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Hazard Analysis for In-Tank Spray Leaks

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Abstract: This report documents the results of a preliminary hazard assessment (PHA) covering in-tank spray leaks. The PHA identified eight hazardous conditions, all associated with waste transfers.

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TERMS

AB	Authorization Basis
AC	Administrative Control
AIChE	American Institute of Chemical Engineers
AWF	aging waste facility
CAM	Continuous Air Monitor
Cat	category
Con	consequence
DCRT	Double-Contained Receiver Tank
DST	double-shell tank
Env	environmental
Freq	Frequency
FSAR	Final Safety Analysis Report
GRE	gas release event
Grp	group
HEPA	high efficiency particulate air [filter]
ID	identification
LCO	Limiting Condition for Operation
MAR	Material at Risk
Mit	mitigative
NC	No Controls
PHA	Preliminary Hazards Assessment
Prev	preventive
Rep Acc	representative accident
RPP	River Protection Project
SSC	structures, systems, and components
SST	single-shell tank
SWP	salt well pumping
TSR	Technical Safety Requirement

1.0 INTRODUCTION

1.1 PURPOSE

The River Protection Project (RPP) Authorization Basis (AB) contains controls that address spray leaks in tanks. However, there are no hazardous conditions in the Hazards Database that specifically identify in-tank spray leak scenarios. The purpose of this Hazards Evaluation is to develop hazardous conditions related to in-tank spray leaks for the Hazards Database and to provide more complete coverage of Tank Farm facilities. Currently, the in-tank spray leak is part of the "Spray Leak in Structures or From Waste Transfer Lines" accidents in Section 3.4.2.9 of the Final Safety Analysis Report (FSAR) (CHG, 2000a). The accident analysis for the "Spray Leak in Structure or From Waste Transfer Lines" states the following regarding the location of a possible spray leak:

> *Inside ventilated waste storage tanks (DSTs, DCRTs, and some SSTs). Aerosols could be generated inside a storage tank during a transfer because of a leak from the portion of the transfer pipe inside the tank. The tank ventilation system could help disperse the aerosols to the atmosphere should the vent system HEPA filters fail.*

This Hazards Evaluation also evaluates the controls currently assigned to the spray leak in structure accident and determines the applicability of the controls to the new hazardous conditions. This comparison reviews both the analysis in the FSAR and the controls found in the Technical Safety Requirements (TSRs) (CHG, 2000b). If the new hazardous conditions do not match the analyzed accident conditions and controls, then additional analysis may be required.

This document is not intended to authorize the activity or determine the adequacy of controls; it is only intended to provide information about the hazardous conditions associated with this activity. The Control decision process as defined in the AB will be used to determine the adequacy of controls and whether the proposed activity is within the AB. This hazard evaluation does not constitute an accident analysis.

1.2 BACKGROUND

Pressurized spray releases are a safety concern because they can be an efficient generator of respirable aerosols. Pressurized spray releases inside actively ventilated waste tanks could result from improperly installed pumps or from small holes or cracks in the piping. A spray leak in an actively ventilated tank could generate enough aerosol to load up the HEPA filters with particulate or moisture. If the filters fail, aerosols from the tank are released through an unfiltered pathway and dispersed through the vent stack.

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2.0 DESCRIPTION

The following are potential sources of in-tank spray leaks:

- **Normal Transfers from DCRTs, SSTs, DSTs, and AWF Tanks:** Submersible centrifugal pumps retrieve waste from the tanks. Raising the liquid to the surface by vacuum is not a viable technique due the specific gravity of the fluid and the depth of the liquid below the surface. Thus, the piping from the pump to where it exits the tank is under pressure. A spray leak could develop because of a failed pipe or pipe connection. The connection from the pump discharge to the pipe would normally be submerged and any leaks would not produce a spray.

- **Salt Well Pumping:** Jet pump systems are used for Salt Well Pumping (SWP). The complete salt well system consists of a jet pump and a salt well casing with a stainless steel salt well screen welded to a Schedule 40 carbon steel pipe. There are 24 screen openings (slots) that are approximately 1.27 mm (0.050 in.) wide. The screen is inserted into the tank riser located in the pump pit and extends to near the tank bottom. The transfer piping is located inside the salt well casing and screen. Two pressurized pipes are required to operate the salt well jet pump: one flowing out of the tank and a return flow line. Once the salt well jet pump system is primed and operating, the jet forces liquid to a centrifugal pump in the pump pit. Most of the flow is re-circulated back to the jet, however, only the waste flowing through the salt cake to the pump is injected into the transfer lines. Thus the total flow in the lines to and from the tank can be significantly larger than the flow into the transfer lines.

- **Transfer of Waste Into A Tank:** Normal transfer of liquids or slurries into the tank has the potential of pressurizing the inlet pipe extending into the dome space. The vapor created by the inlet flow is not considered a spray leak, but the result of a planned activity. This section of pipe is relatively short and under normal conditions the pressure in this section of pipe is low. A spray leak would be the result of a blockage in the discharge piping causing a spray through a crack or joint into the dome space.

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3.0 HAZARD IDENTIFICATION AND EVALUATION

The hazards identification and evaluation of in-tank spray leaks used the Preliminary Hazards Analysis (PHA) method. The PHA consisted of a systematic brainstorming process which included the following:

- Identifying potential methods of producing an in-tank spray leak and other variables that could affect in-tank spray leak hazards,
- Postulating hazards associated with in-tank spray leaks,
- Estimating the frequencies and consequences of the hazardous conditions, and
- Identifying the possible mitigative and preventive measures for each postulated hazardous condition.

Table 3-1 provides a listing of process parameters, deviations, and guide words. This table was used as an aid during the PHA process. The American Institute of Chemical Engineers (AIChE) recognizes the PHA process as a creditable method of hazard evaluation. AIChE (1992) describes this process in their publication, "Guidelines for Hazard Evaluation Procedures." A multi-disciplinary team records the results of this brainstorming process using a tabular format. The depth of the PHA is directly related to the experience and knowledge of the participants. A short resume of each team member is included in Appendix A to document the experience and knowledge of the PHA team.

3.1 METHODOLOGY

The PHA team met to develop the raw data. The information was recorded systematically in tabular format. The following sections describe the PHA table structure and details for recording information. The PHA was structured to ensure a systematic and thorough evaluation of the potential hazards. The PHA captured the following information:

- **Item ID:** The item identification (ID); used to record a unique identifier for the hazardous condition.
- **Location/Activity:** Specific point in the system or process where the deviation from the desired condition of a process variable is evaluated.
- **Hazardous Condition:** The hardware failures, operational faults, or conditions that could result in undesired consequences during waste transfer activities.

Table 3-1. Deviation Guide.

Process Variables	Guide Words						
	No, Not, None	**Less, Low, Short**	**More, High, Long**	**Part Of**	**As Well As, Also**	**Other Than**	**Reverse**
Flow	No Flow	Low Rate, Low Total	High Rate, High Total	Missing Ingredient	Misdirection, Impurities	Wrong Material	Backflow
Pressure	Open to Atmosphere	Low Pressure	High Pressure				Vacuum
Temperature	Freezing	Low Temperature	High Temperature				Auto-refrigeration
Level	Empty	Low Level	High Level	Low Interface	High Interface		
Agitation	No Mixing	Poor Mixing	Excessive Mixing	Mixing Interruption	Foaming		Phase Separation
Reaction	No Reaction	Slow Reaction	Runaway Reaction	Partial Reaction	Side Reaction	Wrong Reaction	Decomposition
Time Procedure	Skipped or missing Step	Too Short, Too Little	Too Long, Too Much	Action(s) Skipped	Extra Action(s) (Shortcuts)	Wrong Action	Out of Order, Opposite
Speed	Stopped	Too Slow	Too Fast	Out of Sync		Web or Belt Break	Backward
pH		Low pH	High pH		Additional Acid, Additional Base	Wrong Acid, Wrong Base	
Concentration		Low Concentration	High Concentration	Missing Ingredient		Additional Ingredient	
Viscosity		Low Viscosity	High Viscosity				
Voltage	No Voltage	Voltage Low	Voltage High	Wrong Waveform	Interference Voltage	Wrong Frequency, AC instead of DC DC instead of AC	Wrong Polarity
Current	No Current	Current High	Current Low			Current Fluctuating	Wrong Polarity
Static			Static Charge				
Special	Utility Failure	External Leak	External Rupture	Tube Leak	Tube Rupture	Startup, Shutdown, Maintenance	
Structural Strength	Structural Failure	Less Strength	More Strength				
Shielding		Less Shielding	More Shielding				

- **Candidate Causes:** The causes leading to the Hazardous Condition. Identifying causes is important when determining potential existing engineering and administrative features for significant hazardous conditions as well as potential consequences. In many cases, multiple hardware or operational faults are required to produce a hazardous condition. This column identifies the sequence of hardware and operational faults required to produce the postulated hazardous condition.

- **Material at Risk:** The material which could be released in an associated accident.

- **Immediate Consequence:** The potential consequences that could result from the postulated hazardous condition.

- **Engineered Safety Features:** Existing engineered features (hardware items) identified by the PHA team that have the potential to mitigate or prevent the hazardous condition of concern. The engineered features are candidates for designation as Safety-Significant items for hazardous conditions that pose a significant threat to the health of facility workers and onsite personnel or Safety-Class for hazards that pose a significant threat to offsite individuals. These items should not be construed as being the "official" controls that would eventually be credited in the AB.

- **Administrative Safety Features:** Technical Safety Requirements and other existing controls identified by the PHA team that have the potential to mitigate or prevent the hazardous condition of concern. These items should not be construed as being the "official" administrative features that would eventually be credited in the AB.

- **Consequence Category No Controls (Con Cat NC):** The consequence ranking is a "first cut," qualitative estimate of the safety severity of the consequences assuming no controls are present. The following system is used:

  S0 Negligible safety concerns for the facility worker.

  S1 Potential industrial injury, low radiological or chemical exposure dose consequences to the facility worker.

  S2 Potential significant radiological dose consequences or chemical exposure to onsite workers located outside the facility.

  S3 Potential significant radiological dose consequences or chemical exposure to the offsite population.

- **Frequency Category No Controls (Freq Cat NC):** The frequency category is a "first cut," qualitative estimate of the likelihood of the hazardous condition assuming no controls are present. The following system is used:

  F3 Events that are expected to occur one or more times during the lifetime of the facility, categorized as "anticipated" events. The frequency range associated with this category is less than 1E-02/yr.

F2	Events that could occur during the lifetime of the facility, but with low probability. Such events are categorized as "unlikely" and fall in the range of 1E-04/yr to 1E-02/yr.
F1	Events not expected to occur during the lifetime of the facility, categorized as "extremely unlikely." The frequency range associated with this category is 1E-06/yr to 1E-04/yr.
F0	Events categorized as "beyond extremely unlikely," with a frequency less than 1E-06/yr. Events in this category (such as a meteor strike) are so unlikely they generally do not require special controls.

- **Environmental Category (Env Cat):** The environmental consequence ranking is a "first cut," qualitative estimate of the environmental severity of the hazardous condition assuming no controls are present. The following system is used:

E0	No significant environmental effect outside the facility confinement systems.
E1	Limited environmental discharge of hazardous material outside the facility.
E2	Large environmental discharge of hazardous material within the plant site boundary.
E3	Significant environmental discharges of hazardous material outside the plant site boundary.

- **Remarks:** Miscellaneous observations or clarifying comments for a given item.

3.2 MAJOR ASSUMPTIONS

There was only one assumption developed, namely that a failure of pressurized transfer systems in the tank dome space would produce a spray that creates respirable aerosols.

3.3 EVALUATION

Eight hazardous conditions were identified by the PHA team during the team deliberations; these are presented in Table 3-2. This table includes the Item ID, Location/Activity, Hazardous Condition, Candidate Cause, Material at Risk, Immediate Consequence, Engineered Safety Features, Administrative Safety Features, Consequence Category No Control, Frequency Category No Control, and remarks. Of the eight hazardous conditions identified by the PHA team, seven were qualitatively assigned an S3 (potential offsite) consequence with an F3 (anticipated) frequency. The last was assigned an S1 (potential facility worker) consequence and F3 (anticipated) frequency. The spray leaks identified by the PHA team were caused by either a failed or mis-assembled transfer line during a normal transfer (pumping) out of the tank or due to a mistransfer that pressurizes the line.

Table 3-2. Initial Preliminary Hazards Assessment Hazards Data Table for the In-Tank Spray Leak. (2 sheets)

Item ID	Location/ Activity	Hazardous Condition	Candidate Cause	Material at Risk	Immediate Consequence	Engineered Safety Features	Administrative Safety Features	Cons Cat NC	Freq Cat NC	Remarks
SPLK-1	SST saltwell pumping using a jet pump.	Release of SST liquid aerosol due to equipment failure during tank pumping or due to mistransfer.	Corrosion or crack in the piping.	SST Liquid	Spray leak in saltwell with some escape to tank headspace.	1) Saltwell screen 2) Low pressure pump shutoff	None identified	S1	F3	Could result in a large ammonia leak.
SPLK-2a	SST pumping supernate using a turbine pump in an actively ventilated tank.	Release of SST liquid aerosol due to equipment failure during tank pumping or due to mistransfer.	Corrosion or crack in the piping.	SST Liquid	Spray leak in the tank headspace. HEPA filter is saturated, fails and releases aerosol waste.	1) Stack CAM 2) Low delta pressure ventilation system shutdown.	None identified	S3	F3	Could result in a large ammonia leak.
SPLK-2b	SST pumping supernate using a turbine pump in an actively ventilated tank.	Release of SST liquid aerosol due to equipment failure during tank pumping or due to mistransfer.	Mis-assembled pump	SST Liquid	Spray leak in the tank headspace. HEPA filter is saturated, fails and releases aerosol waste.	1) Stack CAM 2) Low delta pressure ventilation system shutdown	None identified	S3	F3	Could result in a large ammonia leak.
SPLK-3a	Pumping DST/AWF waste	Release of DST aerosol waste into the tank headspace due to equipment failure during tank pumping or due to mistransfer.	Corrosion or crack in the piping.	DST/AWF Liquid	Spray leak in the tank headspace. HEPA filter is saturated, fails and releases aerosol waste.	1) Stack CAM 2) Low delta pressure ventilation system shutdown 3) De-entrainer	None identified	S3	F3	Could result in a large ammonia leak.

Table 3-2. Initial Preliminary Hazards Assessment Hazards Data Table for the In-Tank Spray Leak. (2 sheets)

Item ID	Location/ Activity	Hazardous Condition	Candidate Cause	Material at Risk	Immediate Consequence	Engineered Safety Features	Administrative Safety Features	Cons Cat NC	Freq Cat NC	Remarks
SPLK-3b	Pumping DST/AWF waste.	Release of DST aerosol waste into the tank headspace due to equipment failure during tank pumping or due to mistransfer.	Mis-assembled pump.	DST/AWF Liquid.	Spray leak in the tank headspace. HEPA filter is saturated, fails and releases aerosol waste.	1) Stack CAM 2) Low delta pressure ventilation system shutdown 3) De-entrainer	None identified	S3	F3	Could result in a large ammonia leak.
SPLK-4	Pumping DST/AWF slurry into DST through the slurry distributor.	Release of DST slurry aerosol into the tank headspace due to equipment failure.	Failure of the slurry distributor (crack).	DST/AWF Slurry	Spray leak in the tank headspace. HEPA filter is saturated, fails and releases aerosol waste.	1) Stack CAM 2) Low delta pressure ventilation system shutdown 3) De-entrainer	None identified	S3	F3	Supernate is added to the slurry for pumping.
SPLK-5a	DCRT pumping supernate using a turbine pump in an actively ventilated tank.	Release of DCRT liquid aerosol due to equipment failure during tank pumping.	Corrosion or crack in the piping.	DCRT Liquid	Spray leak in the tank headspace. HEPA filter is saturated, fails and releases aerosol waste.	1) Stack CAM 2) Low delta pressure ventilation system shutdown	None identified	S3	F3	Could result in a large ammonia leak. Pressurization due to mistransfer added during hazard evaluation.
SPLK-5b	DCRT pumping supernate using a turbine pump in an actively ventilated tank.	Release of DCRT liquid aerosol due to equipment failure during tank pumping.	Mis-assembled pump	DCRT Liquid	Spray leak in the tank headspace. HEPA filter is saturated, fails and releases aerosol waste.	1) Stack CAM 2) Low delta pressure ventilation system shutdown	None identified	S3	F3	Could result in a large ammonia leak. Pressurization due to mistransfer added during hazard evaluation.

Subsequent to the PHA team deliberations, additional technical information was developed concerning the consequence of identified spray leaks. The consequence of spray leaks was reanalyzed on a statistical basis and documented in RPP-5667, Rev. 0, *Stochastic Consequence Analysis for Waste Transfer Leaks* (FFS, 2000). The calculated releases for in tank spray leaks show that the offsite and onsite consequences are well below guidelines. Therefore, the consequences for the hazards associated with the in-tank spray leaks may be reduced from S3 and S2 to S1. This is documented in Table 3-3.

Table 3-4 lists the eight spray leak hazardous conditions grouped according to the consequence category. This table lists the Item ID, Hazardous Condition, Frequency Category, and Environmental Category. Note that the Environmental Category was established to mirror the Consequence Category; for example, an S1 consequence would equivocate to an E1 Environmental Consequence.

There are numerous hazardous conditions found in the Hazard Database associated with spray leaks in general and with breaches of containment due to HEPA filter failure. None of these hazards specifically address in-tank spray leaks. However, the hazardous conditions identified for spray leaks in structures and waste transfer lines are closely related to the in-tank spray leak hazards identified in this PHA. For that reason, the in-tank spray leak hazards can be related directly to the accident associated with the existing spray leak hazards, namely the "Spray Leak in Structure From Waste Transfer Lines" accident [Representative Accident (Rep Acc) 15].

Table 3-5 lists the following information for the representative accident and the new hazardous conditions: BIN, Item ID, Material at Risk (MAR), Hazardous Condition, Cause, Initial Frequency Category, Initial Safety Consequence Category, Cause Group, and Representative Accident (Rep Acc).

- **BIN:** A code that describes the release attributes for high Safety Consequences (S2 or S3) and Worker (S1) with anticipated frequency (F3) hazardous conditions.
- **Cause Grp:** Cause Group – An alpha/numeric code used to permit sorting of data by the cause of the hazardous conditions.
- **Rep Acc:** Representative Accident – An alpha/numeric code used to specify the analyzed accident in the FSAR. Only hazardous conditions with high Safety Consequence (S2 or S3) are assigned as representative accidents.

Table 3-6 lists potential preventive and mitigative structures, systems, and components (SSCs) and Technical Safety Requirement (TSR) controls specific to actively ventilated tanks that address the five identified hazardous conditions. This table lists the Item ID, MAR, Hazardous Condition, Cause, Potential Preventive SSCs, Potential Mitigative SSCs, Potential Preventive TSRs, Potential Mitigative TSRs, Remarks, and Consequence Category. The control for actively ventilated tanks is the ventilation stack continuous air monitor (CAM) interlock with permanent or temporary ventilation systems. This control is a limiting condition for operation (LCO) and is described in Section 3.1.4 in "*Tank Waste Remediation System Technical Safety Requirements*" (CHG, 2000b). LCO 3.1.4 provides assurance that the interlock operates during transfers in and out of actively ventilated tanks and during transfers through routes physically connected to actively ventilated tanks. The CAM interlock system is considered a Safety Class SSC.

Table 3-3 Preliminary Hazards Assessment Hazards Data Table for the In-Tank Spray Leak with Updated Consequences. (2 sheets)

Item ID	Location/ Activity	Hazardous Condition	Candidate Cause	Material at Risk	Immediate Consequence	Engineered Safety Features	Administrative Safety Features	Cons Cat NC	Freq Cat NC	Remarks
SPLK-1	SST saltwell pumping using a jet pump.	Release of SST liquid aerosol due to equipment failure during tank pumping or due to mistransfer.	Corrosion or crack in the piping.	SST Liquid	Spray leak in saltwell with some escape to tank headspace.	1) Saltwell screen 2) Low pressure pump shutoff	None identified	S1	F3	Could result in a large ammonia leak.
SPLK-2a	SST pumping supernate using a turbine pump in an actively ventilated tank.	Release of SST liquid aerosol due to equipment failure during tank pumping or due to mistransfer.	Corrosion or crack in the piping.	SST Liquid	Spray leak in the tank headspace. HEPA filter is saturated, fails and releases aerosol waste.	1) Stack CAM 2) Low delta pressure ventilation system shutdown	None identified	S1	F3	Could result in a large ammonia leak.
SPLK-2b	SST pumping supernate using a turbine pump in an actively ventilated tank.	Release of SST liquid aerosol due to equipment failure during tank pumping or due to mistransfer.	Mis-assembled pump.	SST Liquid	Spray leak in the tank headspace. HEPA filter is saturated, fails and releases aerosol waste.	1) Stack CAM 2) Low delta pressure ventilation system shutdown	None identified	S1	F3	Could result in a large ammonia leak.
SPLK-3a	Pumping DST/AWF waste.	Release of DST aerosol waste into the tank headspace due to equipment failure during tank pumping or due to mistransfer.	Corrosion or crack in the piping.	DST/AWF Liquid	Spray leak in the tank headspace. HEPA filter is saturated, fails and releases aerosol waste.	1) Stack CAM 2) Low delta pressure ventilation system shutdown 3) De-entrainer	None identified	S1	F3	Could result in a large ammonia leak.

Table 3-3 Preliminary Hazards Assessment Hazards Data Table for the In-Tank Spray Leak with Updated Consequences. (2 sheets)

Item ID	Location/ Activity	Hazardous Condition	Candidate Cause	Material at Risk	Immediate Consequence	Engineered Safety Features	Administrative Safety Features	Cons Cat NC	Freq Cat NC	Remarks
SPLK-3b	Pumping DST/AWF waste.	Release of DST aerosol waste into the tank headspace due to equipment failure during tank pumping or due to mistransfer.	Mis-assembled pump.	DST/AWF Liquid	Spray leak in the tank headspace. HEPA filter is saturated, fails and releases aerosol waste.	1) Stack CAM 2) Low delta pressure ventilation system shutdown 3) De-entrainer	None identified	S1	F3	Could result in a large ammonia leak.
SPLK-4	Pumping DST/AWF slurry into DST through the slurry distributor.	Release of DST slurry aerosol into the tank headspace due to equipment failure.	Failure of the slurry distributor (crack).	DST/AWF Slurry	Spray leak in the tank headspace. HEPA filter is saturated, fails and releases aerosol waste.	1) Stack CAM 2) Low delta pressure ventilation system shutdown 3) De-entrainer	None identified	S1	F3	Supernate is added to the slurry for pumping.
SPLK-5a	DCRT pumping supernate using a turbine pump in an actively ventilated tank.	Release of DCRT liquid aerosol due to equipment failure during tank pumping.	Corrosion or crack in the piping.	DCRT Liquid	Spray leak in the tank headspace. HEPA filter is saturated, fails and releases aerosol waste.	1) Stack CAM 2) Low delta pressure ventilation system shutdown	None identified	S1	F3	Could result in a large ammonia leak.
SPLK-5b	DCRT pumping supernate using a turbine pump in an actively ventilated tank.	Release of DCRT liquid aerosol due to equipment failure during tank pumping.	Mis-assembled pump.	DCRT Liquid	Spray leak in the tank headspace. HEPA filter is saturated, fails and releases aerosol waste.	1) Stack CAM 2) Low delta pressure ventilation system shutdown	None identified	S1	F3	Could result in a large ammonia leak.

Table 3-4. In-Tank Spray Leak Hazardous Conditions Segregated By Updated Consequence.

Item ID	Hazardous Condition	Cause	Freq Cat	Env Cat
Potentially Significant Facility Worker Consequences (S1)				
SPLK-1	Release of SST liquid aerosol due to equipment failure during tank pumping or due to mistransfer	Release of SST liquid aerosol due to equipment failure during tank pumping	F3	E1
SPLK-2a	Release of SST liquid aerosol due to equipment failure during tank pumping or due to mistransfer	Corrosion or crack in the piping	F3	E1
SPLK-2b	Release of SST liquid aerosol due to equipment failure during tank pumping or due to mistransfer	Mis-assembled pump	F3	E1
SPLK-3a	Release of DST aerosol waste into the tank headspace due to equipment failure during tank pumping or due to mistransfer	Corrosion or crack in the piping	F3	E1
SPLK-3b	Release of DST aerosol waste into the tank headspace due to equipment failure during tank pumping or due to mistransfer	Mis-assembled pump	F3	E1
SPLK-4	Release of DST slurry aerosol into the tank headspace due to equipment failure	Failure of the slurry distributor (crack)	F3	E1
SPLK-5a	Release of DCRT liquid aerosol due to equipment failure during tank pumping	Corrosion or crack in the piping	F3	E1
SPLK-5b	Release of DCRT liquid aerosol due to equipment failure during tank pumping	Mis-assembled pump	F3	E1

Table 3-5. Analyzed Accident for In-Tank Spray Leaks and the Represented Hazardous Conditions.

BIN	Item ID	MAR	Hazardous Condition	Cause	Freq Cat	Con Cat	Cause Grp	Rep Acc
ANALYZED ACCIDENT: Spray Leak in Structure of from Waste Transfer Line								
B-1-a	XS-06-FLOW02	DCRT waste being transferred to Tank 241-SY-102	Release of liquid radioactive waste form DCRT transfer pumping to Tank 241-SY-102 due to spray leak in DCRT pump pit	Pipe failure in DCRT pump pit causing spray leak	F2	S1	D12	15
In-Tank Spray Leak Hazardous Condition								
B-1-a	SPLK-1	SST Liquid	Release of SST liquid aerosol due to equipment failure during tank pumping or due to mistransfer	Corrosion or crack in the piping	F3	S1	D12	15X
B-1-a	SPLK-2a	SST Liquid	Release of SST liquid aerosol due to equipment failure during tank pumping or due to mistransfer	Corrosion or crack in the piping	F3	S1	D12	15X
B-1-a	SPLK-2b	SST Liquid	Release of SST liquid aerosol due to equipment failure during tank pumping or due to mistransfer	Mis-assembled pump	F3	S1	D12	15X
B-1-a	SPLK-3a	DST/AWF Liquid	Release of DST aerosol waste into the tank headspace due to equipment failure during tank pumping or due to mistransfer	Corrosion or crack in the piping	F3	S1	D12	15X
B-1-a	SPLK-3b	DST/AWF Liquid	Release of DST aerosol waste into the tank headspace due to equipment failure during tank pumping or due to mistransfer	Mis-assembled pump	F3	S1	D12	15X
B-1-a	SPLK-4	DST/AWF Slurry	Release of DST slurry aerosol into the tank headspace due to equipment failure	Failure of the slurry distributor (crack)	F3	S1	D12	15X
B-1-a	SPLK-5a	DCRT Liquid	Release of DCRT liquid aerosol due to equipment failure during tank pumping or due to mistransfer	Corrosion or crack in the piping	F3	S1	D12	15X
B-1-a	SPLK-5b	DCRT Liquid	Release of DCRT liquid aerosol due to equipment failure during tank pumping or due to mistransfer	Mis-assembled pump	F3	S1	D12	15X

Table 3-6. Equipment Important to Safety and Controls from the Authorization Basis that Potentially Address In-Tank Spray Leak Hazardous Condition. (3 sheets)

Item ID	MAR	Hazardous Condition	Cause	Potential Preventive SSC	Potential Mitigative SSC	Potential Preventive TSR	Potential Mitigative TSR	Remarks	Con Cat
SPLK-1	SST Liquid	Release of SST liquid aerosol due to equipment failure during tank pumping or due to mistransfer	Corrosion or crack in the piping	De-entrainer; Demister; Exhaust Heater; HEPA Differential Pressure Gage	Ventilation Stack CAM Interlock	Transfer Pump Administrative Lock Procedure Transfer Controls	CAM Interlock Operability; Emergency Preparedness-Response Procedure	Could result in a large ammonia leak. For SST salt well pumping using a jet pump. Transfer Pump Administrative Lock Procedures are preventive for mistransfers.	S1
SPLK-2a	SST Liquid	Release of SST liquid aerosol due to equipment failure during tank pumping or due to mistransfer	Corrosion or crack in the piping	De-entrainer; Demister; Exhaust Heater; HEPA Differential Pressure Gage	Ventilation Stack CAM Interlock	Transfer Pump Administrative Lock Procedure Transfer Controls	CAM Interlock Operability; Emergency Preparedness-Response Procedure	Could result in a large ammonia leak. For SST pumping supernate using a turbine pump in an actively ventilated tank. Transfer Pump Administrative Lock Procedures are preventive for mistransfers.	S1

Table 3-6. Equipment Important to Safety and Controls from the Authorization Basis that Potentially Address In-Tank Spray Leak Hazardous Condition. (3 sheets)

Item ID	MAR	Hazardous Condition	Cause	Potential Preventive SSC	Potential Mitigative SSC	Potential Preventive TSR	Potential Mitigative TSR	Remarks	Con Cat
SPLK-2b	SST Liquid	Release of SST liquid aerosol due to equipment failure during tank pumping or due to mistransfer	Mis-assembled pump	De-entrainer; Demister; Exhaust Heater; HEPA Differential Pressure Gage	Ventilation Stack CAM Interlock	Transfer Pump Administrative Lock Procedure Transfer Controls	CAM Interlock Operability; Emergency Preparedness-Response Procedure	Could result in a large ammonia leak. For SST pumping supernate using a turbine pump in an actively ventilated tank. Transfer Pump Administrative Lock Procedures are preventive for mistransfers.	S1
SPLK-3a	DST/AWF Liquid or Slurry	Release of DST aerosol waste into the tank headspace due to equipment failure during tank pumping or due to mistransfer	Corrosion or crack in the piping	De-entrainer; Demister; Exhaust Heater; HEPA Differential Pressure Gage	Ventilation Stack CAM Interlock	Transfer Pump Administrative Lock Procedure Transfer Controls	CAM Interlock Operability; Emergency Preparedness-Response Procedure	Could result in a large ammonia leak. Pumping DST/AWF waste	S1
SPLK-3b	DST/AWF Liquid or Slurry	Release of DST aerosol waste into the tank headspace due to equipment failure during tank pumping or due to mistransfer	Mis-assembled pump	De-entrainer; Demister; Exhaust Heater; HEPA Differential Pressure Gage	Ventilation Stack CAM Interlock	Transfer Pump Administrative Lock Procedure Transfer Controls	CAM Interlock Operability; Emergency Preparedness-Response Procedure	Could result in a large ammonia leak. Pumping DST/AWF waste	S1

Table 3-6. Equipment Important to Safety and Controls from the Authorization Basis that Potentially Address In-Tank Spray Leak Hazardous Condition. (3 sheets)

Item ID	MAR	Hazardous Condition	Cause	Potential Preventive SSC	Potential Mitigative SSC	Potential Preventive TSR	Potential Mitigative TSR	Remarks	Con Cat
SPLK-4	DST/AWF Slurry	Release of DST slurry aerosol into the tank headspace due to equipment failure	Failure of the slurry distributor (crack)	De-entrainer; Demister; Exhaust Heater; HEPA Differential Pressure Gage	Ventilation Stack CAM Interlock	Transfer Pump Administrative Lock Procedure	CAM Interlock Operability; Emergency Preparedness-Response Procedure	Supernate is added to the slurry for pumping. Pumping DST/AWF slurry into DST through the slurry distributor.	S1
SPLK-5a	DCRT Liquid	Release of DCRT liquid aerosol due to equipment failure during tank pumping	Corrosion or crack in the piping	De-entrainer; Demister; Exhaust Heater; HEPA Differential Pressure Gage	Ventilation Stack CAM Interlock	None identified	CAM Interlock Operability; Emergency Preparedness-Response Procedure	Could result in a large ammonia leak. For SST pumping supernate using a turbine pump in an actively ventilated tank.	S1
SPLK-5b	DCRT Liquid	Release of DCRT liquid aerosol due to equipment failure during tank pumping	Mis-assembled pump	De-entrainer; Demister; Exhaust Heater; HEPA Differential Pressure Gage	Ventilation Stack CAM Interlock	None identified	CAM Interlock Operability; Emergency Preparedness-Response Procedure	Could result in a large ammonia leak. For SST pumping supernate using a turbine pump in an actively ventilated tank.	S1

Administrative Control (AC) 5.12, Transfer Controls, addresses the five hazards caused by the mistransfer of waste which then results in a pressurized transfer line. AC 5.12 requires independent verification of the transfer route to assure the following: the waste is transferred through the proper route, the piping is in place per configuration status controls, correct and OPERABLE pumps are specified, and valves are properly aligned prior to transfer.

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4.0 CONCLUSIONS

The eight hazardous conditions identified in this PHA do not have consequences requiring controls. The consequences were initially established at a higher level during the PHA. However, a subsequent technical study based on a stochastic evaluation of spray leaks (FFS, 2000) found that the consequences for in-tank spray leaks have only facility worker (S1) consequences.

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5.0 REFERENCES

CHG, 2000a, *Tank Waste Remediation System Final Safety Analysis Report*, HNF-SD-WM-SAR-067, Rev. 1-H, CH2M HILL Hanford Group, Inc., Richland, Washington.

CHG, 2000b, *Tank Waste Remediation System Technical Safety Requirements*, HNF-SD-WM-TSR-006, Rev. 1-H, CH2M HILL Hanford Group, Inc., Richland, Washington.

CHG, 2000c, *Hazard Analysis Database Report*, HNF-SD-WM-TI-764, Rev. 2-B, CH2M HILL Hanford Group, Inc., Richland, Washington

FFS, 2000, *Stochastic Consequence Analysis for Waste Transfer Leaks*, RPP-5667, Rev. 0, Fluor Federal Services, Richland, Washington

AIChE, 1992, *Guidelines for Hazard Evaluation Procedures*, American Institute of Chemical Engineers, New York, New York.

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APPENDIX A

PRELIMINARY HAZARDS ASSESSMENT TEAM BIOGRAPHICAL INFORMATION

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APPENDIX A

PRELIMINARY HAZARDS ASSESSMENT TEAM BIOGRAPHICAL INFORMATION

John W. Bloom – BS Chemistry, MS Chemistry; Mr. Bloom has more than 22 years experience in the nuclear industry with 19+ years at the Hanford Site. His experience includes management positions in operations, production control, independent oversight, Standards/Requirement Identification Document development, and 1-1/2 years on the Basis for Interim Operations/Final Safety Analysis Report development team in a lead position. He was the safety lead for the Hanford Tanks Initiative project for two years.

William H. Grams – BS Mining Engineering, MS Mechanical Engineering; Mr. Grams has more than 20 years of experience in the nuclear industry, all of it with the disposal of high and low-level radioactive waste. He has over 15 years of experience at the Hanford Site including authorization basis (AB) assessments of new activities, accident analysis and release calculations, Unreviewed Safety Question screening and determinations, hazard assessments, and AB revisions. Other nuclear related experience includes low-level waste certification, waste management assessments and audits, preparation of characterization requirements for low-level waste, preparation of design requirements for waste tank retrieval systems, and identification of regulatory requirements.

Brian K. Everett – BS in Mechanical Engineering; Mr. Everett has more than 10 years. experience in the nuclear industry in processing, waste storage and handling and transferring of radioactive waste. All ten years of his experience is at the Hanford Site. His current duties include being a cognizant engineer of a double-shell tank farm and over seeing transfer pumps along with other transfer related activities. He also maintains a structural integrity program for double- and single- shell underground storage tanks.

Paul F. Kison - BS in Chemical Engineering. Mr. Kison has more than 33 years of experience in the nuclear industry. His experience includes spent fuel reprocessing, radioactive waste process development, and spent fuel storage systems. He also has experience in program management and application of Induction Heating Stress Improvement technology, and storage, handling and transfer of radioactive liquid wastes and obsolete equipment. He has over 19 years experience at the Hanford Site including PUREX Operations and engineering associated with spent fuel reprocessing, Grout Process engineering, and process/equipment engineering support to Operations and Maintenance for West Tank Farms during storage, transfer, and surveillance of radioactive wastes.

Dan W. Reberger - BS in Chemical Engineering, Mr. Reberger has more than 25 years of experience at the Hanford Site. His experience includes reprocessing of nuclear fuels and the transferring of radioactive liquid wastes. In his current job assignment, he has been Cognizant Engineer for Liquid Waster Transfers in the 200 East Area Tank Farms for approximately 7 years.

Delmer Scott Jr. - BA degree in Political Science and 17 years experience at the Hanford Site, including Reactor Operations; plutonium production and 8 years spent managing different functions of high level waste storage. Relevant experience includes participation in AB control decision boards and AB implementation.

William F. Zuroff - BS from the University of Idaho. Mr. Zuroff has 31 years experience in the nuclear industry. This included engineering, maintenance and operations of DOE operated nuclear reactors. He was with the Naval Nuclear Power Program for 11 years. He has over 14 years of experience at the Hanford Site including design and plant engineering assignments. He has been the Design Authority for Interim Stabilization for 2 years.

APPENDIX B

PRELIMINARY HAZARDS ASSESSMENT PEER REVIEW

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APPENDIX B

PRELIMINARY HAZARDS ASSESSMENT PEER REVIEW

Practice 134 290 1112
Publication Date 22Nov99
Attachment 02 - Sheet 1 of 1

FLUOR DANIEL NORTHWEST

TECHNICAL PEER REVIEWS

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Document Reviewed: RPP-5990 Rev 0
Title: Hazard Evaluation for In-tank Spray Leaks
Author: W.A. Gramo
Date: 5/25/00
Scope of Review: Technical adequacy and accuracy and clarity of presentation

Yes	No*	NA	
[X]	[ ]	[ ] **	Previous reviews complete and cover analysis, up to scope of this review, with no gaps.
[X]	[ ]	[ ]	Problem completely defined.
[X]	[ ]	[ ]	Accident scenarios developed in a clear and logical manner.
[X]	[ ]	[ ]	Necessary assumptions explicitly stated and supported.
[ ]	[ ]	[X]	Computer codes and data files documented.
[ ]	[ ]	[X]	Data used in calculations explicitly stated in document.
[ ]	[ ]	[X]	Data checked for consistency with original source information as applicable.
[ ]	[ ]	[X]	Mathematical derivations checked including dimensional consistency of results.
[ ]	[ ]	[X]	Models appropriate and used within range of validity, or use outside range of established validity justified.
[ ]	[ ]	[X]	Hand calculations checked for errors. Spreadsheet results should be treated exactly the same as hand calculations.
[ ]	[ ]	[X]	Software input correct and consistent with document reviewed.
[ ]	[ ]	[X]	Software output consistent with input and with results reported in document reviewed.
[X]	[ ]	[ ]	Limits/criteria/guidelines applied to analysis results are appropriate and referenced. Limits/criteria/guidelines checked against references.
[ ]	[ ]	[X]	Safety margins consistent with good engineering practices.
[X]	[ ]	[ ]	Conclusions consistent with analytical results and applicable limits.
[X]	[ ]	[ ]	Results and conclusions address all points required in the problem statement.
[X]	[ ]	[ ]	Format consistent with applicable guides or other standards.
[ ]		[X] **	Review calculations, comments, and/or notes are attached.
[X]	[ ]	[ ]	Document approved (for example, the reviewer affirms the technical accuracy of the document).

Tomoko Jensen-otsu (signature)
Tomoko Jensen-otsu — 5/31/00

Reviewer (printed name and signature) — Date

* All "no" responses must be explained below or on an additional sheet.

** Any calculations, comments, or notes generated as part of this review should be signed, dated, and attached to this checklist. The material should be labeled and recorded in such a manner as to be intelligible to a technically qualified third party.

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