to trapped gas release plus radiolytic hydrogen generation)

- Become flammable in less than 28 days for a tank classified as a Slow Generation Tank (due to trapped gas release plus radiolytic hydrogen generation)
- Become flammable for a tank classified as a Very-Slow Generation Tank (due to trapped gas release plus radiolytic hydrogen generation)
- Exceed 60% of the LFL (due to trapped gas release)

Tanks may be reclassified, based on the engineering evaluation, to meet the above criteria.

Using the total vapor space hydrogen concentration equation of the Pump Run Program Initial Evaluation Methodology (Eq. # 14), the hydrogen concentration due to trapped gas release is added to the initial concentration to determine the total hydrogen concentration in the waste tank vapor space due to non seismic trapped gas release.

VARIABLE H_2INITIAL CALCULATION (USED IN EQ # 14)

An adequate number of vapor space turnovers (and/or comparing the tank LFL reading to a reading obtained using a known LFL concentration) establishes the initial hydrogen concentration in the tank vapor space as low as practical (refer to Reference 27 for combination method example). This assumes that the tank is under conditions that do not cause significant hydrogen release (e.g., no incoming jetted transfers or salt removal activities) and accounts for only radiolytic generation. Vapor space turnovers (and/or comparing the tank LFL reading to a reading obtained using a known LFL concentration) are not required for the insignificant salt removal activities listed in Section 6.4. The time to complete an adequate number of vapor space turnovers is determined based on the best estimate of the actual vapor space volume. The ventilation shall be operable to perform an adequate number of vapor space tumoverswith downtime not exceeding 12 cumulative hours from start to completion. A 12 hour downtime will not significantly impact this initial concentration prior to salt removal activities because of the conservative assumptions used in the vapor space calculations (e.g., low mixing efficiency, high initial hydrogen concentration). Flammability evaluations should use 2.5% LFL as the initial condition where vapor space turnovers are employed. The required number of vapor space turnovers for each tank will be documented in the ERD[3]. In order to determine the adequate number of vapor space turnovers required to reduce the initial concentration (defined by the safety analysis value) to 2.5% LFL, the methodology of Reference 26 shall be employed (assuming a mixing efficiency of 0.2). However, if additional Facility Manager approval is obtained, vapor space tumovers and/or comparing the tank LFL reading to a reading obtained using a known LFL concentration can be employed to reduce the initial concentration below 2.5% LFL (this will affect the seismic time to LFL and Gas Release Mode evaluation). If the later option is used, the methodology used to determine the flammable vapor concentration shall be consistent with the requirements of Reference 8.

VARIABLE TG CALCULATION (USED IN EQ # 14)

The methodology for determining the vapor space hydrogen concentration due to trapped gas release from salt under non-seismic conditions is determined using the trapped gas release equation presented in the Seismic Time to LFL Methodology (Eq. # 8).

For tanks where the interstitial liquid has been drained from the salt, there is no pressure correction term (i.e., only atmospheric pressure is exerted on the saltcake).

For salt tanks where water or inhibitor is added, the time for the water or inhibitor to diffuse into the interstitial liquid (5-10 years depending on particle size, density gradients and temperature gradients) is considered so long that the percent hydrogen in trapped gas is assumed to be unchanged; therefore, current chemistry (i.e., chemistry prior to the water/inhibitor addition) shall be used to determine the hydrogen concentration in trapped gas for Salt Removal Gas Release Mode evaluations.[28]

VARIABLE V_{SOLIDS} (USED IN EQ #8)

For salt dissolution, the amount of salt dissolved in the affected tank is equal to the smaller of the total volume of salt in the waste tank or the volume of the dissolution water source tank which will be used for salt dissolution. If the volume of the dissolution water source tank to be used for salt dissolution is used to estimate the volume of salt dissolved, the water source must not have the capability for continuous makeup.

Continuous makeup capability is defined as a dissolution source that is aligned to a makeup source. A single closed manual makeup isolation valve (or a closed pneumatic valve which is seismically qualified to remain closed) to the batch tank is an acceptable means to isolate the source tank from a makeup source.

The trapped hydrogen release percentage for salt dissolution due to slurry pump/mixer operation is 100% of the total saltcake inventory[2].

For interstitial liquid removal, the amount of salt available to liberate hydrogen in the affected tank is the volume of salt above the pump suction elevation. The pump suction elevation must be defined by a technical baseline document governing the pump installation.

For salt well mining, the amount of hydrogen released is equal to the amount of hydrogen trapped in the volume of salt to be mined.

VARIABLE F_R (USED IN EQ #8)

For the purposes of initially determining if the salt removal activity requires Gas Release Mode controls, the release percentage is assumed to be 100%.

VARIABLE VV CALCULATION (USED IN EQ #8)

For salt removal activities, the HLLCPs are used to protect the vapor space volume in the initial salt removal evaluations to determine if entry into Gas Release Mode is required (see Eq. # 5).

6.4.2 GAS RELEASE MODE SALT DISSOLUTION/INTERSTITIAL LIQUID REMOVAL PROGRAM

For planned salt removal activities where the percent LFL could exceed 60% or the minimum time to LFL is not met for the applicable tank's classification, based on the guidelines presented for the initial evaluation, the waste tank Gas Release mode shall be declared prior to salt dissolution/interstitial liquid removal activities. Requirements during salt removal activities associated with Gas Release mode are documented in Section 3.4.2.11.1 of the DSA. Programmatic controls shall be established to ensure that salt dissolution and interstitial liquid removal activities are controlled to limit the planned release of trapped gases such that the vapor space does not exceed the safety analysis value designated by the Flammability Control Program[2].

The Salt Dissolution/Interstitial Liquid Removal Program shall document an evaluation using a similar methodology to the Salt Removal Gas Release Mode evaluation (refer to Section 6.4.1); however, several assumptions may be modified once Gas Release mode is declared; examples are:

- Actual ventilation may be credited if it is verified in the facility; otherwise, TSR-credited ventilation shall be credited
- Actual vapor space may be credited
- Stepwise hydrogen release may be considered depending on the salt removal operational attributes from Section 8.0 (e.g., pump in rate, pump out rate, hydrogen release rate)
- Actual waste temperature may be credited
- Interstitial liquid removal releases trapped gas from the drained portion of saltcake (Reference 38) prior to salt dissolution

6.4.3 IMPLEMENTATION ACTIONS

1. Operations procedures shall address the requirement to perform an adequate number of vapor space turnovers and/or to compare the tank LFL reading to a reading obtained using a known LFL concentration prior to salt removal activities.

2. Prior to salt removal activities, an engineering evaluation shall be performed to determine if Gas Release Mode controls are required.

3. If required, the Gas Release Mode Salt Dissolution/Interstitial Liquid Removal Program is implemented to limit the vapor space hydrogen concentration.

4. Planned operations (e.g., waste tank to waste tank transfers) shall be pre-evaluated to ensure salt dissolution does not occur for the affected process areas (e.g., receiving tanks) in the Waste Transfer Evaluation and Approval procedure, without an engineering evaluation (excluding Insignificant Salt Removal Activities listed in Section 6.4).

5. Planned operations (e.g., waste tank to waste tank transfers) shall be pre-evaluated to ensure interstitial liquid removal does not occur for the affected process areas (e.g., sending tanks) in the Waste Transfer Evaluation and Approval procedure, without an engineering evaluation.

6. Prior to free supernate removal from a Type III/IIIA Slow Generation Tank, it shall be verified that the tank does not contain an equivalent saltcake inventory greater than 330 inches in the Waste Transfer Evaluation and Approval procedure.

7. Prior to free supernate removal from a Very Slow Generation Tank, it shall be verified that the tank does not contain an equivalent saltcake inventory greater than 150 inches in the Waste Transfer Evaluation and Approval procedure.

6.5 TANK FILL LIMITS

Tank fill limits are imposed for each waste tank. The tank fill limit will incorporate the lowest fill limit imposed by all programs of the DSA.

The DSA credits a maximum waste storage tank level for the most restrictive of the following six considerations:

- Level at which the tank would physically overflow (typically through a sidewall penetration) (Ref. 30)
- Level at which the tank wall stresses would exceed a maximum allowed value (limiting for only Type I and II tanks) (Ref. 31,32)
- Level above which it would be physically possible to siphon waste from the tank through the cooling coils (applicable to only Tanks 1 and 2)
- Level of the lowest known tank wall crack for a single-wall waste tank
- Level required to protect flammable transient assumptions for waste tank trapped gas releases (Ref. 33,34)
- Level used to protect Tank Classification (Rapid, Slow, Very Slow)

The Flammability Level establishes the tank level above which the vapor space is credited for time to LFL calculations. The Flammability Level is directly related to the HLLCP setting by the following:

Eq. # 16 Flammability Level = HLLCP + MMW + instrument uncertainty

Where,

Flammability Level = establishes the credited vapor volume used to protect the Tank Classification, in

MMW = maximum missing waste volume divided by the fill factor, in

The adjusted fill factor is applied as an algorithm to reflect varying fill factors that adjust the established tank calibrations as a result of the displaced volume of the support cone in the upper part of the tank, as applicable.[14,15] The nominal fill factor (Ref. 1) may be used to calculate the waste volume. Application of the nominal fill factor in this way is conservative because the fill factor overestimates the waste volume. The instrument uncertainty values are based on the HLLCP setpoint uncertainty calculations (Ref. 16, 17, 18, 19, 20). The HLLCP set point shall be documented in the ERD.

As a result of pre-evolution time to LFL evaluations (e.g., transfers, sludge or salt removal) it may be necessary to change the HLLCP height to protect the desired Tank Classification. In these cases, an engineering evaluation shall document the new HLLCP setting, taking into account maximum missing waste, instrument uncertainty, analytical analysis uncertainty, and any additional margin deemed appropriate to protect the Tank Classification desired. WCS shall be revised with the new HLLCP set point upon completion of the field work.

For saturated salt solutions, the potential for salt-precipitation exists when the temperature is decreased. As the temperature decreases, the solubility of the nitrate and nitrite ion decreases in the liquid phase. This decrease in the concentration of nitrate and nitrite cause the time to LFL to decrease, which may result in the need to lower the HLLCP.

6.5.1 IMPLEMENTATION ACTIONS

1. The most limiting of the maximum fill levels for each individual waste tank shall be determined in the Waste Characterization System, which is governed by the Waste Characterization System Administrative Program[11].
2. WCS shall verify that the HLLCP set point protects the most limiting of the maximum fill levels (accounting for Maximum Missing Waste and instrument uncertainty) for each individual waste tank.
3. Current HLLCP set points shall be documented in the ERD.
4. Proposed HLLCP set points that support planned operations (e.g., waste tank to waste tank transfers) shall be documented by an engineering evaluation.

5. WCS and the ERD shall be updated with the new HLLCP set point after the field work to set the HLLCP at the proposed set point is complete and prior to the planned activity.

6. Tank Farm influents shall be updated monthly in WCS to ensure that the HLLCP is adjusted at the appropriate height in the tank to maintain greater than 7 days to LFL and tank classification.

7. Waste tank to waste tank transfers shall be pre-evaluated in the Waste Transfer Evaluation and Approval procedure.

8. The Waste Tank Structural Integrity Cognizant Engineering function shall maintain a reference document(s) of current overflow limits (all waste tanks), structural integrity limits (all waste tanks), and lowest known leak sites (only for single-wall tanks).

6.6 Waste Tanks Removed From Service

A requirement for tanks in the Removed from Service Mode is that the hydrogen concentration at equilibrium conditions shall be less than 100% of the LFL considering the effects of atmospheric breathing. Using the Flammability Classification Methodology (Eq. # 6), the equilibrium concentration can be calculated. The criteria for meeting the flammability requirements of the Removed from Service Mode are the same for meeting the criteria for meeting the Very Slow Generation requirements, except that Removed from Service tanks shall assume an additional 100,000 gallons of water (allows for the permitted liquid additions described below and rainwater in-leakage) are reduced from the initial vapor space volume existing at the time Removed from Service mode is entered. Best management practice will be to ensure Removed from Service tanks reach equilibrium at less than 95% of the LFL (same best management practice for Very Slow Generation Tanks).

For tanks in the Removed from Service Mode, the amount of trapped gas in the tank solids shall not cause the peak flammable vapor concentration to reach 100% of the LFL, post seismic. Using the Seismic Time to LFL Methodology (Eq. # 7), the post seismic vapor space hydrogen concentration can be determined by adding the hydrogen equilibrium concentration to the post seismic trapped gas release. The vapor space volume shall be based on actual tank parameters and the addition of 100,000 gallons of water. The temperature limit used to reflect varying temperature conditions shall be determined in the individual flammability evaluations based on tank conditions.

Liquid additions to a waste tank that has been designated removed from service are limited to those necessary to[1]:

- Flush equipment (e.g., pumps, jets) as part of removal/installation, and
- Maintain tank chemistry

Waste additions/transfers to or from a waste tank that has been designated as Removed from Service are prohibited. In addition, operation of slurry pumps/mixers is prohibited in removed from service tanks. This includes physical isolation of pressurization sources to any pump/mixer column[1].

6.6.1 Implementation Actions

1. An engineering evaluation shall be performed to ensure the Removed from Service flammability criteria is met, prior to placing a waste storage tank in Removed from Service Mode.

6.7 Compressor Lube Oil Program

The compressor lube oil program ensures that air compressors do not introduce significant flammable vapors (≥5% CLFL) into analyzed spaces (e.g., evaporator pots, evaporator cells, transfer facilities, waste tanks, and waste tank annuli). Reference 37 lists the currently evaluated compressor lubrication oils that can be used in the facility without causing these analyzed vapor spaces to exceed their 5% CLFL requirement. In order to prevent unevaluated compressor lube oils from being used in the facility certain implementation actions have been established to control the introduction of new compressor lube oils within the facility.

6.7.1 Implementation Actions

1. For installed facility compressors, the model work orders for F and H Tank Farm's preventive maintenance shall ensure the use of approved lube oils.
2. For portable compressors, the preventive maintenance program for these compressors shall ensure that only approved lube oils are used. The facility shall ensure that only those compressors serviced under an appropriate PM program are used in the facility.

7.0 Output Documentation

The output documents generated by this PDD shall ensure independent verification or validation of results and conclusions. Output documents include, but are not limited to, calculations, procedures and technical reports.

Calculations issued as output documents shall be confirmed calculations in accordance with the requirements of the E7 Manual, Procedure 2.31. Technical Reports issued as output documents shall comply with the requirements of E7 Manual, Procedure 3.60. Assumptions and recommendations from these reports shall be addressed in the Design Authority Technical Review (DATR) written against the Proposed Activity. Additionally, the output documents will be included in the USQ review process against the Proposed Activity per Manual 11Q, Procedure 1.05.

8.0 Gas Release Mode Best Management Practice

Best management practice will be to limit releases such that the vapor space does not exceed the TSR hydrogen concentration limit (i.e., as documented in the ERD), which accounts for potential organics (5% LFL) and instrument uncertainty according to the designated safety analysis value, by controlling slurry pump (or other mixing device) operation procedures. Additionally, for tanks that require entry into Gas Release Mode, the pump run and interstitial removal/salt dissolution programs will require an alarm setpoint , which considers alarm setpoint increment limitations to ensure the TSR hydrogen concentration limit is not exceeded[2,3]. The TSR hydrogen concentration limit will be designated in the ERD. Once the ERD is approved, this will drive the revision of the Instrument Scaling and Setpoint Document, which will allow implementation of the required indicated hydrogen concentration reading and/or alarm setpoint in the facility. References 4, 5, and 6 provide instrument uncertainty values for a range in various safety analysis values, which are employed to determine the TSR hydrogen concentration limit (i.e., indicated hydrogen reading) and/or alarm setpoint.

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