5 246

MAR 0 3 2005

ENGINEERING DATA TRANSMITTAL

1. EDT 821664

1A. Page 1 of 1

2. To: (Receiving Organization)	3. From: (Originating Organization)	4. Related EDT No.:
Distribution	Retrieval/Closure Nuclear Safety	N/A
		7. Purchase Order No.: N/A
5. Proj./Prog./Dept./Div.:	6. Design Authority/Resp. Engr./Design Agent:	9. Equip./Component No.:
Demonstration Bulk Vitrification System	J. P. Harris	N/A
		10. System/Bldg./Facility: Tank Farms

8. Originator Remarks:
The purpose of this technical basis report is to support the preliminary documented safety analysis (PDSA) for the demonstration bulk vitrification system (DBVS).

12. Major Assembly Dwg. No.: N/A

13. Permit/Permit Application No.: N/A

11. Receiver Remarks: None

11A. Design Basis Document? ☐ Yes ☒ No

14. Required Response Date: March 2, 2005

15. DATA TRANSMITTED

(A) Item No.	(B) Document/Drawing No.	(C) Sheet No.	(D) Rev. No.	(E) Title or Description of Data Transmitted	(F) Approval Designator	(G) Reason for Transmittal	(H) Originator Disposition	(I) Receiver Disposition
1	RPP-24217	---	0	Technical Basis Report for Large Fire Accidents Involving Aboveground Tanks/Vessels	N/A	1	1	1

16. IMPACTED DOCUMENTS – NON ENGINEERING

Type of Document	Document Number
N/A	N/A

17. IMPACTED DOCUMENTS – ENGINEERING

Type of Document	Document Number
N/A	N/A

18. KEY

Approval Designator (F)	Reason for Transmittal (G)	Disposition (H) & (I)
See TFC-ESHQ-Q-INSP-C-05	1. Approval 2. Review 3. Distribution	1. Approved 2. Approved w/comment 3. Reviewed no comment 4. Reviewed w/comment 5. Disapproved

19. SIGNATURE/DISTRIBUTION

(G) Reason	(H) Disp.	(J) Name (K) Signature (L) Date (M) MSIN	(G) Reason	(H) Disp.	(J) Name (K) Signature (L) Date (M) MSIN
		Originator			
		Design Auth.			
1	1	Resp. Engr. J. P. Harris, S7-90, 3-3-05			
1	1	Resp. Mgr. J. M. Grigsby, S7-90 3/3/05			
		QA N/A			
		IH&S Engr. N/A			
		Env. Engr. N/A			
		Checker N/A			

20. DOE APPROVAL (if required)
Ctrl. No. N/A

DISTRIBUTION SHEET

To	From	Page 1 of 1
Distribution	Retrieval/Closure Nuclear Safety	Date 3/2/05
Project Title/Work Order RPP-24217, Technical Basis Report for Large Fire Accidents Involving Aboveground Tanks/Vessels, Rev. 0		EDT No. 821664 ECN No. N/A

Name		MSIN	Text With All Attach.	Text Only	Attach./ Appendix Only	EDT/ECN Only
J. M. Grigsby		S7-90	x			
M. J. Higuera		S7-90	x			
L. J. Kripps	HARD COPY	S7-90	x			
E. C. Heuback		S7-90	x			
A. R. Marchese		S7-90	x			
R. J. Stevens		R2-58	x			
J. P. Harris		S7-90	x			
NS&L Files	HARD COPY	R2-58	x			
DBVS Project Files	HARD COPY	T4-67	x			
Central Files (Original + 1)	HARD COPY	A3-83	x			
ORP						
R. C. Nelson	HARD COPY	H6-60	x			
Jian-Shun Shuen		H6-60	x			
D. H. Irby		H6-60	x			
DOE Reading Room	HARD COPY	H2-53	x			
Hanford Technical Library	HARD COPY	P8-55	x			

Technical Basis Report for Large Fire Accidents Involving Aboveground Tanks/Vessels

Andrew R. Marchese
Richland, WA 99352
U.S. Department of Energy Contract DE-AC27-99RL14047

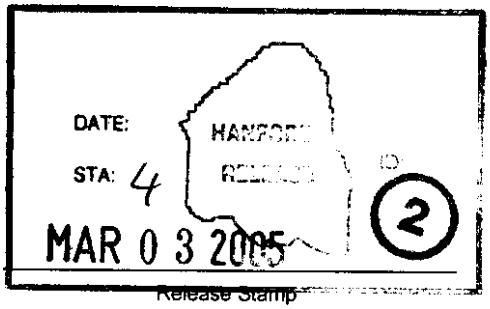
EDT/ECN: 821664 UC: NA
Cost Center: 7G530 Charge Code: 501907
B&R Code: NA Total Pages: 74

Key Words: radiological, toxicological, consequence, fires, vehicle impact, hydraulic fluid, diesel fuel, DBVS, vitrification, risk binning

Abstract: This document analyzes large fire accidents involving aboveground tanks and vessels during DBVS operations. The fire accident scenarios are consistent with RPP-22461, "Preliminary Fire Hazard Analysis (PFHA) for DBVS." The radiological and toxicological consequences are determined for a wide spectrum of fire sizes to bracket the range of possible consequences resulting from large fires involving aboveground tanks/vessels that are part of DBVS.

TRADEMARK DISCLAIMER. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof or its contractors or subcontractors.

Printed in the United States of America. To obtain copies of this document, contact: Document Control Services, P.O. Box 950, Mailstop H6-08, Richland WA 99352, Phone (509) 372-2420; Fax (509) 376-4989.



3/3/05
Release Approval Date

Release Stamp

Approved For Public Release

RPP-24217
Revision 0

Technical Basis Report for Large Fire Accidents Involving Aboveground Tanks/Vessels

A. R. Marchese
CH2M HILL Hanford Group, Inc.

Date Published
March 2005

Prepared for the U.S. Department of Energy
Assistant Secretary for Environmental Management

Contractor for the U.S. Department of Energy
Office of River Protection under Contract DE-AC27-99RL14047

CH2MHILL
Hanford Group, Inc.
P.O. Box 1500
Richland, Washington

Release Approval 3/3/05 Date

CONTENTS

1.0 INTRODUCTION 1-1
1.1 PURPOSE 1-1
1.2 BACKGROUND INFORMATION 1-1
1.2.1 Representative Accident 1-1
1.2.2 Bounding Offsite Accident 1-2
1.2.3 Associated Hazardous Conditions 1-3
1.3 RISK BINNING METHODOLOGY 1-3

2.0 RISK BINNING RESULTS 2-1
2.1 LARGE FIRES INVOLVING ABOVEGROUND TANK/VESSEL ACCIDENTS WITHOUT CONTROLS 2-2
2.1.1 Accident Scenarios 2-2
2.1.2 Frequency Determination 2-3
2.1.3 Consequence Determination 2-3
2.2 CALCULATION RESULTS 2-19
2.2.1 Assignment of Consequence Bins for the Onsite and Offsite Receptors 2-19
2.2.2 Assignment of Environmental Consequences 2-20
2.2.3 Assignment of Risk Bins 2-21

3.0 CONTROL SELECTION 3-1

4.0 REFERENCES 4-1

APPENDICES

A MEETING ATTENDEES ..... A-i

B CALCULATIONS FOR LARGE FIRES INVOLVING ABOVEGROUND TANKS/VESSELS DURING DEMONSTRATION BULK VITRIFICATION SYSTEM OPERATION ..... B-i

C HUMAN FACTORS EVALUATION AND PEER REVIEW CHECKLISTS ..... C-i

LIST OF TABLES

Table 1-1. Offsite (Toxicological Only) Risk Bins. 1-4

Table 1-2. Onsite (100 m) Risk Bins. 1-5

Table 1-3. Environmental Consequence Levels. 1-5

Table 2-1. Summary of Risk Binning Results for Large Fires Involving Aboveground Tank/Vessel Bounding Accidents During Demonstration Bulk Vitrification System Operations. 2-1

Table 2-2. Qualitative Evaluation of Analysis Assumptions for Large Fire During Demonstration Bulk Vitrification System Operations. 2-5

LIST OF TERMS

A	anticipated
AA	analysis assumptions
ARF	airborne release fraction
DBVS	Demonstration Bulk Vitrification System
DR	damage ratio
DSA	documented safety analysis (RPP-13033, *Tank Farms Documented Safety Analysis*)
DST	double-shell tank
ERPG	emergency response planning guideline
HIHTL	hose-in-hose transfer line
L	low
MAR	material at risk
MW	megawatt
NA	not applicable
NFPA	National Fire Protection Association
RF	respirable fraction
SMP	Safety Management Programs
SST	single-shell tank
SSC	structures, systems, and components
SOF	sum of fractions
TEEL	Temporary Emergency Exposure Limit
TSR	technical safety requirement
U	unlikely
ULD	unit-liter dose

This page intentionally left blank.

1.0 INTRODUCTION

1.1 PURPOSE

This technical basis document was developed to support RPP-13033, *Tank Farms Documented Safety Analysis* (DSA), and describes the risk binning process and the technical basis for assigning risk bins for large fires involving aboveground tanks/vessels representative accident and associated represented hazardous conditions. The purpose of the risk binning process is to determine the need for safety-significant structures, systems, and components (SSC) and technical safety requirement (TSR)-level controls for a given representative accident or represented hazardous conditions based on an evaluation of the frequency and consequence. Note that the risk binning process is not applied to facility workers, because all facility worker hazardous conditions are considered for safety-significant SSCs and/or TSR-level controls (see RPP-14286, *Facility Worker Technical Basis Document*). Determination of the need for safety-class SSCs was performed in accordance with DOE-STD-3009-94, *Preparation Guide for U.S. Department of Energy Nonreactor Nuclear Facility Documented Safety Analyses*, as described below.

1.2 BACKGROUND INFORMATION

1.2.1 Representative Accident

Large fires involving aboveground tanks/vessels were not considered to be hazardous conditions for the tank arms and representative accidents were not treated in the original Tank Farms DSA (RPP-13033). Whether this is the case for supplemental treatment projects, such as the Demonstration Bulk Vitrification System (DBVS), needed to be established.

The DBVS project, which is part of the Hanford Supplemental Treatment Project, is intended to supplement the Waste Treatment and Immobilization Plant Low-Activity Waste Plant capacity. The project will determine the feasibility of using bulk vitrification technology to safely and economically produce an immobilized low-activity waste borosilicate glass product that is comparable to Waste Treatment and Immobilization Plant immobilized low-activity waste glass. The Supplemental Treatment Project performs tests using full-scale bulk vitrification equipment and actual Hanford tank waste. The Supplemental Treatment Project has two major systems:

- The Waste Retrieval System will retrieve salt waste, pretreat the waste through selective dissolution and solid/liquid separation, and deliver the waste salt solution to the Demonstration Bulk Vitrification System.
- The DBVS will combine the waste salt solution with glass formers, vitrify the salt/former mixture, and produce a vitrified waste package suitable for disposal in an onsite licensed disposal facility.

The major DBVS subsystems/components, and their functions, include:

- Retrieval - Retrieve salt waste solution from single-shell tank (SST) 241-S-109 using proven retrieval technology, sample and store for analytical verification.
- Feed/Receipt - Receive, sample and store for analytical verification, and feed salt waste solution.
- Waste Dryer Module - Mix salt waste solution with soil and small amounts of zirconia and boria, dry and transfer the mixture to the melt station.
- Melt Station - Using joule heating, melt the mixture to produce borosilicate glass, and confine and direct the off-gas.
- Off-Gas Treatment - Treat off-gas generated during the drying and melting process to remove radionuclides and toxic gases.
- Liquid Effluent - Collect, store and transfer liquid waste to tankers for shipment to the Effluent Treatment Facility.
- Package Interim Storage - Sample finished packages and store until shipment to the disposal facility.

The aboveground tanks/vessels associated with the DVBS are subject to several possible fire scenarios as treated in RPP-22461, *Preliminary Fire Hazard Analysis (PFHA) for the Demonstration Bulk Vitrification System*. The scenarios include a large vehicle diesel fuel spill, a hydraulic oil system failure, and a fuel spill from a boiler diesel fuel tank. Such spills can result from impacts, cracks, leaks, structural degradation, and other failures. These fire scenarios are explained in detail in RPP-22461 and Appendix B of this report. A wide spectrum of potential fire sizes was considered in this analysis to bracket the range of possible consequences resulting from large fires involving aboveground tanks/vessels.

1.2.2 Bounding Offsite Accident

High-energy atmospheric vapor/gas/aerosol release events are bounded by a flammable gas accident that has been qualitatively analyzed for comparison to the DOE-STD-3009-94, Appendix A, "Evaluation Guideline," of 25 rem. The bounding quantitative analysis for a flammable gas accident is documented in RPP-13470, *Offsite Radiological Consequence Analysis for the Bounding Flammable Gas Accident*, and shows that offsite radiological consequences do not challenge the 25 rem evaluation guideline; therefore, no safety-class SSCs or TSR-level controls for protection of the offsite public need to be considered for offsite radiological exposures for any of the high-energy atmospheric vapor/gas/aerosol release events. It is important to note that DOE-STD-3009-94 does not provide any other numerical evaluation guidelines (i.e., evaluation guidelines are not provided for offsite toxicological or onsite radiological and toxicological exposures). These exposures were evaluated for the representative accident and associated hazardous conditions in accordance with the risk binning process described in Section 1.3.

The consequences of the following large fire scenarios were evaluated to coincide with scenarios analyzed in RPP-22461:

- Large vehicle impact and subsequent diesel fuel pool fire near the DBVS waste receipt tanks.
- Hydraulic system reservoir oil spray and pool fire in the DBVS dryer module.
- Failure of the boiler fuel tank and subsequent diesel fuel pool fire near the waste staging area.

Each of the above fire scenarios is assumed to occur near enough to the rubber hose-in-hose-transfer line (HIHTL) resulting in its failure due to the high temperatures produced by the fires. The failure of the HIHTL results in subsequent drainage of the contents of one waste receipt tank through the failed transfer line. The spilled waste is then exposed to the burning fire. Additionally, the above fire scenarios cover a significantly wide range of possible fire sizes to determine if any one particular size is bounding in terms of consequences.

The consequences consist of the atmospheric release from the entrainment of aerosol by convective air movement over either that part of the waste pool that is boiled dry, or release of aerosol by that part of the waste pool that is subjected to vigorous boiling due to bubbles breaking the surface of the waste pool. Onsite radiological and onsite and offsite toxicological consequences were conservatively calculated for a range of potential fires, and the details are presented in Appendix B.

1.2.3 Associated Hazardous Conditions

As previously mentioned, whether there is a representative accident in DBVS for large fires involving aboveground tanks/vessels that presented significant risk and resulted in Risk Bin I or II needed to be established. The current hazard evaluation database lists several hazardous conditions that are representative of large fires involving aboveground tank/vessel accidents. Some of these hazardous conditions are similar to those fire accident scenarios treated here, although the initiators and aerosol release paths may be different. They were assigned to the large fire involving an aboveground tank/vessel accident category because these events all involve high-energy atmospheric releases of vapors, gases and aerosols.

1.3 RISK BINNING METHODOLOGY

Direction on risk binning was provided by the U.S. Department of Energy, Office of River Protection (Klein and Schepens, 2003, "Replacement of Previous Guidance Provided by RL and ORP"). Risk binning begins with a qualitative evaluation of the frequency and consequences of the representative accident. Frequency is qualitatively estimated as "anticipated," "unlikely," "extremely unlikely," or "beyond extremely unlikely." Consequences are evaluated for the following receptors and exposures: offsite toxicological, onsite radiological, and onsite toxicological. These consequences are assigned to one of three levels: high, moderate, or low. Based on the frequency and consequence, risk bins (ranging from I to IV) are assigned.

Tables 1-1 and 1-2 show the criteria for assigning the frequency and consequence levels, and the risk bins, which are assigned to the various combinations of frequency and consequence. After the risk binning process is completed for the representative accident, the process is then repeated for the represented hazardous conditions associated with the representative accident.

In accordance with the control selection guidelines in Klein and Schepens (2003), Risk Bin I events require safety-significant SSCs or TSRs, and Risk Bin II events must consider safety-significant SSCs and TSRs. Risk Bin III events are generally protected by the safety management programs (SMP), and Risk Bin IV events do not require additional measures.

Table 1-1. Offsite (Toxicological Only) Risk Bins.

Consequence level (toxicological only[1])	**Event frequency**			
	$<10^{-6}$/yr Beyond extremely unlikely	**10^{-4} to 10^{-6}/yr Extremely unlikely**	**10^{-2} to 10^{-4}/yr Unlikely**	**$>10^{-2}$ to $\leq 10^{-1}$/yr Anticipated**
>ERPG-2 / TEEL-2 (High)	III	II	I	I
>ERPG-1 / TEEL-1 <ERPG-2 / TEEL-2 (Moderate)	IV	III	II	I
< ERPG-1 / TEEL-1 (Low)	IV	IV	III	III

Notes:

[1] Radiological consequences for the offsite receptor are evaluated in accordance with DOE-STD-3009-94, 2002, *Preparation Guide for U.S. Department of Energy Nonreactor Nuclear Facility Documented Safety Analyses*, Change Notice No. 2, Appendix A, U.S. Department of Energy, Washington D.C.

ERPG = emergency response planning guideline.
SSC = structures, systems, and components.
TEEL = Temporary Emergency Exposure Limit.
TSR = technical safety requirement.

Table 1-2. Onsite (100 m) Risk Bins.

Consequence level (radiological/ toxicological)	Event frequency			
	$<10^{-6}$/yr Beyond extremely unlikely	10^{-4} to 10^{-6}/yr Extremely unlikely	10^{-2} to 10^{-4}/yr Unlikely	$>10^{-2}$ to $\leq 10^{-1}$/yr Anticipated
>100 rem >ERPG-3 / TEEL-3 (High)	III	II	I	I
25 to 100 rem >ERPG-2 / TEEL-2 <ERPG-3 / TEEL-3 (Moderate)	IV	III	II	I
<25 rem <ERPG-2 / TEEL-2 (Low)	IV	IV	III	III

Notes:
ERPG = emergency response planning guideline.
SSC = structures, systems, and components.
TEEL = Temporary Emergency Exposure Limit.
TSR = technical safety requirement.

Environmental consequences are also assigned during the risk binning process. There are four levels of environmental consequences (E0, E1, E2, and E3, in order of increasing severity) and these levels are defined in Table 1-3.

Table 1-3. Environmental Consequence Levels.

Category	Definition
E3	Offsite discharge or discharge to groundwater
E2	Significant discharge onsite
E1	Localized discharge
E0	No significant environmental consequence

This page intentionally left blank.

2.0 RISK BINNING RESULTS

A risk binning team meeting was held November 16, 2004, to obtain consensus on the assignment of frequencies, consequences, and risk bins for large fire scenarios involving aboveground tank/vessel conditions that were identified during the design and hazards analysis of the DBVS, including the preliminary fire hazards analysis (RPP-22461). The attendees represented a wide range of expertise in the areas of engineering, licensing, and operations. Appendix A lists the attendees and the organization each attendee represents. (Note the attendance list is labeled "Control Decision Meeting Attendance – Waste Transfer Leaks During DBVS Operations," since it was at this meeting that large fire accident scenarios for DBVS were also discussed.) As is evident from the results presented in Appendix B, the large fire scenarios involving aboveground tanks/vessels during DBVS operations resulted in "low" consequences, and therefore, based on the qualitative evaluation of frequencies as presented below, were assigned to Risk Bin III. After the meeting, the risk binning results were distributed to the Technical Working Group for review and concurrence. The final risk bin results are shown in Table 2-1.

Table 2-1. Summary of Risk Binning Results for Large Fires Involving Aboveground Tank/Vessel Bounding Accidents During Demonstration Bulk Vitrification System Operations.

Postulated accident/ hazardous condition	Frequency	Consequences				Risk bin		
		Onsite radiological	Offsite toxicological	Onsite toxicological	Environmental	Onsite radiological	Offsite toxicological	Onsite toxicological
Large vehicle impact fire	A	L	L	L	E1	III	III	III
Hydraulic system fire	U	L	L	L	E1	III	III	III
Boiler fuel tank spill fire	A	L	L	L	E1	III	III	III

Notes:
A = anticipated.
L = low.
U = unlikely.

2.1 LARGE FIRES INVOLVING ABOVEGROUND TANK/VESSEL ACCIDENTS WITHOUT CONTROLS

2.1.1 Accident Scenarios

Three large fire accident scenarios are analyzed here: large vehicle impact and subsequent diesel fuel pool fire near the DBVS waste receipt tanks, hydraulic system reservoir oil spray and pool fire in the DBVS dryer module, and failure of the boiler fuel tank and subsequent diesel fuel pool fire near the waste staging area. All three fires are assumed to occur near enough to the rubber HIHTL resulting in its failure due to the high temperatures produced by the fires. The failure of the HIHTL results in subsequent drainage of the contents of one waste receipt tank through the failed transfer line.

Large Vehicle Impact Fire. The large vehicle diesel fuel pool fire scenario (see RPP-22461, Section 7.4.1.1) begins with a large truck impacting the block wall surrounding the waste staging tanks resulting in a 100 gal diesel fuel spill and subsequent pool fire. The fire is large enough and creates sufficiently high temperatures to melt, via indirect radiant heating, the rubber HIHTL connected to one waste receipt tank. The scenario continues with the melting of the HIHTL and the spilling of the contents of one waste receipt tank into the fire, where part of the waste volume is heated to boiling and boiled dry by the pools of burning diesel fuel. The large vehicle impact fire is estimated to last about 7 min (RPP-22461).

Hydraulic System Fire. The hydraulic system fire scenario (see RPP-22461, Section 7.4.1.2) begins with a crack or other leak in the hydraulic system pipeline or fittings that causes a spray of hydraulic fluid onto a hot surface of the dryer. Because of the atomized nature of the spray, the hydraulic fluid ignites at a temperature significantly below its flashpoint. The fire grows as the hydraulic fluid continues to be pumped through the crack until flashover occurs and the metal of the structure deforms and collapses. The crack size in the hydraulic system fluid piping continues to expand through the initial phase of the fire until an open-ended rupture of the hydraulic lines occur, spilling hydraulic fluid (800 gal) on the ground, spreading the fire outwards toward the Waste Receipt System, the hydraulic fluid reservoir, and the HIHTL to the waste receipt tank. The scenario continues with the melting of the rubber HIHTL and the spilling of the contents of one waste receipt tank into the fire, where part of the waste volume is heated to boiling and boiled dry by the pools of burning hydraulic oil. The hydraulic system fire is estimated to last about 6 min (RPP-22461). For this scenario, the sensitivity to the involvement of the dried waste inventory contained in the dryer module is also examined because the dryer is expected to structurally collapse.

Boiler Fuel Tank Spill Fire. There is a large 10,000 gal boiler fuel tank that is located about 30 ft from the waste staging tanks. The boiler fuel tank diesel fuel pool fire scenario (see RPP-22461, Section 7.4.1.1) begins with a large vehicle impacting the tank resulting in a 10,000 gal diesel fuel spill and subsequent pool fire. The fire is large enough and creates sufficiently high temperatures to melt via indirect radiant heating the rubber HIHTL connected to one waste receipt tank. The scenario continues with the melting of the HIHTL and the spilling of

the contents of one waste receipt tank into the fire, where all of the waste volume is heated to boiling and part of it is boiled dry by the pools of burning diesel fuel. The large vehicle impact fire is estimated to last about 10 min (RPP-22461).

2.1.2 Frequency Determination

The initiator for both of the diesel fuel fire scenarios described above is an impact of a large vehicle with either a structure near the waste staging tank, or in the case of the boiler fuel tank spill, the diesel fuel tank itself. The vehicle impact causes a rupture, spill and ignition of the diesel fuel contents (either 100 gal in the case of the vehicle's diesel fuel tank, or 10,000 gal in the case of the boiler fuel tank) resulting in a subsequent diesel fuel pool fire. The DBVS hazard evaluation database lists a hazardous condition (ID # BV01-014b) that is representative of a large vehicle impact and subsequent diesel fuel fire near an aboveground tank/vessel accident. Specifically, the hazardous condition is "release of radioactive and hazardous material to the environment from the DBVS waste feed tank due to vehicle impact and subsequent fire." A frequency of "anticipated" was qualitatively assigned to this hazardous condition based on the Department of Transportation statistics that the likelihood that a large vehicle impact will occur during DBVS operations is between 1.0 and 1 x 10^{-2}/yr. Therefore, for both of the diesel fuel fire scenarios described above, a frequency of "anticipated" was qualitatively assigned.

The initiator for the hydraulic system fire scenario is a crack or other leak in the hydraulic system pipeline or fittings that causes a spray of hydraulic fluid onto a hot surface of the dryer. Since no controls are applied at this stage of the analysis process, it is assumed that the hydraulic oil system would be a non-quality level system and prone to leakage. However, the system is new, will be subjected to startup testing, and will operate for a limited amount of time. Additionally, there is a rather tortuous path that the hydraulic fluid spray would have to follow to contact the hot dryer for ignition. The dryer enclosure includes a wall separating the high pressure, potentially atomizing, hydraulic fluid from coming in contact with hot surfaces on the dryer. The flashpoint (500 F) of the hydraulic fluid is considerable above the dryer's exterior surface temperature (250 °F). Additionally, the hydraulic power unit is located external to the dryer enclosure, which means the hydraulic fluid would need to find its way through the dryer enclosure before reaching the hot surfaces of the dryer. For those reasons, a frequency of "unlikely" was qualitatively assigned to this event based on the judgment that there is between a 1 x 10^{-2} and 1 x 10^{-4}/yr likelihood that a leak or crack will develop in the system and the leak will find its way to the dryer and ignite.

2.1.3 Consequence Determination

From the scenarios described in Section 2.1.1, the primary tank/vessel of concern in terms of containing the greatest material at risk (MAR) and being involved in a fire is one waste receipt tank due to failure of the HIHTL. For the hydraulic system fire scenario, the sensitivity to the involvement of the dried waste inventory contained in the dryer module is also examined because the dryer is expected to structurally collapse during the fire. Consequences were determined for the three fire scenario described in Section 2.1.1.

The consequences consist of the atmospheric release from the entrainment of aerosol by convective air movement over either that part of the waste pool that is boiled dry, or release of aerosol by that part of the waste pool that is subjected to vigorous boiling due to bubbles breaking the surface of the waste pool. Onsite radiological and onsite and offsite toxicological consequences were conservatively calculated for this bounding event and are provided in Appendix B.

The calculations presented in Appendix B provide input into the qualitative assessment of consequences, using conservative modeling assumptions documented in Table 2-2. It is important to note that the analysis assumptions listed in Table 2-2 were selected to maximize the calculated consequences of a large fire involving an aboveground tank/vessel accident. It is the combination of conservative assumptions that truly drives the accident consequences. Because conservative analysis assumptions were used and because of the large difference between the calculated radiological and toxicological consequences, sensitivity studies were not conducted on each of the individual input parameters. However, Table 2-2 provides information on each of the assumptions, the potential effect of changes in the assumption on the frequency or consequence level (qualitatively evaluated), and the need to protect the assumptions.

Table 2-2. Qualitative Evaluation of Analysis Assumptions for Large Fire During Demonstration Bulk Vitrification System Operations. (14 sheets)

Analysis assumptions (AA) with references/basis	Assumption type	Sensitivity (frequency/consequence)	Need to protect AA	Protection/ evaluation basis
Large Vehicle Impact Fire				
The large vehicle impact fire is assumed to spread and melt a HIHTL from the waste receipt tank, spilling the working volume of 18,000 gal (68,000 L) from one waste receipt tank onto the ground where part of it (460 L) is estimated (see Section B3.0, Item 5 below) to be boiled dry by the fire.	Reasonably conservative	No anticipated effect on consequence bin. For the large vehicle impact fire scenario, the onsite radiological dose is 0.011 rem, and so the MAR would have to increase by a factor of over 2,000 to raise the consequence bin from low to moderate. The likelihood of increasing the MAR by this amount is highly unlikely. The results for the radiological and toxicological consequences for the large vehicle impact fire scenario are significantly below consequence bin boundaries, such that increases to the volumes used in the analysis would have little impact on the consequence bins assigned.	No	NA
For radiological consequence calculations, the waste receipt tank is assumed to consist of 95% liquid and 5% sludge from SST 241-S-109. The onsite ULD that was calculated for this mixture is 2.3×10^{2} Sv/L for the waste receipt tank (see Appendix B, Section B6.1).	Reasonably conservative.	No anticipated effect on consequence bin. The sludge ULD and the liquid ULD bounds the saltcake ULD from SST 241-S-109. Even if 100% sludge were assumed the radiological consequence bin would remain low. Onsite ULDs for SST 241-S-109 are taken from RPP-5924 and are given as: Waste Type — ULD (Sv/L) SST Liquid — 7.8×10^{1} SST Sludge — 3.1×10^{3}	No	NA

Table 2-2. Qualitative Evaluation of Analysis Assumptions for Large Fire During Demonstration Bulk Vitrification System Operations. (14 sheets)

Analysis assumptions (AA) with references/basis	Assumption type	Sensitivity (frequency/consequence)	Need to protect AA	Protection/ evaluation basis
For toxicological consequence calculations, the waste receipt tank is assumed to contain 95% liquid and 5% solids from SST 241-S-109. The SOFs that were calculated for waste receipt tank mixture are 8.7×10^8 (TEEL-1), 1.3×10^8 (TEEL-2), and 7.8×10^6 (TEEL-3).	Bounding value.	No anticipated effect on consequence bin. The onsite and offsite toxicological consequences are in the low consequence bin with a wide margin (i.e., significantly below the moderate guidelines), so it would take an unrealistic increase in the solids content to increase the consequence bins from low to moderate. A solids content of 3% is the expected value, so 5% is considered reasonably conservative. SOF multipliers for each TEEL for SST 241-S-109 are taken from RPP-8369 and are given as: Waste Type / TEEL-1 / TEEL-2 / TEEL-3 SST Liquid / 7.97×10^8 / 1.18×10^8 / 7.03×10^6 SST Solids / 2.19×10^9 / 3.22×10^8 / 2.30×10^7	No	NA
The ARF of 1.0 E-01 and RF of 1.0 were selected from DOE-HDBK-3010-94, Section 3.3.7, for a large, vigorously burning organic fire that burns to complete dryness. As indicated above, the amount of waste that is boiled dry by this fire is 460 L.	Bounding values.	No anticipated effect on consequence bin. Applicable bounding values from DOE-HDBK-3010-94, Section 3.3.7, were used. If the burning does not proceed to complete dryness, the bounding values for ARF and RF from DOE-HDBK-3010-94, Section 3.3.7, are 3E-02 and 1.0, respectively. This would not change the onsite radiological and the onsite and offsite toxicological consequences, which are already low.	No	NA

Table 2-2. Qualitative Evaluation of Analysis Assumptions for Large Fire During Demonstration Bulk Vitrification System Operations. (14 sheets)

Analysis assumptions (AA) with references/basis	Assumption type	Sensitivity (frequency/consequence)	*Need to* protect AA	*Protection/* evaluation basis
The large vehicle impact fire is modeled as a 30 MW diesel fuel pool fire with an equivalent diameter of about 5.3 m (RPP-22461. From RPP-13482, the values given for a 30 MW (24.3 MW convective part, see Section B3.0, Item 8 below) diesel fire with a 5.3-m diameter and a less than 1-hr duration were used to determine the atmospheric dispersion coefficients for onsite and offsite. The atmospheric dispersion coefficients for the fire are 3.04 E-05 s/m^3 onsite and 1.36 E-06 s/m^3 offsite.	Reasonably conservative.	No anticipated effect on consequence bin. The atmospheric dispersion coefficients are from RPP-13482 and represent the 95th percent overall value for accidents less than 1 hr. The values given for a 30 MW (24.3 MW convective part, see Section B3.0, Item 8 below) diesel fuel fire with a 5.3-m diameter and a less than 1-hr duration were used to determine the atmospheric dispersion coefficients for onsite and offsite consequences. The atmospheric dispersion coefficients used for the large fire are 3.04 E-05 s/m^3 onsite and 1.36 E-06 s/m^3 offsite. Although the fire is not expected to be more energetic (RPP-22461), the above values are conservative, as the χ/Q' values for a larger, more energetic fire would be smaller than the values used. Note that a factor of 10 reduction in the above χ/Q' values for a more energetic fire would not change the onsite radiological and the onsite and offsite toxicological consequences, which are already low. For a factor of 10 increase in the above χ/Q' values for a less energetic fire, the radiological consequence bin, which is already low by a significant margin, would not change. The onsite and offsite toxicological consequence bins would change from low to moderate, assuming the same amount of waste is boiled dry and the duration of the fire stays the same both of which are unrealistic. The atmospheric dispersion coefficients for various sizes (small to moderate) of diesel fuel fires are as follows: Fire / χ/Q' (s/m^3): Onsite / Offsite 1 MW (D = 1.1 m): 5.83 E-4 / 1.03 E-5 10 MW (D = 3.0 m): 6.66 E-5 / 3.42 E-6 24.3 MW (D = 5.3 m): 3.04 E-5 / 1.36 E-6 100 MW (D = 9.6 m): 9.22 E-6 / 4.50 E-7 200 MW (D = 13.6m): 4.42 E-6 / 2.39 E-7	No	NA

Table 2-2. Qualitative Evaluation of Analysis Assumptions for Large Fire During Demonstration Bulk Vitrification System Operations. (14 sheets)

Analysis assumptions (AA) with references/basis	Assumption type	Sensitivity (frequency/consequence)	Need to protect AA	Protection/ evaluation basis
A breathing rate of 3.33×10^{-4} m^3/s was used to determine the radiological consequences. This is the breathing rate associated with light activity (i.e., it is an 8-hr average which assumes 2.5 hr of sitting and 5.5 hr of light exercise) as derived by the International Commission on Radiological Protection (documented in RPP-5924).	Reasonably conservative.	No anticipated effect on consequence bin. A breathing rate associated with light activity is a standard analysis assumption.	No	NA
For toxicological consequence calculations, the duration of the large vehicle impact fire is estimated in RPP-22461 to be about 7 min.	Reasonably conservative.	No anticipated effect on consequence bin. The duration of about 7 min is less than and more conservative than the duration of 15 min, which is suggested based on information presented in HNF-SD-SNF-TI-059 to cover the time over which maximum toxicological releases occur. Both the onsite and offsite toxicological consequences are already in the low bin. It would require about a factor of about 8 decrease in duration of the fire to change both toxicological consequence bins from low to moderate.	No	NA

Table 2-2. Qualitative Evaluation of Analysis Assumptions for Large Fire During Demonstration Bulk Vitrification System Operations. (14 sheets)

Analysis assumptions (AA) with references/basis	Assumption type	Sensitivity (frequency/consequence)	Need to protect AA	Protection/ evaluation basis
Hydraulic System Fire				
The hydraulic fluid fire is assumed to spread and melt a HIHTL from the waste receipt tank, spilling the working volume of 18,000 gal (68,000 L) from one waste receipt tank onto the ground where part of it (1,730 L) is estimated (see Section B3.0, Item 5 below) to be boiled dry by the fire. Additionally, as described in Sections 2.1.1 above and B2.0 and B7.2 below, the sensitivity to the involvement of a full nominal dryer batch (4,740 L of dried waste) is also examined since the dryer is expected to structurally collapse during the hydraulic system fire.	Reasonably conservative	No anticipated effect on consequence bin. For the hydraulic system fire scenario, the onsite radiological dose is 0.0082 rem, and so the MAR would have to increase by a factor of about 3,000 to raise the consequence bin from low to moderate. However, since the hydraulic system fire could involve the contents of the dryer as explained in Sections 2.1.1 above and B2.0 and B7.2 below, the dryer MAR of 4,740 L for the volume of dried waste product was checked for its possible radiological and toxicological release consequences. As shown in Section B7.2.1 below, the radiological onsite dose for release of dryer material was a factor of 500 below the onsite radiological dose corresponding to the case of release of material by boiling dry part of the contents of one waste receipt tank. Also, as shown in Sections B7.2.2 and B7.2.3 below, the onsite and offsite toxicological consequences for release of dryer material were both a factor of about 5 below the onsite and offsite toxicological consequences corresponding to the case of release of material by boiling dry part of the contents of one waste receipt tank. Therefore, the "low" onsite radiological consequence, and the "low" onsite and offsite toxicological consequences for this scenario are considered to be very robust. Furthermore, the likelihood of increasing the MAR beyond what was used in this scenario is considered to be highly unlikely.	No	NA
For radiological consequence calculations, the waste receipt tank and dryer are assumed to consist of 95% liquid and 5% sludge from SST 241-S-109. The onsite ULDs that were calculated for this mixture are 2.3×10^2 Sv/L and 2.8×10^2 Sv/L for the waste receipt tank and dryer, respectively (see Appendix B, Section B6.1 for these calculations).	Reasonably conservative.	No anticipated effect on consequence bin. The sludge ULD and the liquid ULD bounds the saltcake ULD from SST 241-S-109. Even if 100% sludge were assumed the radiological consequence bin would remain low. Onsite ULDs for SST 241-S-109 are taken from RPP-5924 and are given as: Waste Type — ULD (Sv/L) SST Liquid — 7.8×10^1 SST Sludge — 3.1×10^3	No	NA

Table 2-2. Qualitative Evaluation of Analysis Assumptions for Large Fire During Demonstration Bulk Vitrification System Operations. (14 sheets)

Analysis assumptions (AA) with references/basis	Assumption type	*Sensitivity (frequency/consequence)*	Need to protect AA	Protection/ evaluation basis
For toxicological consequence calculations, the waste receipt tank and dryer are assumed to contain 95% liquid and 5% solids from SST 241-S-109. The SOFs that were calculated for waste receipt tank mixture are 8.7×10^8 (TEEL-1), 1.3×10^8 (TEEL-2), and 7.8×10^6 (TEEL-3). The SOFs that were calculated for the dryer mixture are 1.1×10^9 (TEEL-1), 1.6×10^8 (TEEL-2), and 9.5×10^6 (TEEL-3). (See Appendix B, Section B6.2 for these calculations).	Bounding value.	No anticipated effect on consequence bin. The onsite and offsite toxicological consequences are in the moderate bin, so increasing the solids content would not change the consequence bin. It would take an increase in the solids content to 100%, which is completely unrealistic, for the toxicological consequence bins to change. A solids content of 3% is the expected value, so 5% is considered reasonably conservative. SOF multipliers for each TEEL for SST 241-S-109 are taken from RPP-8369 and are given as: Waste Type / TEEL-1 / TEEL-2 / TEEL-3 SST Liquid / 7.97×10^8 / 1.18×10^8 / 7.03×10^6 SST Solids / 2.19×10^9 / 3.22×10^8 / 2.30×10^7	No	NA
The ULDs documented in RPP-5924 are used for estimating radiological consequences. DBVS operations will mix 8,032 kg of liquid waste with enough soil to produce 4,740 L of dried product in the dryer. Accordingly, the ULDs for the dryer mixture are adjusted for the above concentrations.	Reasonably conservative values for SST 241-S-109 used.	No anticipated effect on consequence bins, since this correction factor is only about 24% (or a factor of 1.24). Additionally, although it would be possible to increase the ratio of liquid to soil, undiluted waste is assumed as feed to the dryer even though an overall fresh water dilution factor of 3.37/1 is planned. The amount of waste transferred would have to be increased by almost several orders of magnitude (which exceeds the physical capacity of the dryer) to change the onsite radiological consequence bin from low to moderate (without the use of any dilution water).	No	NA
The SOF multipliers documented in RPP-8369 are used for estimating toxicological consequences, again adjusted for concentration or dilution. DBVS operations will mix 8,032 kg of liquid waste with enough soil to produce 4,740 L of dried product in the dryer. Accordingly, the SOFs for the dryer mixture are adjusted for the above concentrations.	Reasonably conservative values for SST 241-S-109 used.	No anticipated effect on consequence bins, since this correction factor is only about 24% (or a factor of 1.24). Both the onsite and offsite toxicological consequences are already in the low consequence bin, with a wide margin, so it would require a large increase in MAR for the SOF multipliers to change the toxicological consequence bins from low to moderate.	No	NA

Table 2-2. Qualitative Evaluation of Analysis Assumptions for Large Fire During Demonstration Bulk Vitrification System Operations. (14 sheets)

Analysis assumptions (AA) with references/basis	Assumption type	Sensitivity (frequency/consequence)	Need to protect AA	Protection/ evaluation basis
For the part of the waste receipt tank which boils dry (1,730 L), the ARF of 1.0 E-01 and RF of 1.0 were applied from DOE-HDBK-3010-94, Section 3.3.7, for a large, vigorously burning organic fire that burns to complete dryness. Additionally, as previously described, the case of including the dried waste content of the dryer in the fire was examined in Section B7.2 below. The airborne release fraction (6.0 E-03) and respirable fraction (1.0 E-02) for thermal stress on powders with non-reactive compounds from DOE-HDBK-3010-94, Section 4.4.1.1, were applied to the 4,740 L of dried waste in the dryer.	Bounding values.	No anticipated effect on consequence bin. Applicable bounding values from DOE-HDBK-3010-94, Section 3.3.7, were used. If the energy of the fire is directed towards releasing the contents of the dried waste material in the dryer, the airborne release fraction of 6.0 E-03 and respirable fraction of 1.0 E-02 (for thermal stress on powders with non-reactive compounds from DOE-HDBK-3010-94, Section 4.4.1.1), when applied to the 4,740 L of dried waste in the dryer, results in radiological and toxicological consequences that are considerably less than the base case results which are already low by a wide margin.	No	NA

Table 2-2. Qualitative Evaluation of Analysis Assumptions for Large Fire During Demonstration Bulk Vitrification System Operations. (14 sheets)

Analysis assumptions (AA) with references/basis	Assumption type	Sensitivity (frequency/consequence)	Need to protect AA	Protection/ evaluation basis
The hydraulic system fire is modeled as a 154 MW oil spray and pool fire with an equivalent diameter of about 13 m (RPP-22461). From RPP-13482 the values given for a 154 MW (128 MW convective part, see Section B3.0, Item 8 below) oil fire with a 13-m diameter and a less than 1-hr duration were used to determine the atmospheric dispersion coefficients for onsite and offsite. The atmospheric dispersion coefficients for the fire are 6.28 E-06 s/m^3 onsite and 2.95 E-07 s/m^3 offsite.	Reasonably conservative.	No anticipated effect on consequence bin. The atmospheric dispersion coefficients are from RPP-13482 and represent the 95th percent overall value for accidents less than 1 hr. The values given for a 154 MW (128 MW convective part, see Section B3.0, Item below) oil fire with a 13-m diameter and a less than 1-hr duration were used to determine the atmospheric dispersion coefficients for onsite and offsite consequences. The atmospheric dispersion coefficients used for this large fire are 6.28 E-06 s/m^3 onsite and 2.96 E-07 s/m^3 offsite. Although the fire is not expected to be more energetic (RPP-22461), the above values are conservative, as the χ/Q' values for a larger, more energetic fire would be smaller than the values used. Note that a factor of 10 reduction in the above χ/Q' values for a more energetic fire would not change the onsite radiological and the onsite and offsite toxicological consequence bins, which are already low by a significant margin., but would change the toxicological consequence bin from low to moderate for both the onsite and offsite receptors. For a factor of 10 increase in the above χ/Q' values for a less energetic fire, the radiological consequence bin, which is already low by a significant margin, would not change. The onsite and offsite toxicological consequence bins would change from low to moderate, assuming the same amount of waste is boiled dry and the duration of the fire stays the same, both of which are unrealistic. The atmospheric dispersion coefficients for various sizes (moderate to large) of oil fires are as follows: Fire / χ/Q' (s/m^3) — Onsite / Offsite 31 MW (D = 5.8 m): 3.21 E-5 / 1.36 E-6 38 MW (D = 6.5 m): 2.62 E-5 / 1.10 E-6 62 MW (D = 8.3 m): 1.64 E-5 / 7.27 E-7 128 MW (D = 13 m): 6.28 E-6 / 2.95 E-7 1384 MW (D = 39 m): 9.76 E-7 / 1.47 E-7	No	NA

Table 2-2. Qualitative Evaluation of Analysis Assumptions for Large Fire During Demonstration Bulk Vitrification System Operations. (14 sheets)

Analysis assumptions (AA) with references/basis	Assumption type	Sensitivity (frequency/consequence)	Need to protect AA	Protection/ evaluation basis
A breathing rate of 3.33×10^{-4} m^3/s was used to determine the radiological consequences. This is the breathing rate associated with light activity (i.e., it is an 8-hr average which assumes 2.5 hr of sitting and 5.5 hr of light exercise) as derived by the International Commission on Radiological Protection (documented in RPP-5924).	Reasonably conservative.	No anticipated effect on consequence bin. A breathing rate associated with light activity is a standard analysis assumption.	No	NA
For toxicological consequence calculations, the duration of the hydraulic system fire is estimated in RPP-22461 to be about 6 min.	Reasonably conservative.	No anticipated effect on consequence bin. The duration of about 6 min is less than and more conservative than the duration of 15 min, which is suggested based on information presented in HNF-SD-SNF-TI-059 to cover the time over which maximum toxicological releases occur. Both the onsite and offsite toxicological consequences are already in the low bin. It would require about a factor of about 8 decrease in duration of the fire to change both toxicological consequence bins from low to moderate.	No	NA
Boiler Fuel Tank Spill Fire				
The boiler fuel tank spill fire is assumed to spread and melt a HIHTL from the waste receipt tank, spilling the working volume of 18,000 gal (68,000 L) from one waste receipt tank onto the ground where all of it is subjected to vigorous boiling and part of it (14,500 L) is estimated (see Section B3.0, Item 5 below) to be boiled dry by the fire.	Reasonably conservative	No anticipated effect on consequence bin. For the boiler fuel tank spill fire scenario, the onsite radiological dose is 0.0093 rem, and so the MAR would have to increase by a factor of about 2,700 to raise the consequence bin from low to moderate. The likelihood of increasing the MAR by this amount is highly unlikely. The results for the radiological and toxicological consequences for the boiler fuel tank spill fire scenario are significantly below consequence bin boundaries, such that increases to the volumes used in the analysis would have little impact on the consequence bins assigned.	No	NA

Table 2-2. Qualitative Evaluation of Analysis Assumptions for Large Fire During Demonstration Bulk Vitrification System Operations. (14 sheets)

Analysis assumptions (AA) with references/basis	Assumption type	Sensitivity (frequency/consequence)	Need to protect AA	Protection/ evaluation basis
For radiological consequence calculations, the waste receipt tank is assumed to consist of 95% liquid and 5% sludge from SST 241-S-109. The onsite ULD that was calculated for this mixture is 2.3×10^{2} Sv/L for the waste receipt tank (see Appendix B, Section B6.1).	Reasonably conservative.	No anticipated effect on consequence bin. The sludge ULD and the liquid ULD bounds the saltcake ULD from SST 241-S-109. Even if 100% sludge were assumed the radiological consequence bin would remain low. Onsite ULDs for SST 241-S-109 are taken from RPP-5924 and are given as: Waste Type — ULD (Sv/L) SST Liquid — 7.8×10^{1} SST Sludge — 3.1×10^{3}	No	NA
For toxicological consequence calculations, the waste receipt tank is assumed to contain 95% liquid and 5% solids from SST 241-S-109. The SOFs that were calculated for waste receipt tank mixture are 8.7×10^{8} (TEEL-1), 1.3×10^{8} (TEEL-2), and 7.8×10^{6} (TEEL-3).	Bounding value.	No anticipated effect on consequence bin. The onsite and offsite toxicological consequences are in the low consequence bin with a wide margin (i.e., significantly below the moderate guidelines), so it would take an unrealistic increase in the solids content to increase the consequence bins from low to moderate. A solids content of 3% is the expected value, so 5% is considered reasonably conservative. SOF multipliers for each TEEL for SST 241-S-109 are taken from RPP-8369 and are given as: Waste Type — TEEL-1 — TEEL-2 — TEEL-3 SST Liquid — 7.97×10^{8} — 1.18×10^{8} — 7.03×10^{6} SST Solids — 2.19×10^{9} — 3.22×10^{8} — 2.30×10^{7}	No	NA

Table 2-2. Qualitative Evaluation of Analysis Assumptions for Large Fire During Demonstration Bulk Vitrification System Operations. (14 sheets)

Analysis assumptions (AA) with references/basis	Assumption type	Sensitivity (frequency/consequence)	Need to protect AA	Protection/ evaluation basis
If the waste volume is not boiled dry but subjected to vigorous boiling, the appropriate bounding ARF and RF from DOE-HDBK-3010-94, Section 3.3.7 are 3.0 E-2 are 1.0, respectively. The case was also examined where part of the waste receipt tank contents is boiled dry. For this case, the ARF of 1.0 E-01 and RF of 1.0 were selected from DOE-HDBK-3010-94, Section 3.3.7, for a large, vigorously burning organic fire that burns to complete dryness. As indicated above, the amount of waste that is boiled dry by this fire is 14,500 L.	Bounding values.	No anticipated effect on consequence bin. For the boiler fuel tank spill (10,000 gal of diesel) fire, there is enough energy to subject the entire waste receipt tank contents to vigorous boiling, but not enough energy to boil the entire contents dry. Therefore, it was more conservative to apply the ARF = 0.03 (vigorously boiling but not boiled dry) to the entire content of one waste receipt tank (68,000 L x 0.03 = 2,040 L), rather than apply an ARF = 0.1 to the amount that boils dry (14,500 L), or (0.03 x 14,500 L = 1,450 L). As shown in Section B7.3 below, the onsite radiological and the onsite and offsite toxicological consequences are in the "low" bin by a significant margin, and are therefore, not sensitive to reasonable variations in ARF.	No	NA

Table 2-2. Qualitative Evaluation of Analysis Assumptions for Large Fire During Demonstration Bulk Vitrification System Operations. (14 sheets)

Analysis assumptions (AA) with references/basis	**Assumption type**	***Sensitivity (frequency/consequence)***	**Need to protect AA**	**Protection/ evaluation basis**
The boiler fuel tank spill fire is modeled as a 2,000 MW diesel fuel pool fire with an equivalent diameter of about 43 m (RPP-22461. From RPP-13482 the values given for a 2,000 MW (1,880 MW convective part, see Section B3.0, Item 8 below) diesel fire with a 43-m diameter and a less than 1-hr duration were used to determine the atmospheric dispersion coefficients for onsite and offsite. The atmospheric dispersion coefficients for the fire are 6.04 E-07 s/m^3 onsite and 1.47 E-07 s/m^3 offsite.	Reasonably conservative.	No anticipated effect on consequence bin. The atmospheric dispersion coefficients are from RPP-13482 and represent the 95th *percent overall value for accidents less than 1 hr. The values given* for a 2,000 MW (1,880 MW convective part, see Section B3.0, Item 8 below) diesel fuel fire with a 43-m diameter and a less than 1 hr duration were used to determine the atmospheric dispersion coefficients for onsite and offsite consequences. The atmospheric dispersion coefficients used for the large fire are 6.04 E-07 s/m^3 onsite and 1.47 E-07 s/m^3 offsite. Although the fire is not expected to be more energetic (RPP-22461), the above values are conservative, as the χ/Q' values for a larger, more energetic fire would be smaller than the values used. Note that a factor of 10 reduction in the above χ/Q' values for a more energetic fire would not change the onsite radiological and the onsite and offsite toxicological consequences, which are already low. For a factor of 10 increase in the above χ/Q' values for a less energetic fire, the radiological consequence bin, which is already low by a significant margin, would not change. The onsite and offsite toxicological consequence bins would change from low to moderate, assuming the same amount of waste is subjected to vigorous boiling and the duration of the fire stays the same, both of which are unrealistic. The atmospheric dispersion coefficients for various sizes of large diesel fuel fires are as follows: Fire: 300 MW (D = 17 m) — χ/Q' (s/m^3): Onsite 2.51 E-6, Offsite 1.67 E-7 Fire: 1,000 MW (D = 31 m) — χ/Q' (s/m^3): Onsite 1.08 E-6, Offsite 1.47 E-7 Fire: 1,880 MW (D = 43 m) — χ/Q' (s/m^3): Onsite 6.04 E-7, Offsite 1.47 E-7 Fire: 3,000 MW (D = 54 m) — χ/Q' (s/m^3): Onsite 4.37 E-7, Offsite 1.47 E-7 Fire: 10,000 MW (D =99m) — χ/Q' (s/m^3): Onsite 2.42 E-7, Offsite 1.47 E-7	No	NA

Table 2-2. Qualitative Evaluation of Analysis Assumptions for Large Fire During Demonstration Bulk Vitrification System Operations. (14 sheets)

Analysis assumptions (AA) with references/basis	Assumption type	Sensitivity (frequency/consequence)	Need to protect AA	Protection/ evaluation basis
A breathing rate of 3.33×10^{-4} m^3/s was used to determine the radiological consequences. This is the breathing rate associated with light activity (i.e., it is an 8-hr average which assumes 2.5 hr of sitting and 5.5 hr of light exercise) as derived by the International Commission on Radiological Protection (documented in RPP-5924).	Reasonably conservative.	No anticipated effect on consequence bin. A breathing rate associated with light activity is a standard analysis assumption.	No	NA
For toxicological consequence calculations, the duration of the large boiler fuel tank fire is estimated in RPP-22461 to be about 10 min.	Reasonably conservative.	No anticipated effect on consequence bin. The duration of about 10 min is less than and more conservative than the duration of 15 min, which is suggested based on information presented in HNF-SD-SNF-TI-059 to cover the time over which maximum toxicological releases occur. Both the onsite and offsite toxicological consequences are already in the low bin. It would require about a factor of about 4 decrease in duration of the fire to change both toxicological consequence bins from low to moderate.	No	NA

Table 2-2. Qualitative Evaluation of Analysis Assumptions for Large Fire During Demonstration Bulk Vitrification System Operations. (14 sheets)

Analysis assumptions (AA) with references/basis	Assumption type	Sensitivity (frequency/consequence)	Need to protect AA	Protection/ evaluation basis

Notes:

DOE-HDBK-3010-94, 2000, *Airborne Release Fractions/Rates and Respirable Fractions for Nonreactor Nuclear Facilities*, Change Notice No. 1, U.S. Department of Energy, Washington, D.C.

RPP-5924, 2003, *Radiological Source Terms for Tank Farm Safety Analysis*, Rev. 4, CH2M HILL Hanford Group, Inc., Richland, Washington.

RPP-8369, 2003, *Chemical Source Terms for Tank Farm Safety Analysis*, Rev. 2, CH2M HILL Hanford Group, Inc., Richland, Washington.

RPP-13482, 2005, *Atmospheric Dispersion Coefficients and Radiological and Toxicological Exposure Methodology for Use in Tank Farms*, Rev. 4, CH2M HILL Hanford Group, Inc., Richland, Washington.

RPP-22461, 2005, *Preliminary Fire Hazard Analysis for the Demonstration Bulk Vitrification System*, Rev. 0, CH2M HILL Hanford Group, Inc., Richland, Washington.

HNF-SD-SNF-TI-059, 1999, *A Discussion on the Methodology for Calculating Radiological and Toxicological Consequences for the Spent Nuclear Fuel Project at the Hanford Site*, Rev. 2, Fluor Daniel Northwest, Inc., Richland, Washington.

AA = analysis assumption.
ARF = airborne release fraction.
DBVS = Demonstration Bulk Vitrification System.
HIHTL = hose-in-hose transfer line.
MAR = material at risk.
MW = megawatt
NA = not applicable.
RF = respirable fraction.
SOF = sum-of-fractions.
SST = single-shell tank.
TEEL = Temporary Emergency Exposure Limit.
ULD = unit liter dose.

2.2 CALCULATION RESULTS

2.2.1 Assignment of Consequence Bins for the Onsite and Offsite Receptors

For the large vehicle impact fire involving a spill of 100 gal of diesel fuel, the maximum effects calculated in Appendix B produced estimated onsite radiological consequences of 1.1×10^{-2} rem, onsite toxicological consequences sum of fractions (SOF) of 4.4×10^{-1} (emergency response planning guide [ERPG]-2) and offsite toxicological consequences SOFs of 1.3×10^{-1}(ERPG-1).

In determining the offsite toxicological and onsite radiological and toxicological consequences bins, the risk binning team meeting (held November 16, 2004) participants considered the existing analysis which applied a combination of conservative assumptions to calculate radiological and toxicological consequences. The calculated radiological consequences are low when compared to the guidelines (i.e., the onsite radiological consequence <25 rem), resulting in a consequence bin of "low." The onsite and offsite toxicological consequences (SOFs) are <1 for ERPG-2/Temporary Emergency Exposure Limit (TEEL)-2 and <1 for ERPG-1/TEEL-1, respectively. Therefore, a consequence bin of "low" was assigned to the onsite and offsite toxicological exposures.

For the hydraulic system fire involving the spill of 800 gal of hydraulic fluid, the maximum effects calculated in Appendix B produced estimated onsite radiological consequences of 8.3×10^{-3} rem, onsite toxicological consequences SOFs of 4.0×10^{-1} (ERPG-2) and offsite toxicological consequences SOFs of 1.3 x 10-1 (ERPG-1).

In determining the offsite toxicological and onsite radiological and toxicological consequences bins, the risk binning team meeting participants considered the existing analysis which applied a combination of conservative assumptions to calculate radiological and toxicological consequences. The calculated radiological consequences are low when compared to the guidelines (i.e., the onsite radiological consequence <25 rem), resulting in a consequence bin of "low." The onsite and offsite toxicological consequences (SOFs) are <1 for ERPG-2/TEEL-2 and <1 for ERPG-1/TEEL-1, respectively. Therefore, a consequence bin of "low" was assigned to the onsite and offsite toxicological exposures.

For the boiler fuel tank spill fire involving 10,000 gal of diesel fuel, the maximum effects calculated in Appendix B produced estimated onsite radiological consequences of 9.4×10^{-3} rem, onsite toxicological consequences SOFs of 2.6×10^{-1} (ERPG-2) and offsite toxicological consequences SOFs of 4.2×10^{-1}(ERPG-1).

In determining the offsite toxicological and onsite radiological and toxicological consequences bins, the risk binning team meeting participants considered the existing analysis which applied a combination of conservative assumptions to calculate radiological and toxicological consequences. The calculated radiological consequences are low when compared to the guidelines (i.e., the onsite radiological consequence <25 rem), resulting in a consequence bin of "low." The onsite and offsite toxicological consequences (SOFs) are <1 for ERPG-2/TEEL-2

and <1 for ERPG-1/TEEL-1, respectively. Therefore, a consequence bin of "low" was assigned to the onsite and offsite toxicological exposures.

2.2.2 Assignment of Environmental Consequences

For all three large fire accident scenarios described above, the contents of one waste receipt tank (68,000 L) are considered to be involved in the fires because of failure of the rubber HIHTL. The enclosure surrounding the waste receipt tank is large enough to contain the operating volume of spilled liquid waste. Insofar as the 100 gal of diesel fuel postulated to be involved in the large vehicle impact fire, or the 10,000 gal boiler fuel tank fire, the fire protection program will implement the following features to minimize the diesel fuel pool fire hazards:

- Provide designated parking location for trucks parked adjacent to waste containing aboveground tanks/vessels.
- Ensure parking location is situated at least 10 ft from waste containing aboveground tanks/vessels.
- Either provide a berm or dike between the designated parking location and the waste containing aboveground tanks/vessels or slope the parking surface away from the waste containing aboveground tanks/vessels.
- Remove the truck from operational area when not needed.
- For the 10,000 gal boiler diesel fuel tank, provide secondary containment either through berming or double-walled tank; and install piping per National Fire Protection Association (NFPA) standards, including protection from traffic accidents and other mechanical impacts via installation of bollards or jersey barriers around the tank.

To minimize the hydraulic system fire hazard, the fire protection program will implement the following features:

- Provide secondary containment or diking around the hydraulic reservoir to contain the hydraulic fluid
- Locate hydraulic fluid storage reservoir, which contains 800 gal of hydraulic fluid, at grade level and at least 15 m (50 ft) from critical equipment and filtration systems.

Additionally, the site will employ concrete pads and stone gravel, which, coupled with the above fire protection features, will serve to greatly reduce the amount of waste and fuel that would be released directly to the ground.

Based on the consequence calculations presented in Appendix B, all three fire scenarios involve only localized atmospheric discharges onsite and insignificant atmospheric discharges onsite and offsite. The atmospheric release is from the entrainment of aerosol by convective air movement over that part of the waste pool that is boiled dry, or release of aerosol by that part of the waste pool that is subjected to vigorous boiling due to bubbles breaking the surface of the waste pool.

For all three fire scenarios, it was concluded that there is insignificant potential for material release to the atmosphere either onsite or offsite. Therefore, an environmental consequence of E1 was assigned to all three large fire accident scenarios involving aboveground tanks/vessels analyzed in this report.

2.2.3 Assignment of Risk Bins

The assignment of risk bins is based on Section 1.3, Tables 1-1 and 1-2. As discussed previously, the frequency of the two fires resulting from large vehicle impacts (i.e., fire involving a spill of 100 gal of diesel fuel, and the boiler fuel tank spill fire involving 10,000 gal of diesel fuel) was considered to be in the "anticipated" range. Since the onsite radiological consequence bin is "low," this results in Risk Bin III. Since the onsite and offsite toxicological consequence bins are "low," they are Risk Bin III for both receptors. These risks bins are true for both diesel fuel fires.

Also, as discussed previously, the frequency of the postulated hydraulic system fire involving an aboveground/tank vessel was considered to be in the "unlikely" range. Since the onsite radiological consequence bin is "low," this results in Risk Bin III. Since the onsite and offsite toxicological consequence bins are also "low," they are Risk Bin III for both receptors.

With respect to other aboveground tanks/vessels that are part of DBVS operations and could be subjected to a fire hazard, there is the SST 241-S-109 staging tank, which will be used during the Phase I demonstration of the bulk vitrification process. The staging tank will be an upright, double wall, flat bottom storage tank containing mixed radioactive waste. The 241-S-109 Phase I staging tank is constructed of polyethylene (plastic) with a nominal working volume of 1,100 gal; however, the actual volume of stored waste will be less than 1,100 gal. The tank has a cylindrical geometry with outer diameter and height of 76 in. and 103.5 in., respectively. Because the tank will be located across the access road from the DBVS in the 241-T Tank Farm, the only fire hazard of concern is a large vehicle impact with this tank. The radiological and toxicological consequences will be the same as those for the large vehicle impact fire described above in Section 2.2.1 and in Appendix B, Section B7.1. That is, the onsite radiological and the onsite and offsite toxicological consequences are "low." The frequency of this accident is judged to be "anticipated" (see Section 2.1.2). This combined with the low radiological and toxicological consequences results in Risk Bin III without controls. Accordingly, the same non-safety defense-in-depth SSCs and safety management programs (e.g., vehicle barriers, fire protection safety management program) that will be applied to the large waste staging tanks will also be applied to the 241-S-109 Phase I staging tank to further reduce the residual risk for a large vehicle impact followed by a subsequent diesel fuel pool fire.

This page intentionally left blank.

3.0 CONTROL SELECTION

For large fires involving aboveground tanks/vessels during DBVS operations, Table 2-1 indicates that all three accident scenarios are assigned to Risk Bin III for the onsite receptor due to radiological releases and for the onsite and offsite receptors due to toxicological releases. Because these accidents present limited risk (i.e., Risk Bin III), they require no controls beyond existing SMPs. Therefore, safety significant SSCs and/or TSR-level controls will not be required to prevent or mitigate the releases of hazardous material from large fire accident scenarios involving aboveground tanks/vessels.

This page intentionally left blank.

4.0 REFERENCES

DOE-HDBK-3010-94, 2000, *Airborne Release Fractions/Rates and Respirable Fractions for Nonreactor Nuclear Facilities*, Change Notice No. 1, U.S. Department of Energy, Washington, D.C.

DOE-STD-3009-94, 2002, *Preparation Guide for U.S. Department of Energy Nonreactor Nuclear Facility Documented Safety Analyses*, Change Notice No. 2, U.S. Department of Energy, Washington, D.C.

Klein, K. A. and R. J. Schepens, 2003, "Replacement of Guidance Provided by RL and ORP," (letter 03-ABD-0047/0300642 to E. K. Thompson, Fluor Hanford, Inc., and E. S. Aromi, CH2M HILL Hanford Group, Inc., February 4), U.S. Department of Energy, Hanford Site, Richland, Washington.

RPP-5924, 2003, *Radiological Source Terms for Tank Farms Safety Analysis*, Rev. 4, CH2M HILL Hanford Group, Inc., Richland, Washington.

RPP-8369, 2003, *Chemical Source Terms for Tank Farms Safety Analyses*, Rev. 2, CH2M HILL Hanford Group, Inc., Richland, Washington.

RPP-13033, *Tank Farms Documented Safety Analysis*, as amended, CH2M HILL Hanford Group, Inc., Richland, Washington.

RPP-13470, 2005, *Offsite Radiological Consequence Analysis for the Bounding Flammable Gas Accident*, Rev. 2, CH2M HILL Hanford Group, Inc., Richland, Washington.

RPP-13482, 2005, *Atmospheric Dispersion Coefficients and Radiological and Toxicological Exposure Methodology for Use in Tank Farms*, Rev. 4, CH2M HILL Hanford Group, Inc., Richland, Washington.

RPP-14286, 2003, *Facility Worker Technical Basis Document*, Rev. 1, CH2M HILL Hanford Group, Inc., Richland, Washington.

RPP-14821, 2004, *Technical Basis Document for Defense-In-Depth Features*, Rev. 3, CH2M HILL Hanford Group, Inc., Richland, Washington.

RPP-22461, 2005, *Preliminary Fire Hazard Analysis for the Demonstration Bulk Vitrification System*, Rev. 0, CH2M HILL Hanford Group, Inc., Richland, Washington.

RPP-23429, 2005, *Preliminary Documented Safety Analysis for the Demonstration Bulk Vitrification System*, Rev. 0, CH2M HILL Hanford Group, Inc., Richland, Washington.

HNF-SD-SNF-TI-059, 1999, *A Discussion on the Methodology for Calculating Radiological and Toxicological Consequences for the Spent Nuclear Fuel Project at the Hanford Site*, Rev. 2, Fluor Daniel Northwest, Inc., Richland, Washington.

This page intentionally left blank.

APPENDIX A

MEETING ATTENDEES

This page intentionally left blank.

APPENDIX A

MEETING ATTENDEES

CONTROL DECISION MEETING ATTENDANCE

Meeting Subject: Waste Transfer Leaks during DBVS Operations

Meeting Date: 11/16/04

Name	Organization	Telephone
Bruce Zimmerman	CH2M HILL NS&L	376-7440
Mark Hasty	CH2M HILL Closure Project	373-9378
David Shuford	CH2M HILL DBVS	372-0703
Dick Whitehurst	DMJM	375-7883
Tom May	CH2M HILL	372-2493
John Harris	CH2M HILL NS&L	372-1237
Lawrence J. Kripps	CH2M HILL	376-1061
George Janicek	CH2M HILL - DA	376-2225
D. W. Hamilton	CH2M HILL	376-2425
Pete Dirkmaat	CH2M HILL	(208) 521-9397
John Guberski	CH2M HILL	376-5084
Steve Kozlowski	CH2M HILL	373-1360

This page intentionally left blank.

APPENDIX B

CALCULATIONS FOR LARGE FIRES INVOLVING ABOVEGROUND TANKS/VESSELS DURING DEMONSTRATION BULK VITRIFICATION SYSTEM OPERATION

This page intentionally left blank.

APPENDIX B

CALCULATIONS FOR LARGE FIRES INVOLVING ABOVEGROUND TANKS/VESSELS DURING DEMONSTRATION BULK VITRIFICATION SYSTEM OPERATION

B1.0 INTRODUCTION

The purpose of this appendix is to provide a basis for the qualitative assessment of consequences to be used for risk binning. Consequences are calculated for the radiological and toxicological exposures resulting from accidental release of radioactive or hazardous waste materials due to large fires involving aboveground tanks/vessels during Demonstration Bulk Vitrification System (DBVS) operation.

B2.0 WASTE RETRIEVAL SYSTEM OPERATIONS HAZARDOUS CONDITIONS

The aboveground tanks/vessels associated with the DBVS are subject to several possible fire scenarios as treated in RPP-22461, *Preliminary Fire Hazard Analysis (PFHA) for the Demonstration Bulk Vitrification System*. The scenarios include a large vehicle diesel fuel spill, a hydraulic oil system failure, and a fuel spill from a boiler diesel fuel tank. Such spills can result from impacts, cracks, leaks, structural degradation, and other failures. These fire scenarios are explained in detail in RPP-22461 and are summarized below.

Large Vehicle Impact Fire. (See RPP-22461, Section 7.4.1.1). During operations, over-the-road heavy trucks (i.e., semi or tractor) will be entering and exiting the facility. In several instances, a truck could be traveling near the waste staging area block wall enclosure. One example will be the truck transporting soil to be mixed with the feedstock for final drying and vitrification. The large vehicle diesel fuel pool fire scenario begins with a large truck impacting the block wall surrounding the waste staging tanks resulting in a 100-gal diesel fuel spill and subsequent pool fire. Calculations presented in RPP-22461 indicate that a 100-gal diesel fuel spill could result in a pool fire with a heat rate of about 30 MW, a pool diameter of about 5.3 m, a flame height of about 9 m, and burn for about 7 min.

The fire is large enough and hot enough to melt, via indirect radiant heating, the rubber hose-in-hose transfer line (HIHTL) connected to one waste receipt tank. The scenario continues with the melting of the HIHTL and the spilling of the contents of one waste receipt tank into the fire. Part of the waste volume is heated to boiling and boiled dry (see Section B3.0, Item 5, below) by the pools of burning diesel fuel.

Hydraulic System Fire. (See RPP-22461, Section 7.4.1.2). The dryers for the DBVS may utilize hydraulic fluids to rotate the equipment. The system could have hydraulic systems requiring an 800-gal reservoir and operating at pressures in excess of 1,000 lb/in^2. Factory Mutual Loss Prevention Data Sheet 7-98, *Hydraulic Fluids* (FM 2000), states that:

> When hydraulic oil is released under pressure, the result is an atomized spray or mist of oil droplets that may extend up to 40 ft from the break. The flammable oil spray is ignited readily by hot surfaces, such as heated or molten metal, electric heaters, open flames, or welding arcs. The resulting fire usually is torch-like with a very high rate of heat release.

The hydraulic system fire scenario begins with a crack or other leak in the hydraulic system pipeline or fittings that causes a spray of hydraulic fluid onto a hot surface of the dryer. Because of the atomized nature of the spray, the hydraulic fluid ignites at a temperature significantly below its flashpoint. The fire grows as the hydraulic fluid continues to be pumped through the crack until flashover occurs and the metal of the structure deforms and collapses. The crack size in the hydraulic system fluid piping continues to expand through the initial phase of the fire until an open-ended rupture of the hydraulic lines occur, spilling hydraulic fluid (800 gal) on the ground. Calculations presented in RPP-22461 indicate that an 800-gal hydraulic oil fire (spray followed by pool) would result in a large fire with a heat rate of about 154 MW, a pool diameter of about 13 m, a flame height of about 15 m, and burn for about 6 min.

The fire is large enough to spread outwards toward the Waste Receipt System and the HIHTL, which is connected to one waste receipt tank. The scenario continues with the melting of the rubber HIHTL and the spilling of the contents of one waste receipt tank into the fire, where part of the waste volume is heated to boiling and boiled dry by the pools of burning hydraulic fluid. For this scenario, the sensitivity to the involvement of the dried waste inventory contained in the dryer module is also examined (see Section 2.1.3, Table 2-2, and Section B7.2) since the dryer is expected to structurally collapse. The waste receipt tank contains about eight batches of dryer waste feed. The operations of DBVS are such that when the one waste receipt tank that feeds the dryer is full (i.e., a working volume of 13,170 gal), then the dryer at that time is empty. If the dryer is full with liquid waste (i.e., about 1,650 gal) before drying), then the waste receipt tank would contain that much less waste or about 7/8 of its total capacity. The radiant energy from the fire would go into either boiling dry part of the waste receipt tank contents or thermally lofting the dried waste that spilled from the dryer. It is physically unrealistic to include the entire volumes of both the waste receipt tank and dryer in the fire scenario; however, the sensitivity of the consequences to the release of dried waste from the dryer was examined and results are presented in Section B7.2.

Boiler Fuel Tank Spill Fire. (See RPP-22461, Section 7.4.1.1). There is a large 10,000 gal boiler fuel tank that is located approximately 30 ft from the waste staging tanks. As previously mentioned, over-the-road heavy trucks will be entering and exiting the facility during DBVS operations. In several instances, a truck could be traveling near the boiler fuel tank. The boiler fuel tank spill fire scenario begins with a large truck impacting the boiler fuel tank resulting in a 10,000 gal diesel fuel spill and subsequent pool fire. Calculations presented in RPP-22461 indicate that a 10,000-gal diesel fuel spill could result in a pool fire with a heat rate of about

2,000 MW, a pool diameter of about 43 m, a flame height of about 33 m, and burn for about 10 min.

The fire is large enough and creates sufficiently high temperatures to melt via indirect radiant heating the rubber HIHTL connected to one waste receipt tank. The scenario continues with the melting of the HIHTL and the spilling of the contents of one waste receipt tank into the fire, where all of the waste volume is heated to boiling and part of it is boiled dry (see Section B3.0, Item 5) by the pools of burning diesel fuel.

Accordingly, for the large fire scenarios described above, the primary tank/vessel of concern in terms of containing the greatest material at risk (MAR) and being involved in large fires is one waste receipt tank via failure of the HIHTL.

Consequences were determined for the three large fire scenario described above. Onsite radiological and onsite and offsite toxicological consequences were conservatively calculated. The consequences consist of the atmospheric release from the entrainment of aerosol by convective air movement over either that part of the waste pool that is boiled dry or is already dry (such as dried waste in the dryer), or release of aerosol by that part of the waste pool that is subjected to vigorous boiling due to bubbles breaking the surface of the waste pool and carried aloft by the thermal plume of the fire.

B3.0 ASSUMPTIONS

The following conservative assumptions are considered for all of the large fire scenarios described above:

1. The waste from single-shell tank (SST) 241-S-109 is the only waste processed during DBVS operations.

2. It is assumed that the liquid waste entrains as much as 5 vol% of sludge.

3. The waste receipt tank is assumed to be full to maximize the MAR (given as the full volume of 18,000 gal).

4. The material assumed to be involved in the fire is conservatively assumed to be the contents of one full waste receipt tank (18,000 gal or 68,000 L) due to the fire-induced failure of the HIHTL. For the hydraulic system fire, the sensitivity of the consequences to involving the content of the dryer (i.e., 4740 L of dried waste inventory) in the fire is examined in Section 2.1.3, Table 2-2, and Section B7.2, since the dryer is expected to structurally collapse during the fire.

5. Only the radiant part of the total fire heat rate with an assumed view factor of 0.5 is available to heat the waste pool. From RPP-22461, the total heat rates for the three fire sizes are 30 MW, 154 MW, and 2,000 MW, respectively. From the *SFPE Handbook of Fire Protection Engineering* (Babraskus 2002), the radiative fraction of a pool fire is given by the expression: $0.21 - 0.0034D$, where D is the diameter of the pool in meters and for pool fires with a diameter over 50 m, the value of 50 m should be used in the

expression. For the three fire sizes, the radiative fractions are 0.19, 0.17, and 0.06, respectively. Also from RPP-22461, the duration of each fire is estimated to be about 7 min, 6 min, and 10 min, respectively. Based on the energy required to raise water from room temperature to steam (2,590 J/g) and the radiant energy from the fire reaching the waste pool, it is estimated that for the three fire sizes, 460 L, 1,730 L, and 14,500 L respectively, of the waste receipt tank contents are burned dry by the energy from the fires. For the 10,000 gal diesel fuel fire from the boiler fuel tank, there is sufficient energy to cause vigorous boiling of the entire content of the waste receipt tank. This is not the case for the other two fires. Additionally, as indicated in Item 4 above, the case is examined where the dryer is full (4,470 L) with dried waste material and the one waste receipt tank that is connected to the HIHTL is 7/8 full. It is assumed that the radiant energy part of the 800 gal hydraulic fluid fire goes into thermally lofting the dried waste material that has spilled from the dryer and is not available to dry out a portion of the volume of one waste receipt tank.

6. As alluded to above, the 30 MW fire is composed of a convective part (24.3 MW) and a radiant part (5.7 MW). The radiant part goes into heating up the waste pool and the convective part, as described in Item 8, is used to determine the appropriate atmospheric dispersion coefficient (χ/Q') values. That is, the χ/Q' values are based only on the convective part of the total fire heat release rate. For the 154 MW hydraulic oil fire, the corresponding convective and radiant parts of the total fire heat release rate are 128 MW and 26 MW, respectively. For the 2,000 MW boiler fuel tank spill fire, the corresponding convective and radiant parts of the total fire heat release rate are 1,880 MW and 120 MW, respectively.

7. Values for the airborne release fraction (ARF) and respirable fraction (RF) were selected from the DOE-HDBK-3010-94, *Airborne Release Fractions/Rates and Respirable Fractions for Nonreactor Nuclear Facilities*. For the fire scenarios involving the contents of the waste receipt tank, the ARF and RF for the organic solvent over an aqueous solution were used for the case where the aqueous solution is boiled dry (ARF = 1.0 E-01 and RF = 1.0) (DOE-HDBK-3010-94, Section 3.3.7). However, if the waste volume is not boiled dry but subjected to vigorous boiling, the appropriate bounding ARF and RF from DOE-HDBK-3010-94, Section 3.3.7 are 3.0 E-2 are 1.0, respectively. For the large vehicle impact fire (100 gal of diesel) and hydraulic system fire (800 gal of hydraulic oil), as indicated above, the amount of MAR in the waste receipt tank (68,000 L) that can be boiled dry was estimated. This amount corresponded to 460 L and 1,730 L, respectively, for those two fire scenarios. An ARF = 0.1 (vigorously boiling and boils dry) was then applied to those two fire scenarios assuming that amount of waste collects in a small pool and is boiled dry. For the boiler fuel tank spill (10,000 gal of diesel), there is enough energy to subject the entire waste receipt tank contents to vigorous boiling, but not enough energy to boil the entire contents dry. Therefore, it was more conservative to apply the ARF = 0.03 (vigorously boiling but not boiled dry) to the entire content of one waste receipt tank (68,000 L x 0.03 = 2,040 L), rather than apply an ARF = 0.1 to the amount that boils dry (14,500 L), or (0.03 x 14,500 L = 1,450 L). Additionally, as previously mentioned for the hydraulic system fire, the sensitivity of including dried waste content of the dryer in the fire was examined in Section 2.1.3, Table 2-2. The airborne release fraction (6.0 E-03) and respirable fraction (1.0 E-02) for

thermal stress on powders with non-reactive compounds from DOE-HDBK-3010-94, Section 4.4.1.1, were applied to the 4,740 L of dried waste that has spilled from the dryer.

8. From RPP-22461, large vehicle impact fire is modeled as a 30 MW diesel fuel pool fire with about a 5.3 m diameter. As described in Item 6, the convective part of the total fire heat release rate, which is used to establish the atmospheric dispersion coefficients with thermal plume rise, is 24.3 MW for this fire. From RPP-13482, *Atmospheric Dispersion Coefficients and Radiological and Toxicological Exposure Methodology for Use in Tank Farms*, the values given for a 24.3 MW diesel fuel fire with a 5.3-meter diameter and a less than 1 hour duration were used to determine the χ/Q's for onsite and offsite. The χ/Q' for the fire are 3.04 E-05 s/m^3 onsite and 1.36 E-06 s/m^3 offsite. From RPP-22461, the hydraulic system fire is modeled as a 154 MW hydraulic oil fire with about a 13-m diameter. The convective part of the total fire heat release rate is 128 MW for this fire. From RPP-13482, the values given for a 128 MW fire with a 13-m diameter and a less than 1-hr duration were used to determine the χ/Q's for onsite and offsite. The atmospheric dispersion coefficients for the fire are 6.28 E-06 s/m^3 onsite and 2.95 E-07 s/m^3 offsite. From RPP-22461, the boiler fuel tank spill fire is modeled as a 2,000 MW diesel fuel fire with about a 43-m diameter. The convective part of the total fire heat release rate is 1,880 MW for this fire. From RPP-13482, the values given for a 1,880 MW fire with a 43-m diameter and a less than 1-hr duration were used to determine the atmospheric dispersion coefficients for onsite and offsite. The atmospheric dispersion coefficients for the fire are 6.04 E-07 s/m^3 onsite and 1.47 E-07 s/m^3 offsite. As previously mentioned, a wide spectrum of fire sizes was considered in this analysis to bracket the range of possible consequences resulting from large fires involving aboveground tanks/vessels. Although the fires are not expected to be more energetic (RPP-22461), the above values are conservative, as the χ/Q' values for larger, more energetic fires would be smaller than the values used.

B4.0 METHODOLOGY

Radiological dose exposure consequences are calculated consistent with the methodology documented in RPP-13482, *Atmospheric Dispersion Coefficients and Radiological and Toxicological Exposure Methodology for Use in Tank Farms*. The radiological dose (Equation B-1) is given by:

$$Dose = (Q, released)(\chi/Q')(BR)(ULD) \qquad \text{(B-1)}$$

where:

Dose	=	inhalation dose to receptor, Sv
Q, released	=	liters of respirable material released to the environment, L
χ/Q'	=	atmospheric dispersion coefficient, s/m^3
BR	=	breathing rate, m^3/s
ULD	=	dose per unit liter of material inhaled as aerosols, Sv/L.

The toxicological consequences were calculated per the methodology established in RPP-13482 for toxicological releases. The toxicological releases considered in this appendix are modeled as continuous releases. For a continuous release, the toxicological consequence (Equation B-2) is given by:

$$Consequence = (Q/t)(\chi/Q')(SOF\ Multiplier) \quad \text{(B-2)}$$

where:

Consequence	= final sum of fractions value, unitless
Q	= release to the environment, m^3
t	= release time, s
χ/Q'	= atmospheric dispersion coefficient, s/m^3
SOF Multiplier	= sum of fractions multiplier, unitless.

Determining the quantity of airborne respirable material released to the environment requires knowledge of the volume that is affected and is provided in Equation B-3:

$$Source\ Term\ (Q) = (MAR)(DR)(ARF)(RF) \quad \text{(B-3)}$$

where:

Q	=	source term, L
MAR	=	material at risk, L
DR	=	damage ratio = 1*
ARF	=	airborne release fraction
RF	=	respirable fraction (not applicable to toxicological consequences).

*Note: The damage ratio is not used for the scenarios in this appendix so a value of 1 is applied to all cases.

B5.0 INPUT DATA

The input data used is as follows:

1. Onsite unit liter doses (ULD) for SST 241-S-109 are taken from RPP-5924, *Radiological Source Terms for Tank Farms Safety Analysis*:

Waste Type	ULD (Sv/L)	Basis Tank
SST Liquid	7.8×10^1	241-S-109
SST Sludge	3.1×10^3	241-S-109

2. Sum of fractions (SOF) multipliers for each Temporary Emergency Exposure Limit (TEEL) for SST 241-S-109 are taken from RPP-8369, *Chemical Source Terms for Tank Farms Safety Analyses*:

Waste Type	TEEL-1	TEEL-2	TEEL-3	Basis Tank
SST Liquid	7.97×10^{8}	1.18×10^{8}	7.03×10^{6}	241-S-109
SST Solids	2.19×10^{9}	3.22×10^{8}	2.30×10^{7}	241-S-109

3. For radiological consequence calculations, the release is assumed to consist of 95% liquid and 5% sludge from SST 241-S-109.

4. For toxicological consequence calculations, the tank/vessel is assumed to contain 95% liquid and 5% solids from SST 241-S-109.

5. Although a 15-min duration for the toxicological releases is suggested from HNF-SD-SNF-TI-059, *A Discussion on the Methodology for Calculating Radiological and Toxicological Consequences for the Spent Nuclear Fuel Project at the Hanford Site*, to cover the period of peak toxicological releases, RPP-22461 actually determined the duration of each fire considered in this report. For the large vehicle impact fire, the hydraulic system fire, and the boiler fuel tank spill fire, the fire durations are estimated to last about 7, 6, and 10 min, respectively, based on the results in RPP-22461. The shorter durations would result in increased toxicological releases, and therefore, are considered conservative.

6. The breathing rate for light activity is 3.33×10^{-4} m^3/sec (RPP-5924) and is used for all radiological consequence calculations.

B6.0 CALCULATION OF MIXTURE UNIT LITER DOSES AND SUM OF FRACTIONS FOR DRYER AND WASTE RECEIPT TANK

ULDs and SOF multipliers for each TEEL must be calculated for consequence calculations involving the dryer vessel and the waste receipt tank. As discussed above, the only fire scenario that could involve the waste contents of the dryer is the hydraulic system fire, but because of the DBVS operations, it is not possible to involve simultaneously the contents of one full waste receipt tank and one full dryer batch. However, the case where the dryer was filled with dried waste material (4,740 L) and the waste receipt tank had 7/8 of its total contents needed to be evaluated by a sensitivity check. The result is presented in Section 2.1.3, Table 2-2 above, and in Section B7.2 below.

B6.1 DEMONSTRATION BULK VITRIFICATION SYSTEM UNIT LITER DOSE MULTIPLIERS

As stated in Item 3, Section B5.0, the tank/vessel is assumed to contain a mixture of 95% liquid and 5% solids from SST 241-S-109 for the radiological consequences.

Dryer ULD - DBVS operations will mix 8,032 kg of liquid waste with enough soil to produce 4,740 L of dried product. This is accounted for by applying a correction factor to the resultant ULD as shown below.

Since the waste is 95% liquid and 5% sludge, the resultant onsite ULD can be found by:

$$[(8{,}032\ \text{kg}) / (1.37\ \text{kg/L})(4{,}740\ \text{L})]\ [(7.8 \times 10^{1}\ \text{Sv/L})\ (0.95) + (3.1 \times 10^{3}\ \text{Sv/L})\ (0.05)] = 2.8 \times 10^{2}\ \text{Sv/L}$$

where:

- 8,032kg = mass of liquid waste before drying
- 1.37 kg/L = density of liquid waste (BBI, 9/16/04)
- 7.8×10^{1} Sv/L = onsite liquid ULD before drying (RPP-5924)
- 3.1×10^{3} Sv/L = onsite sludge ULD before drying (RPP-5924)
- 4,740 L = volume of dried product.

Waste Receipt Tank ULD - The waste receipt tank ULD can be found for the mixture of 95% liquid and 5% sludge as follows:

$$[(7.8 \times 10^{1}\ \text{Sv/L})\ (0.95) + (3.1 \times 10^{3}\ \text{Sv/L})\ (0.05)] = 2.3 \times 10^{2}\ \text{Sv/L}$$

where:

- 7.8×10^{1} Sv/L = onsite liquid ULD before drying (RPP-5924)
- 3.1×10^{3} Sv/L = onsite sludge ULD before drying (RPP-5924).

B6.2 DEMONSTRATION BULK VITRIFICATION SYSTEM SUMS OF FRACTIONS MULTIPLIERS

As stated in Item 4, Section B5.0, the tank/vessel is assumed to contain a mixture of 95% liquid and 5% solids from SST 241-S-109 for the toxicological consequences.

Dryer SOFs – The dryer SOF multipliers are calculated for the mixture as follows:

TEEL-1 SOF multiplier

$$= [(8{,}032\ \text{kg}) / (1.37\ \text{kg/L})(4{,}740\ \text{L})]\ [(7.97 \times 10^{8})(0.95) + (2.19 \times 10^{9})\ (0.05)] = 1.1 \times 10^{9}$$

where:

7.97×10^8 = liquid TEEL-1 SOF multiplier before drying (RPP-8369).
2.19×10^9 = solid TEEL-1 SOF multiplier before drying (RPP-8369).

TEEL-2 SOF multiplier

$= [(8{,}032 \text{ kg}) / (1.37 \text{ kg/L})(4{,}740 \text{ L})] [(1.18 \times 10^8)(0.95) + (3.22 \times 10^8)(0.05)]$

$= 1.6 \times 10^8$

where:

1.18×10^8 = liquid TEEL-2 SOF multiplier before drying (RPP-8369).
3.22×10^8 = solid TEEL-2 SOF multiplier before drying (RPP-8369).

TEEL-3 SOF multiplier

$= [(8{,}032 \text{ kg}) / (1.37 \text{ kg/L})(4{,}740 \text{ L})] [(7.03 \times 10^6)(0.95) + (2.30 \times 10^7)(0.05)]$

$= 9.7 \times 10^6$

where:

7.03×10^6 = liquid TEEL-3 SOF multiplier before drying (RPP-8369).
2.30×10^7 = solid TEEL-3 SOF multiplier before drying (RPP-8369).

Waste Receipt Tank SOFs – The waste receipt tank SOF multipliers are calculated for the mixture as follows:

TEEL-1 SOF multiplier

$= [(7.97 \times 10^8)(0.95) + (2.19 \times 10^9)(0.05)]$

$= 8.7 \times 10^8$

where:

7.97×10^8 = liquid TEEL-1 SOF multiplier before drying (RPP-8369).
2.19×10^9 = solid TEEL-1 SOF multiplier before drying (RPP-8369).

TEEL-2 SOF multiplier

$= [(1.18 \times 10^8)(0.95) + (3.22 \times 10^8)(0.05)]$

$= 1.3 \times 10^8$

where:

1.18×10^8 = liquid TEEL-2 SOF multiplier before drying (RPP-8369).
3.22×10^8 = solid TEEL-2 SOF multiplier before drying (RPP-8369).

TEEL-3 SOF multiplier

$= [(7.03 \times 10^6)(0.95) + (2.30 \times 10^7)(0.05)]$

$= 7.8 \times 10^6$

where:

7.03×10^6 = liquid TEEL-3 SOF multiplier before drying (RPP-8369).
2.30×10^7 = solid TEEL-3 SOF multiplier before drying (RPP-8369).

B7.0 ACCIDENT CONSEQUENCE COMPARISON

B7.1 Large Vehicle Impact Fire

The postulated accident scenario is a large vehicle impact and subsequent diesel fuel pool fire near the DBVS waste receipt tanks that would result in failure of the HIHTL with drainage of the contents on one waste receipt tank through the failed transfer line. From RPP-22461, this scenario results in a 30 MW (24.3 MW convective part, see Section B3.0, Item 8) fire with an equivalent diameter of 5.3 m and duration of about 7 min. From RPP-13482, the appropriate onsite and offsite atmospheric dispersion coefficients with buoyant plume rise caused by the fire are 3.04×10^{-5} s/m^3 and 1.36×10^{-6} s/m^3, respectively.

B7.1.1 Onsite Radiological Consequences

The onsite dose is found using the methodology in RPP-13482. The dose is given by Equation B-1:

$$D = (Q, released)(\chi/Q')(BR)(ULD_{onsite})$$

where:

$Q, released$ = liters of respirable material released to the environment (L)
= $[\ MAR_{waste\ receipt\ tank-boiled\ dry}\ ] \times DR \times ARF_{boiled\ dry} \times RF_{boiled\ dry}$
= [(460 L)](1.0)(0.1)(1)]
= 46 L

$MAR_{waste\ receipt\ tank-boiled\ dry}$ = 460 L= the amount of waste receipt tank volume that is boiled dry by the 100 gal diesel fuel fire (see Section B3.0, Item 5)

DR = damage ratio = 1.0 was used for all calculations

$ARF_{boiled\ dry}$ = 0.1 = airborne release fraction for waste that is boiled dry (see Section B3.0, Item 7)

$RF_{boiled\ dry}$ = 1.0 = respirable fraction for waste that is boiled dry (see Section B3.0, Item 7)

χ/Q' = onsite atmospheric dispersion coefficient
= 3.04×10^{-5} s/m^3

BR = breathing rate
= 3.33×10^{-4} m^3/s (same breathing rate used for all radiological consequence calculations)

ULD_{onsite} = onsite ULD
= 2.3×10^{2} Sv/L for waste receipt tank mixture (calculated above)

Therefore, the onsite dose for the above described large vehicle impact fire scenario is:

$$D_{onsite} = (46\ L)(3.04 \times 10^{-5}\ s/m^3)(3.33 \times 10^{-4}\ m^3/s)(2.3 \times 10^{2}\ Sv/L)$$
$$= 1.1 \times 10^{-4}\ Sv = 1.1 \times 10^{-2}\ rem.$$

B7.1.2 Onsite Toxicological Consequences

The toxicological consequences are calculated per the methodology established in RPP-13482. The onsite toxicological consequences can be determined from Equation B-2:

$$Consequence = (Q/t)(\chi/Q')(SOF\ Multiplier)$$

where:

Consequence	=	final sum of fractions value, unitless
Q/t	=	rate of release to the environment (m^3/s)
	=	$[Q_{waste\ receipt\ tank\ -\ boiled\ dry}/(t \times conversion\ factor)](ARF_{boiled\ dry})$
t	=	414 s (release time, or fire duration from RPP-22461)
Conversion factor	=	1,000 L/m^3
$ARF_{boiled\ dry}$	=	0.1 = airborne release fraction for waste that is boiled dry (see Section B3.0, Item 7)
χ/Q'	=	onsite atmospheric dispersion coefficient
	=	$3.04 \times 10^{-5}\ s/m^3$ (from RPP-13482)
$SOF_{waste\ receipt\ tank}$ *Multiplier*	=	sum-of-fractions multiplier, unitless = 1.3×10^{8} = TEEL-2 SOF multiplier for the waste receipt tank mixture (calculated above).

Therefore, the onsite moderate toxicological consequence (based on the TEEL-2 SOF multiplier) is:

$$Consequence = (460\ L) / [(414\ s)(1{,}000\ L/m^3)]\ (0.1)\ (3.04 \times 10^{-5}\ s/m^3)\ (1.3 \times 10^{8})$$
$$= 4.4 \times 10^{-1}$$

B7.1.3 Offsite Toxicological Consequences

The offsite toxicological consequences can be determined similarly from Equation B-2:

$$Consequence = (Q/t)(\chi/Q')(SOF\ Multiplier)$$

where:

Consequence	=	final sum of fractions value, unitless
Q/t	=	rate of release to the environment (m^3/s)
	=	$[Q_{waste\ receipt\ tank-boiled\ dry}/(t \times conversion\ factor)](ARF_{boiled\ dry})$
t	=	414 s (release time, or fire duration from RPP-22461)
Conversion factor	=	1,000 L/m^3
$ARF_{boiled\ dry}$	=	0.1 = airborne release fraction for waste that is boiled dry (see Section B3.0, Item 7)
χ/Q'	=	offsite atmospheric dispersion coefficient
	=	1.36×10^{-6} s/m^3 (from RPP-13482)
$SOF_{waste\ receipt\ tank}$ *Multiplier*	=	sum-of-fractions multiplier, unitless = 8.7×10^8 = TEEL-1 SOF multiplier for the waste receipt tank mixture (calculated above).

The offsite moderate toxicological consequence (based on the TEEL-1 SOF multiplier) is:

$$Consequence = (460\ L) / [(414\ s)(1{,}000\ L/m^3)]\ (0.1)\ (1.36 \times 10^{-6}\ s/m^3)\ (8.7 \times 10^8)$$
$$= 1.3 \times 10^{-1}$$

B7.2 Hydraulic System Fire

The postulated accident scenario is a crack or other leak in the hydraulic system pipeline or fittings that causes a spray of hydraulic fluid onto a hot surface of the dryer that results in a subsequent oil spray and pool fire in the DBVS dryer module that would spread out and result in failure of the HIHTL with drainage of the contents of one waste receipt tank through the failed transfer line. Additionally, as discussed in Section B2.0 above, the sensitivity of the consequences to the release of dried waste inventory contained in the dryer module is also examined below since the dryer is expected to structurally collapse for this scenario.

From RPP-22461, this scenario results in a 154 MW (128 MW convective part, see Section B3.0, Item 8) fire with an equivalent diameter of 13 m and duration of about 6 min. From RPP-13482, the appropriate onsite and offsite atmospheric dispersion coefficients with buoyant plume rise caused by the fire are 6.28×10^{-6} s/m^3 and 2.95×10^{-7} s/m^3, respectively.

B7.2.1 Onsite Radiological Consequences

The onsite dose is found using the methodology in RPP-13482. The dose is given by Equation B-1:

$$D = (Q,\ released)(\chi/Q')(BR)(ULD,\ onsite)$$

where:

Q, *released* = liters of respirable material released to the environment (L)
= [$MAR_{waste\ receipt\ tank-boiled\ dry}$] x DR x $ARF_{boiled\ dry}$ x $RF_{boiled\ dry}$
= [(1,730 L)](1.0)(0.1)(1)]
= 173 L

$MAR_{waste\ receipt\ tank-boiled\ dry}$ = 1,730 L= the amount of waste receipt tank volume that is boiled dry by the 800 gal hydraulic fluid fire (see Section B3.0, Item 5)

DR = damage ratio = 1.0

$ARF_{boiled\ dry}$ = 0.1 = airborne release fraction for waste that is boiled dry (see Section B3.0, Item 7)

$RF_{boiled\ dry}$ = 1.0 = respirable fraction for waste that is boiled dry (see Section B3.0, Item 7)

χ/Q' = onsite atmospheric dispersion coefficient
= 6.28×10^{-6} s/m^3

BR = breathing rate
= 3.33×10^{-4} m^3/s

ULD = onsite ULD
= 2.3×10^{2} Sv/L for waste receipt tank mixture (calculated above)

The above parameters are for the case where the one waste receipt tank that is connected to the HIHTL is full and the dryer is empty, and the radiant energy of the fire goes into drying out a portion of the volume of one waste receipt tank.

Therefore, the onsite dose for the above described hydraulic system fire scenario is:

D_{onsite} = (173 L)(6.28 x 10^{-6} s/m^3)(3.33 x 10^{-4} m^3/s) (2.3 x 10^{2} Sv/L)
= 8.3 x 10^{-5} Sv = 8.3 x 10^{-3} rem.

For the case where the dryer is full with dried material and the one waste receipt tank that is connected to the HIHTL is 7/8 full, it is assumed that the radiant energy of the fire goes into thermally lofting the dried waste material that has spilled from the dryer and is not available to dry out a portion of the volume of one waste receipt tank, the input parameters to Equation B-1 are as follows:

Q, *released* = liters of respirable material released to the environment (L)
= [MAR_{dryer}] x DR x $ARF_{thermal\ stress\ on\ powders}$ x $RF_{thermal\ stress\ on\ powders}$
= [(4,740 L)](1.0)(6. x 10^{-3})(1. x 10^{-2})]
= 0.284 L

MAR_{dryer} = 4,740 L= the maximum amount of dried waste material that can be spilled from the dryer and subjected to thermal lofting by the radiant part of the 800 gal hydraulic fluid fire (see Section B3.0, Item 5)

DR = damage ratio = 1.0

$ARF_{thermal\ stress\ on\ powders}$ = 6. x 10^{-3} = airborne release fraction for thermal stress on powders (see Section B3.0, Item 7)
$RF_{thermal\ stres\ on\ powders}$ = 1. x 10^{-2} = respirable fraction for thermal stress on powders (see Section B3.0, Item 7)
χ/Q' = onsite atmospheric dispersion coefficient
= 6.28 x 10^{-6} s/m^3
BR = breathing rate
= 3.33 x 10^{-4} m^3/s
ULD = onsite ULD
= 2.8 x 10^2 Sv/L for dryer mixture (calculated above).

Therefore, the onsite dose for the above described hydraulic system fire scenario is:

$$D_{onsite} = (0.284\ L)(6.28 \times 10^{-6}\ s/m^3)(3.33 \times 10^{-4}\ m^3/s)\ (2.8 \times 10^2\ Sv/L)$$
$$= 1.7 \times 10^{-7}\ Sv = 1.7 \times 10^{-5}\ rem.$$

These results show that the dose from release of drying out a portion of one waste receipt tank (8.3 x 10^{-3} rem) is a factor of 500 greater than the dose from the release of thermally lofting the dried waste material from the dryer (1.7 x 10^{-5} rem). Both releases are several orders of magnitude < 25 rem.

B7.2.2 Onsite Toxicological Consequences

The toxicological consequences are calculated per the methodology established in RPP-13482. The onsite toxicological consequences can be determined from Equation B-2:

$$Consequence = (Q/t)(\chi/Q')(SOF\ Multiplier)$$

where:

Consequence = final sum of fractions value, unitless
Q/t = rate of release to the environment (m^3/s)
= $[Q_{waste\ receipt\ tank\text{-}boiled\ dry}/(t \times conversion\ factor)](ARF_{boiled\ dry})$
t = 351 s (release time, or fire duration from RPP-22461)
Conversion factor = 1,000 L/m^3
$ARF_{boiled\ dry}$ = 0.1 = airborne release fraction for waste that is boiled dry (see Section B3.0, Item 7)
χ/Q' = onsite atmospheric dispersion coefficient
= 6.28 x 10^{-6} s/m^3 (from RPP-13482)
$SOF_{waste\ receipt\ tank}$ *Multiplier* = sum-of-fractions multiplier, unitless = 1.3 x 10^8 = TEEL-2 SOF multiplier for the waste receipt tank mixture (calculated above).

The above parameters are for the case where the one waste receipt tank that is connected to the HIHTL is full and the dryer is empty, and the radiant energy of the fire goes into drying out a portion of the volume of one waste receipt tank.

Therefore, the onsite moderate toxicological consequence (based on the TEEL-2 SOF multiplier) is:

$$\textit{Consequence} = (1{,}730\ \text{L}) / [(351\ \text{s})(1{,}000\ \text{L/m}^3)]\ (0.1)\ (6.28 \times 10^{-6}\ \text{s/m}^3)\ (1.3 \times 10^{8})$$
$$= 4.0 \times 10^{-1}$$

For the case where the dryer is full with dried material and the one waste receipt tank that is connected to the HIHTL is 7/8 full, it is assumed that the radiant energy of the fire goes into thermally lofting the dried waste material that has spilled from the dryer and is not available to dry out a portion of the volume of one waste receipt tank. The input parameters to Equation B-2 are as follows:

Consequence	= final sum of fractions value, unitless
Q/t	= rate of release to the environment (m^3/s)
	= $[Q_{dryer}/(t \times \textit{conversion factor})](\textit{ARF}_{\textit{thermal stress on powders}})$
t	= 351 s (release time, or fire duration from RPP-22461)
Conversion factor	= 1,000 L/m^3
$\textit{ARF}_{\textit{thermal stress on powders}}$	= 6. x 10^{-3} = airborne release fraction for thermal stress on powders (see Section B3.0, Item 7)
χ/Q'	= onsite atmospheric dispersion coefficient
	= 6.28 x 10^{-6} s/m^3 (from RPP-13482)
SOF_{dryer} *Multiplier*	= sum-of-fractions multiplier, unitless = 1.6 x 10^8 = TEEL-2 SOF multiplier for the dryer mixture (calculated above).

Therefore, the onsite moderate toxicological consequence (based on the TEEL-2 SOF multiplier) is:

$$\textit{Consequence} = (4{,}740\ \text{L})/\ [(351\ \text{s})(1{,}000\ \text{L/m}^3)]\ (6.0 \times 10^{-3})(6.28 \times 10^{-6}\ \text{s/m}^3)(\ 1.6 \times 10^{8})$$
$$= 8.1 \times 10^{-2}$$

Therefore, the onsite toxicological consequence from release of drying out a portion of one waste receipt tank is about a factor of 5 greater than the onsite toxicological consequence from the release of thermally lofting the dried waste material from the dryer, and both are < 1.0.

B7.2.3 Offsite Toxicological Consequences

The offsite toxicological consequences can be determined similarly from Equation B-2:

$$Consequence = (Q/t)(\chi/Q')(SOF\ Multiplier)$$

where:

Consequence	=	final sum of fractions value, unitless
Q/t	=	rate of release to the environment (m^3/s)
	=	$[Q_{waste\ receipt\ tank\text{-}boiled\ dry}/(t \times conversion\ factor)](ARF_{boiled\ dry})$
t	=	351 s (release time, or fire duration from RPP-22461)
Conversion factor	=	1,000 L/m^3
$ARF_{boiled\ dry}$	=	0.1 = airborne release fraction for waste that is boiled dry (see Section B3.0, Item 7)
χ/Q'	=	offsite atmospheric dispersion coefficient
	=	2.95×10^{-7} s/m^3 (from RPP-13482)
$SOF_{waste\ receipt\ tank}$ *Multiplier*	=	sum-of-fractions multiplier, unitless = 8.7×10^8 = TEEL-1 SOF multiplier for the waste receipt tank mixture (calculated above).

The above parameters are for the case where the one waste receipt tank that is connected to the HIHTL is full and the dryer is empty, and the radiant energy of the fire goes into drying out a portion of the volume of one waste receipt tank.

Therefore, the offsite moderate toxicological consequence (based on the TEEL-1 SOF multiplier) is:

$$Consequence = (1{,}730\ L)/[(351\ s)(1{,}000\ L/m^3)](0.1)\ (2.95 \times 10^{-7}\ s/m^3)\ (8.7 \times 10^8)$$
$$= 1.3 \times 10^{-1}$$

For the case where the dryer is full with dried material and the one waste receipt tank that is connected to the HIHTL is 7/8 full, it is assumed that the radiant energy of the fire goes into thermally lofting the dried waste material that has spilled from the dryer and is not available to dry out a portion of the volume of one waste receipt tank. The input parameters to Equation B-2 are as follows:

Consequence	=	final sum of fractions value, unitless
Q/t	=	rate of release to the environment (m^3/s)
	=	$[Q_{dryer}/(t \times conversion\ factor)](ARF_{thermal\ stress\ on\ powders})$
T	=	351 s (release time, or fire duration from RPP-22461)
Conversion factor	=	1,000 L/m^3
$ARF_{thermal\ stress\ on\ powders}$	=	$6. \times 10^{-3}$ = airborne release fraction for thermal stress on powders (see Section B3.0, Item 7)

χ/Q' = offsite atmospheric dispersion coefficient
= 2.95×10^{-7} s/m^3 (from RPP-13482)
$SOF_{dryer\ Multiplier}$ = sum-of-fractions multiplier, unitless = 1.1×10^9= TEEL-1 SOF multiplier for the dryer mixture (calculated above).

Therefore, the offsite moderate toxicological consequence (based on the TEEL-1 SOF multiplier) is:

$$Consequence = (4{,}740\ L)/[(351\ s)(1{,}000\ L/m^3)](6. \times 10^{-3})(2.95 \times 10^{-7}\ s/m^3)(1.1 \times 10^9)$$
$$= 2.6 \times 10^{-2}$$

Therefore, the offsite toxicological consequence from release of drying out a portion of one waste receipt tank is about a factor of 5 greater than the offsite toxicological consequence from the release of thermally lofting the dried waste material from the dryer, and both are < 1.0.

B7.3 Boiler Fuel Tank Spill Fire

The boiler fuel tank spill fire scenario begins with a large truck impacting the boiler fuel tank resulting in a 10,000 gal diesel fuel spill and subsequent pool fire near the DBVS waste receipt tanks. The fire is large enough and creates sufficiently high temperatures to melt via indirect radiant heating the rubber HIHTL connected to one waste receipt tank. This results in drainage of the contents on one waste receipt tank through the failed transfer line. From RPP-22461, this scenario results in a 2,000 MW (1,880 MW convective part, see Section B3.0, Item 8 above) fire with an equivalent diameter of 43 m and duration of about 10 min. From RPP-13482, the appropriate onsite and offsite atmospheric dispersion coefficients with buoyant plume rise caused by the fire are 6.04×10^{-7} s/m^3 and 1.47×10^{-7} s/m^3, respectively.

B7.3.1 Onsite Radiological Consequences

The onsite dose is found using the methodology in RPP-13482. The dose is given by Equation B-1:

$$D = (Q, released)(\chi/Q')(BR)(ULD, onsite)$$

where:

$Q, released$ = liters of respirable material released to the environment (L)
= $[\ MAR_{waste\ receipt\ tank-\ vigorous\ boiling}\ ] \times DR \times ARF_{vigorous\ boiling} \times RF_{vigorous\ boiling}$
= [(68,000 L)](1.0)(0.03)(1)]
= 2,040 L
$MAR_{waste\ recipt\ tank-\ vigorous\ boiling}$ = 68,000 L= the full amount of waste receipt tank volume that can be subjected to vigorous boiling by the 10,000 gal boiler fuel tank diesel spill fire (see Section B3.0, Item 5)

DR = damage ratio = 1.0
$ARF_{vigorous\ boiling}$ = 3. x 10^{-2} = airborne release fraction for vigorous boiling, but not boiled dry (see Section B3.0, Item 7)
$RF_{vigorous\ boiling}$ = 1.0 = respirable fraction for vigorous boiling (see Section B3.0, Item 7)
χ/Q' = onsite atmospheric dispersion coefficient
= 6.04 x 10^{-7} s/m^3
BR = breathing rate
= 3.33 x 10^{-4} m^3/s
ULD = onsite ULD
= 2.3 x 10^{2} Sv/L for waste receipt tank mixture (calculated above).

Therefore, the onsite dose for the above described large vehicle impact fire scenario is:

D_{onsite} = (2,040 L)(6.04 x 10^{-7} s/m^3)(3.33 x 10^{-4} m^3/s) (2.3 x 10^{2} Sv/L)
= 9.4 x 10^{-5} Sv = 9.4 x 10^{-3} rem.

B7.3.2 Onsite Toxicological Consequences

The toxicological consequences are calculated per the methodology established in RPP-13482. The onsite toxicological consequences can be determined from Equation B-2:

$$Consequence = (Q/t)(\chi/Q')(SOF\ Multiplier)$$

where:

Consequence = final sum of fractions value, unitless
Q/t = rate of release to the environment (m^3/s)
= [$Q_{waste\ receipt\ tank\ -vigorous\ boiling}$/(t x *conversion factor*)] ($ARF_{vigorous\ boiling}$)
T = 624 s (release time, or fire duration from RPP-22461)
Conversion factor = 1,000 L/m^3
$ARF_{vigorous\ boiling}$ = 3. x 10^{-2} = airborne release fraction for vigorous boiling, but not boiled dry (see Section B3.0, Item 7)
χ/Q' = onsite atmospheric dispersion coefficient
= 6.04 x 10^{-7} s/m^3 (from RPP-13482)
$SOF_{waste\ receipt\ tank}$ *Multiplier* = sum-of-fractions multiplier, unitless = 1.3 x 10^{8} = TEEL-2 SOF multiplier for the waste receipt tank mixture (calculated above)

Therefore, the onsite moderate toxicological consequence (based on the TEEL-2 SOF multiplier) is:

$$Consequence = (68{,}000\ L)\ /[(624\ s)(1{,}000\ L/m^3)](0.03)\ (6.04 \times 10^{-7}\ s/m^3)\ (1.3 \times 10^{8})$$
$$= 2.6 \times 10^{-1}$$

B7.3.3 Offsite Toxicological Consequences

The offsite toxicological consequences can be determined similarly from Equation B-2:

$$Consequence = (Q/t)(\chi/Q')(SOF\ Multiplier)$$

where:

Consequence	=	final sum of fractions value, unitless
Q/t	=	rate of release to the environment (m^3/s)
	=	$[Q_{waste\ receipt\ tank\ -\ vigorous\ boiling}/(t \times conversion\ factor)](ARF_{vigorous\ boiling})$
T	=	624 s (release time, or fire duration from RPP-22461)
Conversion factor	=	1,000 L/m^3
$ARF_{vigorous\ boiling}$	=	3. x 10^{-2} = airborne release fraction for vigorous boiling, but not boiled dry (see Section B3.0, Item 7)
χ/Q'	=	offsite atmospheric dispersion coefficient
	=	1.47 x 10^{-7} s/m^3 (from RPP-13482)
$SOF_{waste\ receipt\ tank}$ *Multiplier*	=	sum-of-fractions multiplier, unitless = 8.7 x 10^8 = TEEL-1 SOF multiplier for the waste receipt tank mixture (calculated above).

Therefore, the offsite moderate toxicological consequence (based on the TEEL-1 SOF multiplier) is:

$$Consequence = (68{,}000\ L)\ /[(624\ s)(1{,}000\ L/m^3)](0.03)\ (1.47 \times 10^{-7}\ s/m^3)\ (8.7 \times 10^{8})$$
$$= 4.2 \times 10^{-1}$$

B8.0 RESULTS

Tables B8-1 compares the accident consequences with the radiological evaluation guidelines. Reviewing the consequences shows that the onsite radiological release from a large vehicle impact fire, a hydraulic system fire, or a boiler fuel tank spill fire involving aboveground tanks/vessels is below all guideline values (moderate and high). Therefore, the onsite radiological consequence bin is "low" for all postulated large fire scenarios involving aboveground tanks/vessels during DBVS operations.

Table B8-1. Summary of Onsite Radiological Consequences Without Controls for Large Fire Scenarios Involving Aboveground Tanks/Vessels During Demonstration Bulk Vitrification System Operations.

Case	Onsite radiological consequences		
	Calculated dose (rem)	Moderate consequence guideline (rem)	High consequence guideline (rem)
Large vehicle impact fire	1.1×10^{-2}	$2.5 \times 10^{+1}$	$1.0 \times 10^{+2}$
Hydraulic system fire	8.3×10^{-3}	$2.5 \times 10^{+1}$	$1.0 \times 10^{+2}$
Boiler fuel tank spill fire	9.4×10^{-3}	$2.5 \times 10^{+1}$	$1.0 \times 10^{+2}$

Table B8-2 compares the accident consequences with the toxicological evaluation guidelines. Reviewing the consequences shows that the onsite and offsite toxicological releases for all three fire scenarios involving aboveground tanks/vessels are below the moderate guideline value. That is, both the onsite and offsite toxicological consequences are in the "low" range for all postulated large fire scenarios involving aboveground tanks/vessels during DBVS operations.

Table B8-2. Summary of Toxicological Consequences Without Controls for Large Fire Scenarios Involving Aboveground Tanks/Vessels During Demonstration Bulk Vitrification System Operations.

Case	Toxicological consequences							
	Onsite				Offsite			
	Moderate consequence		High consequence		Moderate consequence		High consequence	
	SOF	Guideline	SOF	Guideline	SOF	Guideline	SOF	Guideline
Large vehicle impact fire	4.4×10^{-1}	1	--	1	1.3×10^{-1}	1	--	1
Hydraulic system fire	4.0×10^{-1}	1	--	1	1.3×10^{-1}	1	--	1
Boiler fuel tank spill fire	2.6×10^{-1}	1	--	1	4.2×10^{-1}	1	--	1

Note:

SOF = sum of fractions.

B9.0 REFERENCES

Babraskus, 2002, *SFPE Handbook of Fire Protection Engineering,* 3rd Edition, National Fire Protection Association, Quincy, Massachusetts.

DOE-HDBK-3010-94, 2000, *Airborne Release Fractions/Rates and Respirable Fractions for Nonreactor Nuclear Facilities*, Change Notice No. 1, U.S. Department of Energy, Washington, D.C.

FM, 2000, *Hydraulic Fluids*, Loss Prevention Data Sheet 7-98, Factory Mutual Research Corporation, Norwood, Massachusetts.

HNF-SD-SNF-TI-059, 1999, *A Discussion on the Methodology for Calculating Radiological and Toxicological Consequences for the Spent Nuclear Fuel Project at the Hanford Site*, Rev. 2, Fluor Daniel Northwest, Inc., Richland, Washington.

RPP-5924, 2003, *Radiological Source Terms for Tank Farms Safety Analysis*, Rev. 4, CH2M HILL Hanford Group, Inc., Richland, Washington.

RPP-8369, 2003, *Chemical Source Terms for Tank Farms Safety Analyses*, Rev. 2, CH2M HILL Hanford Group, Inc., Richland, Washington.

RPP-13482, 2005, *Atmospheric Dispersion Coefficients and Radiological and Toxicological Exposure Methodology for Use in Tank Farms*, Rev. 4, CH2M HILL Hanford Group, Inc., Richland, Washington.

RPP-22461, 2005, *Preliminary Fire Hazard Analysis for the Demonstration Bulk Vitrification System*, Rev. 0, CH2M HILL Hanford Group, Inc., Richland, Washington.

This page intentionally left blank.

APPENDIX C

HUMAN FACTORS EVALUATION AND PEER REVIEW CHECKLIST

This page intentionally left blank.

APPENDIX C

HUMAN FACTORS EVALUATION AND PEER REVIEW CHECKLIST

Human Factors Evaluation Checklist.

Hazard Analysis Title: Demonstration Bulk Vitrification System (DBVS) – Large Fire Accidents Involving Aboveground Tanks/Vessels

Documented Safety Analysis Section Number: RPP-24217, *Technical Basis Report for Large Fires Involving Aboveground Tanks/Vessels*, to support Chapter 3, Section 3.3.2.3.1, of the DBVS Preliminary Documented Safety Analysis

Item No.	Issue	Yes, No, Unknown
1	Does the activity/event being planned/analyzed require human interaction to successfully complete the activity or mitigate consequences of the event? If the answer is No, go to Item No. 23. Otherwise continue with Item No. 2.	No[1]
2	Are procedures/instructions available to the individuals responsible for the action?	
3	Are procedures/instructions complete, accurate, and validated?	
4	Are the individuals responsible for the action also responsible for collateral duties?	
5	Are staffing levels adequate to perform the activity?	
6	Are the individuals responsible for the action adequately trained, qualified, and experienced to perform the actions?	
7	Have the required actions been walked down in the field to verify execution within the time constraints identified in the hazard analysis?	
8	Have physical obstacles that could prevent successful completion of the activity been removed or accounted for?	
9	Have work area environmental concerns been identified and accounted for?	
10	Has PPE been dedicated and is available, if required?	
11	Have the appropriate tools been dedicated and are available, if required?	
12	Does workstation configuration facilitate completion of the actions?	
13	Are instruments, valves, switches, or other devices accessible?	
14	Are instruments, valves, switches, or other devices properly tagged or labeled?	
15	Is communication equipment operable, dedicated, and available, if necessary?	
16	Is adequate fixed lighting in place?	
17	Is portable lighting dedicated, functional, and available, if necessary?	
18	Are confined space restrictions adequately addressed?	
19	Is temperature, humidity, radiological, and toxicological conditions acceptable for human occupancy?	
20	Is hazard material or radiological monitoring equipment dedicated, functional, and available, if needed?	
21	Are access controls identified and keys available?	
22	Can activities be completed within the time prescribed in the hazard analysis?	

If any answer for Items 2 through 22 is No or Unknown, corrective actions may be required to ensure successful completion of the activity as described in the hazard analysis. Complete and document corrective actions on Documented Safety Analysis Implementation Checklist and go to Item No. 23.

23	Evaluator:	Andrew R. Marchese Print	A R Marchese Signature	1-7-05 Date
	Peer Reviewer:	Edward C. Heubach Print	E C Heubach III Signature	01/07/05 Date

[1] No new or specific Technical Safety Requirements (excluding Safety Management Programs) have been allocated for the activities being analyzed. In other words, no specific operator actions are credited in the control allocation. Required activities and necessary training and qualification requirements will be defined by the Safety Management Programs.

NS&L CHECKLIST FOR TECHNICAL PEER REVIEW

Document Reviewed: RPP-24217, *Technical Basis for Large Fire Accidents Involving Aboveground Tanks/ Vessels,* Rev.0 (draft)

Scope of Review (e.g., document section or portion of calculation): Entire document.

Yes	No*	NA	
☐	☐	☒	1. Previous reviews are complete and cover the analysis, up to the scope of this review, with no gaps. **Explanation:*
☒	☐	☐	2. Problem is completely defined. **Explanation:*
☒	☐	☐	3. Accident scenarios are developed in a clear and logical manner. **Explanation:*
☒	☐	☐	4. Analytical and technical approaches and results are reasonable and appropriate. *(ORP QAPP criterion 2.8)* **Explanation:*
☒	☐	☐	5. Necessary assumptions are reasonable, explicitly stated, and supported. *(ORP QAPP criterion 2.2)* **Explanation:*
☐	☐	☒	6. Computer codes and data files are documented. **Explanation:*
☒	☐	☐	7. Data used in calculations are explicitly stated. **Explanation:*
☒	☐	☐	8. Bases for calculations, including assumptions and data, are consistent with the supported safety basis document (e.g., the Tank Farms Documented Safety Analysis). **Explanation:*
☒	☐	☐	9. Data were checked for consistency with original source information as applicable. *(ORP QAPP criterion 2.9)* **Explanation:*
☒	☐	☐	10. For both qualitative and quantitative data, uncertainties are recognized and discussed, as appropriate. *(ORP QAPP criterion 2.17)* **Explanation:*
☒	☐	☐	11. Mathematical derivations were checked including dimensional consistency of results. *(ORP QAPP criterion 2.16)* **Explanation:*
☒	☐	☐	12. Models are appropriate and were used within their established range of validity or adequate justification was provided for use outside their established range of validity. **Explanation:*
☒	☐	☐	13. Spreadsheet results and all hand calculations were verified. **Explanation:*
☒	☐	☐	14. Calculations are sufficiently detailed such that a technically qualified person can understand the analysis without requiring outside information. *(ORP QAPP criterion 2.5)* **Explanation:*
☐	☐	☒	15. Software input is correct and consistent with the document reviewed. **Explanation:*
☐	☐	☒	16. Software output is consistent with the input and with the results reported in the document reviewed. **Explanation:*
☐	☐	☒	17. Software verification and validation are addressed adequately. *(ORP QAPP criterion 2.6)* **Explanation:*
☒	☐	☐	18. Limits/criteria/guidelines applied to the analysis results are appropriate and referenced. Limits/criteria/guidelines were checked against references. *(ORP QAPP criterion 2.9)* **Explanation:*
☒	☐	☐	19. Safety margins are consistent with good engineering practices. **Explanation:*
☒	☐	☐	20. Conclusions are consistent with analytical results and applicable limits. **Explanation:*
☒	☐	☐	21. Results and conclusions address all points in the purpose. *(ORP QAPP criterion 2.3)* **Explanation:*
☒	☐	☐	22. All references cited in the text, figures, and tables are contained in the reference list. **Explanation:*
☒	☐	☐	23. Reference citations (e.g., title and number) are consistent between the text callout and the reference list. **Explanation:*

ECHz / 01-10-05
Initials/Date

Form Current To 12/08/2004

NS&L CHECKLIST FOR TECHNICAL PEER REVIEW

Yes	No*	NA	
☐	☒	☐	24. Only released (i.c., not draft) references are cited. *(ORP QAPP criterion 2.1)* **Explanation:*
☒	☐	☐	25. Referenced documents are retrievable or otherwise available. **Explanation:*
☒	☐	☐	26. The most recent version of each reference is cited, as appropriate. *(ORP QAPP criterion 2.1)* **Explanation:*
☒	☐	☐	27. There are no duplicate citations in the reference list. **Explanation:*
☒	☐	☐	28. Referenced documents are spelled out (title and number) the first time they are cited. **Explanation:*
☒	☐	☐	29. All acronyms are spelled out the first time they are used. **Explanation:*
☒	☐	☐	30. The Table of Contents is correct. **Explanation:*
☒	☐	☐	31. All figure, table, and section callouts are correct. **Explanation:*
☒	☐	☐	32. Unit conversions are correct and consistent. **Explanation:*
☒	☐	☐	33. The number of significant digits is appropriate and consistent. **Explanation:*
☐	☐	☒	34. Chemical reactions are correct and balanced. **Explanation:*
☒	☐	☐	35. All tables are formatted consistently and are free of blank cells. **Explanation:*
☒	☐	☐	36. The document is complete (pages, attachments, and appendices) and in the proper order. **Explanation:*
☒	☐	☐	37. The document is free of typographical errors. *Only the section(s) being reviewed was checked for typographical errors.* **Explanation:*
☒	☐	☐	38. The tables are internally consistent. **Explanation:*
☒	☐	☐	39. The document was prepared in accordance with HNF-2353, Section 4.3, Attachment B, "Calculation Note Format and Preparation Instructions." **Explanation:*
☐	☐	☒	40. Impacted documents are appropriately identified in Blocks 7 and 25 of the Engineering Change Notice (form A-6003-563.1). **Explanation:*
☒	☐	☐	41. If more than one Technical Peer Reviewer was designated for this document, an overall review of the entire document was performed after resolution of all Technical Peer Review comments and confirmed that the document is self-consistent and complete. **Explanation:*
☒	☐	☐	**Concurrence** *(Concurrence qualified by response to item #24 above.)*

E. C. Heubach II E C Heubach II 01/10/05

Reviewer (Printed Name and Signature) Date

* If No is chosen, an explanation must be provided on this form.

Additional explanation:

Form Current To 12/08/2004

CHECKLIST FOR TECHNICAL PEER REVIEW

Document Reviewed: RPP-24217 Rev 0

Scope of Review (e.g., document section or portion of calculation): Technical edit

Yes	No	NA*	
[ ]	[ ]	[x]	1. Previous reviews are complete and cover the analysis, up to the scope of this review, with no gaps.
[ ]	[ ]	[x]	2. Problem is completely defined.
[ ]	[ ]	[x]	3. Accident scenarios are developed in a clear and logical manner.
[ ]	[ ]	[x]	4. Analytical and technical approaches and results are reasonable and appropriate. *(ORP QAPP criterion 2.8)*
[ ]	[ ]	[x]	5. Necessary assumptions are reasonable, explicitly stated, and supported. *(ORP QAPP criterion 2.2)*
[ ]	[ ]	[x]	6. Computer codes and data files are documented.
[ ]	[ ]	[x]	7. Data used in calculations are explicitly stated.
[ ]	[ ]	[x]	8. Bases for calculations, including assumptions and data, are consistent with the supported safety basis document (e.g., the Tank Farms Final Safety Analysis Report).
[ ]	[ ]	[x]	9. Data were checked for consistency with original source information as applicable. *(ORP QAPP criterion 2.9)*
[ ]	[ ]	[x]	10. For both qualitative and quantitative data, uncertainties are recognized and discussed, as appropriate. *(ORP QAPP criterion 2.17)*
[ ]	[ ]	[x]	11. Mathematical derivations were checked including dimensional consistency of results. *(ORP QAPP criterion 2.16)*
[ ]	[ ]	[x]	12. Models are appropriate and were used within their established range of validity or adequate justification was provided for use outside their established range of validity.
[ ]	[ ]	[x]	13. Spreadsheet results and all hand calculations were verified.
[ ]	[ ]	[x]	14. Calculations are sufficiently detailed such that a technically qualified person can understand the analysis without requiring outside information. *(ORP QAPP criterion 2.5)*
[ ]	[ ]	[x]	15. Software input is correct and consistent with the document reviewed.
[ ]	[ ]	[x]	16. Software output is consistent with the input and with the results reported in the document reviewed.
[ ]	[ ]	[x]	17. Software verification and validation are addressed adequately. *(ORP QAPP criterion 2.6)*
[ ]	[ ]	[x]	18. Limits/criteria/guidelines applied to the analysis results are appropriate and referenced. Limits/criteria/guidelines were checked against references. *(ORP QAPP criterion 2.9)*
[ ]	[ ]	[x]	19. Safety margins are consistent with good engineering practices.
[ ]	[ ]	[x]	20. Conclusions are consistent with analytical results and applicable limits.

CHECKLIST FOR TECHNICAL PEER REVIEW

[ ]	[ ]	[x]	21. Results and conclusions address all points in the purpose. *(ORP QAPP criterion 2.3)*
[x]	[ ]	[ ]	22. All references cited in the text, figures, and tables are contained in the reference list.
[x]	[ ]	[ ]	23. Reference citations (e.g., title and number) are consistent between the text callout and the reference list.
[x]	[ ]	[ ]	24. Only released (i.e., not draft) references are cited. *(ORP QAPP criterion 2.1)*
[x]	[ ]	[ ]	25. Referenced documents are retrievable or otherwise available.
[x]	[ ]	[ ]	26. The most recent version of each reference is cited, as appropriate. *(ORP QAPP criterion 2.1)*
[x]	[ ]	[ ]	27. There are no duplicate citations in the reference list.
[x]	[ ]	[ ]	28. Referenced documents are spelled out (title and number) the first time they are cited.
[x]	[ ]	[ ]	29. All acronyms are spelled out the first time they are used.
[x]	[ ]	[ ]	30. The Table of Contents is correct.
[x]	[ ]	[ ]	31. All figure, table, and section callouts are correct.
[x]	[ ]	[ ]	32. Unit conversions are correct and consistent.
[x]	[ ]	[ ]	33. The number of significant digits is appropriate and consistent.
[ ]	[ ]	[x]	34. Chemical reactions are correct and balanced.
[x]	[ ]	[ ]	35. All tables are formatted consistently and are free of blank cells.
[x]	[ ]	[ ]	36. The document is complete (pages, attachments, and appendices) and in the proper order.
[x]	[ ]	[ ]	37. The document is free of typographical errors.
[x]	[ ]	[ ]	38. The tables are internally consistent.
[x]	[ ]	[ ]	39. The document was prepared in accordance with HNF-2353, Section 4.3, Attachment B, "Calculation Note Format and Preparation Instructions".
[ ]	[ ]	[x]	40. Impacted documents are appropriately identified in Blocks 7 and 25 of the Engineering Change Notice (form A-6003-563.1).
[ ]	[ ]	[x]	41. If more than one Technical Peer Reviewer was designated for this document, an overall review of the entire document was performed after resolution of all Technical Peer Review comments and confirmed that the document is self-consistent and complete.
[x]	**[ ]**	**[ ]**	**Concurrence**

Leona Aamot _____ 3/2/05

Reviewer (Printed Name and Signature) Date

* If No or NA is chosen, provide an explanation on this form.

Technical Edit

This page intentionally left blank.