SEP 30 1994

ENGINEERING DATA TRANSMITTAL

Page 1 of 1

1. EDT

608175

35 Station 21

2. To: (Receiving Organization) Distribution	3. From: (Originating Organization) Hanford Hazards Assessment	4. Related EDT No.: N/A
5. Proj./Prog./Dept./Div.: Emergency Preparedness	6. Cog. Engr.: Ralph E. Broz	7. Purchase Order No.: N/A
8. Originator Remarks: Emergency Preparedness Hazards Assessment for the Tank Farms		9. Equip./Component No.: N/A
		10. System/Bldg./Facility: Tank Farms
11. Receiver Remarks:		12. Major Assm. Dwg. No.: N/A
		13. Permit/Permit Application No.: N/A
		14. Required Response Date: 9/19/94

15. DATA TRANSMITTED					(F)	(G)	(H)	(I)
(A) Item No.	(B) Document/Drawing No.	(C) Sheet No.	(D) Rev. No.	(E) Title or Description of Data Transmitted	Approval Designator	Reason for Transmittal	Originator Disposition	Receiver Disposition
1	WHC-SD-PRP-HA-013		0	Tank Farms Hazards Assessment	AS	1/2	1	

16. KEY		
Approval Designator (F)	Reason for Transmittal (G)	Disposition (H) & (I)
E, S, Q, D or N/A (see WHC-CM-3-5, Sec.12.7)	1. Approval 4. Review 2. Release 5. Post-Review 3. Information 6. Dist. (Receipt Acknow. Required)	1. Approved 4. Reviewed no/comment 2. Approved w/comment 5. Reviewed w/comment 3. Disapproved w/comment 6. Receipt acknowledged

(G)		(H)	17. SIGNATURE/DISTRIBUTION (See Approval Designator for required signatures)				(G)	(H)
Reason	Dis p.	(J) Name	(K) Signature (M) MSIN	(L) Date	(J) Name	(K) Signature (M) MSIN	(L) Date	Reason Dis p.
4,1	1	Cog.Eng. R. E. Broz	A3-05	9/29/94				
1	1	Cog. Mgr. D. A. Marsh	A3-05	9/29/94				
		QA						
1	1	Safety J. M. Garcia	R3-05	9/29/94				
1	1	Ops. J. L. Lee	R2-50	9/29/94				

18. R. E. Broz 9/29/94 Signature of EDT Date Originator	19. D. A. Marsh 9/29/94 Authorized Representative Date for Receiving Organization	20. D. A. Marsh 9/29/94 Cognizant Manager Date	21. DOE APPROVAL (if required) Ctrl. No. ☐ Approved ☐ Approved w/comments ☐ Disapproved w/comments
--	--	--	---

MASTER

DISPATCHED BY THE DOE

BD-7400-172-1 (07/91)

DISCLAIMER

**Portions of this document may be illegible
in electronic image products. Images are
produced from the best available original
document.**

RELEASE AUTHORIZATION

Document Number: WHC-SD-PRP-HA-013 Rev. 0

Document Title: Tank Farm Hazards Assessment

Release Date: 9/29/94

* * * * *

This document was reviewed following the
procedures described in WHC-CM-3-4 and is:

APPROVED FOR PUBLIC RELEASE

* * * * *

WHC Information Release Administration Specialist:

C. Willingham
(Signature)

9/29/94
(Date)

SUPPORTING DOCUMENT		1. Total Pages ⁸³ 86
2. Title Tank Farm Hazards Assessment	3. Number WHC-SD-PRP-HA-013	4. Rev No. 0
5. Key Words Emergency Preparedness, Tank Farms, Hazards Assessment	6. Author Name: R. E. Broz <i>R E Broz</i> 9/29/94 Signature Organization/Charge Code 3A200/MD5EP	
7. Abstract This document establishes the technical basis in support of Emergency Planning activities for the Tank Farms on the Hanford Site. The document represents an acceptable interpretation of the implementing guidance document for DOE ORDER 5500.3A. Through this document, the technical basis for the development of facility specific Emergency Action Levels and the Emergency Planning Zone is demonstrated.		
<p>8. PURPOSE AND USE OF DOCUMENT - This document was prepared for use within the U.S. Department of Energy and its contractors. It is to be used only to perform, direct, or integrate work under U.S. Department of Energy contracts. This document is not approved for public release until reviewed.</p> <p>PATENT STATUS - This document copy, since it is transmitted in advance of patent clearance, is made available in confidence solely for use in performance of work under contracts with the U.S. Department of Energy. This document is not to be published nor its contents otherwise disseminated or used for purposes other than specified above before patent approval for such release or use has been secured, upon request, from the Patent Counsel, U.S. Department of Energy Field Office, Richland, WA.</p> <p>DISCLAIMER - This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, nor any of their contractors, subcontractors or their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or any third party's use or the results of such use of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. 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. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.</p>		<p>10. RELEASE STAMP</p> <div style="border: 1px solid black; padding: 10px; text-align: center;"> <p>OFFICIAL RELEASE BY WHC DATE SEP 30 1994</p> <p>35 Station 21</p> </div>
9. Impact Level <i>2S</i>		

APPROVED FOR
PUBLIC RELEASE
CW
9-29-94

TANK FARMS HAZARDS ASSESSMENT

R. E. Broz

TABLE OF CONTENTS

1.0	INTRODUCTION	1
2.0	FACILITY DESCRIPTIONS	2
2.1	Facility Location	2
2.2	Facility Mission	2
2.3	Single Shell Tanks	3
2.3.1	Tank Structures	3
2.3.1.1	Primary Tank	3
2.3.1.2	Concrete Tank	3
2.3.1.3	Dome Risers	8
2.3.2	Secondary Containment and Leak Detection	8
2.3.2.1	Single-Shell Tank Process and Service Pits	8
2.3.3	Single Shell Tank Farm Facility Descriptions	8
2.3.3.1	241-A Tank Farm Facilities (200 East Area)	8
2.3.3.2	241-AX Tank Farm Facilities (200 East Area)	9
2.3.3.3	241-B Tank Farm Facilities (200 East Area)	9
2.3.3.4	241-BX Tank Farm Facilities (200 East Area)	9
2.3.3.5	241-BY Tank Farm Facilities (200 East Area)	12
2.3.3.6	241-C Tank Farm Facilities (200 East Area)	12
2.3.3.7	241-S Tank Farm Facilities (200 West Area)	12
2.3.3.8	241-SX Tank Farm Facilities (200 West Area)	13
2.3.3.9	241-T Tank Farm Facilities (200 West Area)	13
2.3.3.10	241-TX Tank Farm Facilities (200 West Area)	14
2.3.3.11	241-TY Tank Farm Facilities (200 West Area)	14
2.3.3.12	241-U Tank Farm Facilities (200 West Area)	14
2.4	Double Shell Tank Farms and Systems	15
2.4.1	Tank Structures	15
2.4.2	Secondary Containment and Leak Detection	16
2.4.3	Waste Transfer Systems	16
2.4.4	Double-Shell Tank Farm Ventilation System	17
2.4.5	Double Shell Tank Farm Facility Descriptions	17

2.4.5.1	241-AN Tank Farm Facilities (200 East Area)	17
2.4.5.2	241-AP Tank Farm Facilities (200 East Area)	19
2.4.5.3	241-AW Tank Farm Facilities (200 East Area)	19
2.4.5.4	241-AY and AZ Tank Farm Facilities (200 East Area)	20
2.4.5.5	241-SY Tank Farm Facilities (200 West Area)	20
2.5	Waste Transfer Systems	20
2.6	Evaporator/Crystallizer	20
2.6.1	242-A (200 East Area)	20
2.6.2	242-S (200 West Area)	21
2.7	204-AR Unloading Facility	22
3.0	IDENTIFICATION AND SCREENING OF HAZARDS	22
3.1	Radioactive Hazards	22
3.2	Non-Radioactive Hazards	27
4.0	HAZARD CHARACTERIZATION	28
4.1	Radioactive Hazards	28
4.1.1	Strontium and Cesium	28
4.1.2	Uranium	28
4.1.3	Cobalt	28
4.1.4	Plutonium	29
4.1.5	Americium	29
4.2	Non-Radiological Hazards	30
4.2.1	Ammonia	30
4.2.2	Acetone	30
4.2.3	Nitric Acid	31
4.2.4	Sodium Hydroxide	32
5.0	EVENT SCENARIOS	32
5.1	Radiological Releases	32
5.1.1	Peripheral Seal, HEPA Filter Failure - Active Ventilation	32
5.1.2	HEPA Filter Failure - Active Ventilation	33
5.1.3	Release During HEPA Filter Changeout or Vehicle Collision	34
5.1.4	Loss of Loop Seal - Passive Ventilation	34
5.1.5	Primary Tank Pressurization	34
5.1.6	Waste Transfer Hazards 204-AR	35
5.1.7	242-A Liquid/Airborne Release	36
5.2	Containment Breach	36
5.2.1	Waste Leak from Jumper, Connector, or DCRT - Spray Leak	36
5.2.2	Loss of 242-A Confinement	37

5.3	Uncontrolled Chemical Reactions and Thermodynamic Occurrences	37
5.3.1	Hydrogen Burn	37
5.3.2	Hydrogen Explosion in Dome Vapor Space	38
5.4	Non-Radiological Scenarios	39
5.4.1	Release of Ammonia	39
5.4.2	Acetone	39
5.4.3	Nitric Acid	39
5.4.4	Sodium Hydroxide	39
5.5	Natural Emergencies	39
5.5.1	Seismic Event (Earthquake)	39
5.5.1.1	Seismic Activity Pipe Break/Ventilation Breach	39
5.5.1.2	SST Dome Failure - Seismic	40
5.5.1.3	Thermal Roll-over	41
5.5.1.4	242 Evaporator Seismic Event	41
5.5.2	Tornado/High Winds/Thunderstorm	42
5.5.3	Volcanic Ashfall/Snowfall	42
5.5.4	Range Fire	43
5.5.5	Flood	43
5.6	Security Events	43
5.6.1	Explosive Device	43
5.6.2	Sabotage	43
5.6.3	Hostage Situation	43
5.6.4	Armed Intruder	43
5.6.5	Aircraft Crash	44
6.0	EVENT CONSEQUENCES	44
6.1	Calculation Models	44
6.2	Receptor Locations	45
6.3	Radiological Releases	45
6.3.1	Peripheral Seal, HEPA Filter Failure - Active Ventilation	45
6.3.2	HEPA Filter Failure - Active Ventilation	45
6.3.3	Loss of Loop Seal - Passive Ventilation	45
6.3.4	Primary Tank Pressurization	46
6.3.5	204-AR Waste Transfer From Rail Car With Fire	46
6.3.6	242-A Liquid/Airborne Release	46
6.3.7	Waste Leak from Jumper, Connector, or DCRT - Spray Leak	46
6.3.8	Loss of 242-A Confinement	46
6.3.9	Hydrogen Burn	47
6.3.10	Hydrogen Explosion in Dome Void	47
6.4	Non-Radiological Releases	47
6.4.1	Release of Ammonia	47
6.4.2	Acetone	47
6.4.3	Nitric Acid	47
6.4.4	Sodium Hydroxide	47

6.5	Natural Emergencies	48
6.5.1	Earthquake	48
6.5.1.1	Seismic Activity Pipe Break/Ventilation Breach	48
6.5.1.2	SST Dome Failure - Seismic	48
6.5.1.3	Thermal Roll-over	48
6.5.1.4	242 Evaporator Seismic Event	48
6.5.2	Tornado/High Winds/Thunderstorm	48
6.5.3	Volcanic Ashfall/Snowfall	49
6.5.4	Range Fire	49
6.6	Security Contingencies	49
6.6.1	Explosive Device	49
6.6.2	Sabotage	49
6.6.3	Hostage Situation	49
6.6.4	Armed Intruder	49
6.6.5	Aircraft Crash	49
7.0	EMERGENCY PLANNING ZONE	50
7.1	The Minimum EPZ Radius	50
7.2	Tests of Reasonableness	51
8.0	EMERGENCY CLASSES, PROTECTIVE ACTIONS, AND EMERGENCY ACTION LEVELS	52
8.1	Emergency Classes	52
8.2	Emergency Action Levels	53
9.0	MAINTAINANCE AND REVIEW OF THIS HAZARDS ASSESSMENT	53
10.0	REFERENCES	54
APPENDIX A	Tank Farm EMERGENCY ACTION LEVELS	55

LIST OF FIGURES

Figure 2.1	Location of Plant Relative to Major Metropolitan Areas . . .	4
Figure 2.2	200 East Area	5
Figure 2.3	200 West Area	6
Figure 2.4	Waste Storage and Transfer Facilities	7
Figure 2.5	Typical Single Shell Tank Elevation	10
Figure 2.6	Typical Diversion Box Layout	11
Figure 2.7	Double Shell Waste Tank Elevation	18
Figure 2.8	Maps, Distances, and Facility Details	23
Figure 2.9	Cutaway View of the 242-A Evaporator-Crystallizer Facility .	24

LIST OF TABLES

Table 3.1	Tank Farm Radiological Concentrations: 100th Percentile Activities	25
Table 3.2	Nominal Tank Crust Activity	26
Table 3.3	Rail Car Inventory	27
Table 3.4	Comparison of Extremely Hazardous Chemical Inventory with TPQ Values	27
Table 4.1	Physical Properties of Concentrated Ammonia	30
Table 4.2	Physical properties of Acetone	30
Table 4.3	Physical Properties of Concentrated HNO ₃	31
Table 4.4	Physical Properties of Sodium Hydroxide Solution	32
Table 5.1	Peripheral Seal, HEPA Filter Failure and Activity Release at Ground Level	33
Table 5.2	HEPA Filter Failure and Activity Release at Ground Level . .	33
Table 5.3	Loop Seal Failure and Activity Released	34
Table 5.4	Primary Tank Pressurization and Activity Released	35
Table 5.5	204-AR Rail Car Release with Fire	35
Table 5.6	242-A Filter Breach and Release	36
Table 5.7	Jumper, Connector, or DCRT Spray/Activity Released	36
Table 5.8	242-A Jumper Breach and Release	37
Table 5.9	Tank Hydrogen Burn and Crust Release	38
Table 5.10	Hydrogen Explosion in Dome Vapor Space and Release	38
Table 5.11	Seismic Event and Activity Released	40
Table 5.12	SST Dome Failure/Seismic Event Release	40
Table 5.13	Thermal Roll-over With ALC Failure and Activity Released . .	41
Table 5.14	242-A Evaporator Seismic Event and Activity Released	41
Table 5.16	Estimated Ash Depth at 200 Area from Major Eruptions	42
Table 8.1	Radiological Release Criteria	52
Table 8.2	Non-Radiological Release Criteria	52

1.0 INTRODUCTION

Hanford contractors are writing new facility specific emergency procedures in response to new and revised U.S. Department of Energy (DOE) Orders on emergency preparedness. The orders reflect initiatives to improve the emergency preparedness and response capabilities at DOE facilities. The concept of the new procedures is that operational emergencies will be assigned an emergency category based on the severity of the emergency and then predetermined actions for the appropriate emergency category will be implemented. The new procedures supplement and extend the existing facility specific Building Emergency Plan and DOE and contractor general emergency response procedures.

Emergency procedures are required for each Hanford facility that has the potential to exceed the criteria for the lowest level emergency, an Alert. The set includes: (1) a facility specific procedure on Recognition and Classification of Emergencies, (2) and area procedures on Initial Emergency Response and, (3) an area procedure on Protective Action Guidance. The first steps in developing these procedures are to identify the hazards at each facility, identify the conditions that could release the hazardous material, and calculate the consequences of the releases. These steps are called a Hazards Assessment.

DOE Order 5500.3A and the Emergency Management Guide on Hazards Assessment provide the requirements and guidance for performing and documenting the Hazard Assessments. The final product is a document that is similar in some respects to a Safety Analysis Report (SAR). The document could be produced in a month for a simple facility but could take much longer for a complex facility. Hanford has both types of facilities. A strategy has been adopted to permit completion of the first version of the new emergency procedures before all the facility Hazards Assessments are complete. The procedures will initially be based on input from a task group for each facility. Existing safety documentation will be reviewed and a limited amount of analysis performed, if necessary, to support the procedure development. The emergency procedures will then be revised, if necessary, when the Hazards Assessments per the DOE guidance and orders are completed. This strategy will put improved emergency procedures in place sooner and therefore enhance Hanford emergency preparedness.

The purpose of this document is to summarize the applicable information contained within the Waste Tank Facility "Interim Safety Basis Document, WHC-SD-WM-ISB-001" (C.E. Leach, S.M. Stahl 1992) as a resource, since the SARs covering Waste Tank Operations are not current in all cases. This hazards assessment serves to collect, organize, document and present the information utilized during the determination process.

2.0 FACILITY DESCRIPTIONS

Detailed descriptions of the Waste Tank Facilities and the Hanford site are found in sections 1, 2 and 3 of the Hanford Site Tank Farm Facilities Interim Safety Basis Document (ISB) WHC-SD-WM-ISB-001, Volume 2. The following facility description summary is derived from that document.

2.1 Facility Location

The Waste Tank facilities are located in the 200-East and West Areas near the center of the $1.45\text{E}+9 \text{ m}^2$ DOE Hanford Reservation in the south central part of the State of Washington along the west bank of the Columbia River (see Figure 2.1). In addition to the Waste Tank facilities, the Hanford Reservation contains the following major facilities or activities: six reactor areas designated 100-B, 100-N, 100-K, 100-D, 100-H, and 100-F, which contain eight shutdown production reactors and one shutdown dual purpose reactor (N Reactor); the 300 Area which contains a shutdown fuel fabrication facility and laboratory facilities supporting all of DOE's Hanford Programs; two areas for waste processing and waste storage designated 200-E and 200-W Areas; a commercial nuclear waste burial operation on land leased to the State of Washington; the Fast Flux Test Facility (FFTF); and an operating Washington Public Power Supply System (WPPSS) Nuclear Power Plant. Major metropolitan areas within the broad vicinity of the plant, Figure 2.1 include Spokane, Washington, about 193.1 kilometers (km) to the northeast; Seattle, Washington, about 209.2 km to the northwest; and Portland, Oregon, about 241.4 km to the southwest. Two other areas of significant population density include Moses Lake, Washington, about 48.3 km north of the K-area and the Yakima Valley, in Washington, extending from Yakima, about 72.4 km west of the plant, to Richland, Kennewick, and Pasco, in Washington, about 65.3 km southeast of the tank farms.

2.2 Facility Mission

The Hanford Waste Tanks are for the storage of high level radioactive and mixed waste from chemical separations activities during plutonium production from 1943 to the present. The current plans are to stabilize the waste remaining in underground storage tanks and prepare the waste for permanent storage. Several issues associated with characterization and storage of the high level waste are yet unresolved and considerable effort is being expended to determine the best technological means to continue to treat and store the waste. The waste tanks received waste from all processing plants located within the 200 (Chemical Separations) Areas including PUREX, B-Plant, WESF, Hot Semi Works, REDOX, U-Plant, T-Plant, the Analytical Laboratories (222-S) and various other waste treatment facilities in the separations areas. Wastes included radiological and chemical as well as liquid waste streams transported from the 300 Area via rail car.

The ISB also states that the only seismic design criteria found in the literature was specified for the 241-AX Tank Farms prefabricated steel buildings as Uniform Building Code (UBC) Zone 2.

The ISB states that new double shell tank farm structures, equipment, and piping classified as Safety Class 1 are designed to withstand a Safe Shutdown Earthquake (designated a Design Basis Earthquake for the 241-AZ Tank Farm), which imposes a horizontal acceleration of 0.25g and a vertical acceleration of 0.17g (2/3 of the horizontal). The other systems and support facilities (including the Tank Farm ventilation system and its components for tanks 241-AN-101 through 106 only), will comply with UBC for Seismic Zone 2. For normal operation condition in the 241-AZ Tank Farm, an Operating Basis Earthquake (0.12g horizontal and 0.08g vertical) is superimposed upon all other design loads. The 241-AY Tank Farm functional design criteria does not directly impose seismic qualification for the 241-AY Tank Farm.

2.3 Single Shell Tanks

2.3.1 Tank Structures

2.3.1.1 Primary Tank

The primary tank provides containment of the waste material, Figure 2.5. The 149 Single Shell Tanks (SSTs) are located on 12 separate tank farms. One hundred thirty-three of these tanks are 22.9 meters (m) in diameter with nominal capacities of 2.0E+6 to 3.8E+6 liters (l). Sixteen of the tanks are 63.7 m in diameter with capacities of 2.1E+5 l each. The tanks are reinforced-concrete, cylindrical, dome-roofed, buried tanks with a single steel liner lying across the tank bottom and up the concrete tank wall but not the domed top. Surface live loads, static and dynamic soil loads, and hydrostatic and hydrodynamic loads are reacted by the reinforced-concrete tank, dome and base mat. The steel liner (structurally independent from the reinforced-concrete tank) provides the confinement for the liquid wastes.

2.3.1.2 Concrete Tank

A typical exterior reinforced concrete tank consists of foundation, walls, and dome. The concrete tank is designed to sustain soil loads, dead loads, live (vehicles/cranes) loads, seismic loads, and loads caused by thermal gradients between the radioactive wastes and the surrounding soil.

Figure 2.1 Location of Plant Relative to Major Metropolitan Areas

Figure 2.2 200 East Area

200
EAST
AREA

Q135 H-2-24781

5

LEGEND

CHAIN LINK FENCE
POST & CHAIN FENCE
PERIMETER FENCE
RAILROAD
ROAD

4/28/89

CAOFILE# ZILM0007_2002

Figure 2.3 200 West Area

Figure 2.4 Waste Storage and Transfer Facilities

2.3.1.3 Dome Risers

Numerous vertical pipes (called risers) penetrate the tank domes into various parts of the tank. Common diameters of the risers are 0.1 m, 0.3 m, and 1.1 m. Other sizes are used infrequently. Dome risers provide access to the tank interior for a variety of operating and monitoring equipment. Dome risers emerge at the following locations: Covered pits; ground level or below as spare risers; underground, joined to a pipeline; ventilation air supply and exhaust ducts.

Dome risers use instruments that measure or monitor, temperature, pressure, specific gravity, liquid levels, and sludge levels. The remaining risers are used for sampling of tank liquid contents, pumping and/or draining of tank contents, construction or observation points, spare lines, and occasionally photographic purposes.

2.3.2 Secondary Containment and Leak Detection

2.3.2.1 Single-Shell Tank Process and Service Pits

Process and service pits are concrete enclosures placed belowgrade that typically house pumps, monitoring equipment, or diversion equipment. The following types of pits are typically associated with SSTs.

- Central pump pit - located at the center of the tank dome, through which waste normally is pumped out of the tank
- Receiver pit - provides a dedicated line for moving waste from a facility to a tank
- Valve pit - allows flow of waste to be diverted to pipelines using valves and/or jumpers (pit is located at a central location in a tank farm)
- Flush pits - through which water (sometimes mixed with steam) is supplied to flush out pipelines after waste transfer
- Seal pot pit - through which condensate is collected and removed from the ventilation piping.

2.3.3 Single Shell Tank Farm Facility Descriptions

2.3.3.1 241-A Tank Farm Facilities (200 East Area)

The 241-A Tank Farm complex is located directly north of the 241-AW Tank Farm, in the south east corner of the 200 East Area. The 241-A Tank Farm include the following main facilities/buildings: 241-A Tank Farm; 241-A-271 Control Room; 241-A-702 Ventilation Building; 241-A-401 Condenser Building; 241-A-701 Compressor Building.

The 241-A Tank Farm has six tanks rated at $3.8\text{E}+6$ l each. These tanks were constructed during 1954 and 1955. All tanks in the 241-A Tank Farm have been inactive since November 1980.

2.3.3.2 241-AX Tank Farm Facilities (200 East Area)

The 241-AX Tank Farm is located north of the 241-A Tank Farm complex and east of the 241-AY Tank Farm complex. Additional facilities associated with the 241-AX farm are the 241-AX-2707 Change House.

2.3.3.3 241-B Tank Farm Facilities (200 East Area)

The B Farm complex is located north of B-Plant in Baltimore Avenue in the 200 East Area. The 241-B Tank Farm, one of the first four tank farms constructed, was built from 1943-44. The 241-B Tank Farm has 12 tanks rated at $2.0\text{E}+6$ l each. These tanks are 22.9 m in diameter. The B Tank Farm also has four smaller tanks, each 6.1 m in diameter, and rated at $2.1\text{E}+5$ l each. These tanks were constructed during 1943 and 1944. The 241-B Tank Farm tanks were used to settle and store low-level waste from B Plant, primarily first- and second-cycle cladding removal waste and evaporator bottoms. Tanks 241-B-102, 103, 106, 108, 109, 112 were modified to accept in-tank solidification ([ITS]-1 and ITS-2) evaporator bottoms. Residual liquor was removed from four tanks (241-B-101, 105, 107, 110) when they were inactivated and was pumped to tank 241-B-102.

2.3.3.4 241-BX Tank Farm Facilities (200 East Area)

Tanks in the 241-BX Tank Farm were built from 1946 to 1947 using the original tank design for 241-B Tank Farm. The tanks were arranged in four cascades of three tanks each. Tanks in the 241-BX Tank Farm supported cross-site transfers and the 242-A Evaporator until the Double Shell Tank system became the only receivers of wastes.

The 241-BX Tank Farm has twelve $2.0\text{E}+6$ l SSTs. Tanks 241-BX-101 through 106 received B Plant metal waste until the two cascades were full in January 1950. Tanks 241-BX-107 through 112 received B Plant first-cycle waste and Cell 23 concentrated waste. During the ITS-1 program, tank 241-BX-110 received evaporator bottoms. Several tanks served to stage the feed. The first two cascades also received tributyl phosphate (TBP) waste. One Double Contained Receiver Tank (DCRT), 244-BX serves the 241-B, 241-BX and 241-BY Tank Farms for salt well pumping activities.

Figure 2.5 Typical Single Shell Tank Elevation

29111046.2

September 28, 1994

Figure 2.6 Typical Diversion Box Layout

38008090.11

2.3.3.5 241-BY Tank Farm Facilities (200 East Area)

The 241-BY Tank Farm was built from 1948 to 1949, using a modified 241-B Tank Farm design. The capacity of each of the 12 tanks is 2.8×10^6 l and the riser pattern is modified to gain more uniform access to the tank interior. The tanks were arranged in four cascades of three tanks each. 241-BX and 241-BY Tank Farms are fenced as a unit. The 241-BY Tank Farm were initially operated to back up 241-BX Tank Farm. Tanks 241-BY-101 through 106 received B Plant metal wastes in cascade after 241-BX Tank Farm was full. Tanks 241-BY-107 through 110 received B Plant first cycle waste and TBP waste, while tanks 241-BY-111 and 112 were used for the temporary storage of metal waste.

2.3.3.6 241-C Tank Farm Facilities (200 East Area)

The 241-C Tank Farm is located north of the Plutonium-Uranium Extraction Plant (PUREX) Complex, just northwest of the 241-AN Tank Farm. The 241-C Tank Farm has twelve 2.0×10^6 l tanks (241-C-101-112) and four 2.1×10^5 l tanks (241-C-201-204). These tanks were constructed during 1943 and 1944. Twelve of the tanks are 22.9 m in diameter, and four are 6.1 m in diameter. The 22.9 m diameter tanks are arranged in four cascades of three tanks each. The 6.1 m diameter tanks were also used to settle waste.

The 241-C Tank Farm has been used to support several operations. The first cascade began in March 1946 to store metal waste from B Plant. Tanks 241-C-101 through 106 initially stored metal wastes and 241-C-107 through 112 received first-cycle B Plant decontamination waste. The first cascade (241-C-101 through 103) was pumped and converted to a TBP receiver in 1953. Several tanks acted as feed and receiver tanks for PUREX fission product waste processed in vault 244-CR. The processing left a large amount of strontium in tank 241-C-106; it contains the highest heat load of the SSTs.

Studies indicate tanks 241-C-105 and 106 contain quantities of heat-generating radionuclides in the range of 25,000 Btu/hr for tank 241-C-105 and 110,000 Btu/hr for tank 241-C-106. Three tanks 241-C-103, 104, and 107 have received insoluble, strontium-leached sluicing solids (terminal solids) from the operation of the 244-CR vault resulting in structural concrete temperatures below 300°F.

One DCRT, 244-CR serves the 241-C Tank Farm for salt well pumping activities.

2.3.3.7 241-S Tank Farm Facilities (200 West Area)

This facility is located on 13th street, northwest of S Plant (the Reduction-Oxidation [REDOX] plant). The 241-S Tank Farm includes the following main facilities/buildings: 241-S Tank Farm; 242-S Evaporator/Crystallizer; and the 244-S DCRT.

The 241-S Tank Farm has twelve 2.8×10^6 l SSTs constructed to the second-generation tank design similar to the original 22.9 m diameter tanks but with increased operating depth. These tanks were constructed during 1950 and 1951. The 241-S Tank Farm received several types of REDOX Plant wastes in all four cascades (waste segregation was not practiced until 1955). In 1953, surface condensers were installed which self-concentrated the wastes in the first two cascades by disposing of vapor condensate via cribbing. Further concentration was achieved in most of the tanks during the 1970's using the 242-S Evaporator.

2.3.3.8 241-SX Tank Farm Facilities (200 West Area)

The 241-SX Tank Farm has 15 SSTs representing third-generation tank design. Each can hold 3.8×10^6 l. These tanks were constructed during 1953 and 1954. These were the first tanks designed for self-boiling waste. Original construction included underground duct headers connected to a common condenser-ventilation system. Tanks 241-SX-101 through 106, vent through the system to tank 241-SX-109. Tanks 241-SX-107 through 112 and 114, are connected by an above ground vent system which is exhausted to 296-S-15.

The first six tanks started operation in 1954, receiving REDOX Plant salt waste and first-cycle condensate. The salt waste tanks began boiling shortly after startup, but the condensate tanks took up to 2 years to start boiling. After the tanks had self-concentrated for several years, they served as receiver tanks for the 242-S Evaporator.

The other nine tanks (241-SX-107 through 115) were not released for use until late 1955. They received REDOX boiling high-level waste and salt waste. Self-concentration began very soon after startup. The heat load on the vent system increased as wastes self-concentrated, and in time condensate was refluxed (recycled) back to the tanks to maintain an even cooling rate. (Recycled condensate evaporates and removes heat.)

Airlift circulators were necessary to mix tank contents and prevent bumping. Today, the airlift circulators are blanked and deenergized and do not work.

2.3.3.9 241-T Tank Farm Facilities (200 West Area)

The 241-T Tank Farm complex is located directly west of the T Plant, in the 200 West Area of the Hanford Site. The 241-T Tank Farm was one of the first four tank farms built from 1943 to 1944. 241-T Tank Farm has 16 SSTs. Twelve of the tanks are 22.9 m in diameter with capacities of 2.0×10^6 l, and four are 6.1 m in diameter with 2.1×10^5 l capacities. The 22.9 m diameter tanks are arranged in four cascades of three tanks each. Feed was pumped into the high tank and overflowed into the low tank. Each cascade in succession is one vertical foot lower than the previous one. The four 6.1 m diameter tanks were also used to settle waste, with the supernate overflowing into a crib (soil disposal).

The first cascade began receiving metal waste from the T Plant bismuth phosphate process in December, 1944. The other cascades received decontamination-cycle wastes. Over several years, the tanks were emptied and used for ion exchange wastes, 221-T Plant wastes, and TBP waste from the 244-CR vault (generated after the fourth cascade in 241-C Tank Farm became full).

2.3.3.10 241-TX Tank Farm Facilities (200 West Area)

The 241-TX Tank Farm was constructed from 1947 to 1948 using a modified 241-B Tank Farm design that consisted of 18 tanks with a $2.8E+6$ l capacity arranged in three cascades of four tanks each and two cascades of three tanks. Only half the tanks were used in cascade.

The first two cascades (tanks 241-TX-101 through 108) were filled with T Plant metal waste. During the 1950's, six of the tanks were sluiced until empty, at which time the tanks began receiving REDOX waste. Tanks 241-TX-103 and 108 were used for TBP waste after sluicing. These tanks were used as bottoms and recycled for the 242-T Evaporator in later years. The third cascade (tanks 241-T-108 through 112) stored first-cycle decontamination waste before being used with the 242-T Evaporator.

The last six tanks were not used until the early 1950's and were used in combination with the 242-T Evaporator as feed, bottoms, and recycle tanks.

2.3.3.11 241-TY Tank Farm Facilities (200 West Area)

The 241-TY Tank Farm was built from 1951 to 1952. All six tanks have a $2.8E+6$ l capacity and are of the same design as the tanks in the 241-S Tank Farm. Tanks in the 241-TY Tank Farm were used to settle and decant low-level wastes and were used as lag storage for the 242-T Evaporator feed.

2.3.3.12 241-U Tank Farm Facilities (200 West Area)

The 241-U Tank Farm is located directly west of the U Plant on Camden Avenue. The 241-U Tank Farm was built from 1943 to 1944. Tanks in the 241-U Tank Farm received slurry from the 242-S Evaporator. Twelve of the tanks are 22.9 m in diameter with capacities of $2.0E+6$ l, and four are 6.1 m in diameter with capacities of $2.1E+5$ l. The 22.9 m diameter tanks are arranged in four cascades of three tanks each; feed was pumped into the high tanks and overflowed into the tank. The 6.1 m diameter tanks also were used to settle/decant waste.

Tanks 241-U-101 through 109 received metal waste from T Plant and were subsequently sluiced back to the TBP recovery process in U Plant. Waste was received from various storage tanks for processing in the 242-T Evaporator. The last cascade (241-U-110 through 112) received first-cycle decontamination waste that was self-evaporated. All three tanks were then used for REDOX waste storage and evaporator feed.

Tank 241-U-101 received a variety of solid waste items from May, 1969 to June, 1971. These included experimental fuel elements, shroud tubes, and samarium balls. The total fissile material contents of the waste was 1,530 grams of 4.5% enriched uranium and 6 grams of plutonium.

2.4 Double Shell Tank Farms and Systems

The six DST farms are located in the 200 East and 200 West Areas. The DST farms became operational in the 1980's. For efficiency during construction and operation, the $3.8\text{E}+6$ l tanks were grouped into these six DST farms: 241-AN, 241-AP, 241-AW, 241-AZ and 241-SY. The 241-SY and 241-AZ Tank Farms are referred to collectively as the Aging Waste Facilities (AWF). Tank Farm 241-SY is the only DST farm located in the 200 West Area. The other five DST farms are in the 200 East Area. There are 28 tanks in the system. Each DST can hold $3.8\text{E}+6$ to $4.4\text{E}+6$ l of high-level mixed waste for a maximum combined storage capacity of $124.2\text{E}+6$ l for up to 50 years.

DSTs have been used to store liquid radioactive waste (transuranic [TRU], high-level, low-level, and Hanford Site facility waste). DSTs have been used exclusively for receiving liquid waste since 1980, when single shell tanks were retired from waste-receiving service. Several operating plants in the 200 East and 200 West areas of the Hanford Site transfer mixed wastes from the facility through buried transfer lines to the DSTs. The liquid waste is accumulating in the DSTs until it can be disposed of at the Hanford Waste Vitrification Plant.

In addition to the tanks and tank farms, the DST system includes the following ancillary equipment; transfer lines; double contained receiver tanks; diversion boxes and valve pits; diverter stations; and catch tanks.

2.4.1 Tank Structures

The DSTs are fabricated as three concentric tanks (see Figure 2.7). The free-standing primary tank contains the waste material. The primary tank is 22.9 m in diameter and 14.2 m high at the crown. The primary tank sits on a concrete insulating pad. The secondary tank, 1.5 m larger in diameter than the primary tank, creates a surrounding space called the annulus. The secondary tank sits on a concrete structural pad. The completely enclosed annulus serves as a containment barrier if the primary tank should leak. The annulus is ventilated and continually monitored for evidence of primary tank leakage. The third tank is a concrete shell that encloses both primary and secondary tanks for additional containment, radiation shielding, and structural support. A summary of the dimensions of the tanks is provided in Table 2.7

The component elements of a typical DST are as follows:

- Primary containment
 - Concrete foundation
 - Primary tank
 - Insulating concrete pad
- Secondary containment
 - Secondary tank
 - Concrete shell
 - Dome and annulus risers
- Waste transfer system
 - Pits and enclosures
 - Piping
- Ventilation system
- Leak detection/monitoring instrumentation systems
- Electrical system.

2.4.2 Secondary Containment and Leak Detection

The Secondary Tank System is built directly on top of the foundation. The 24.4 m-diameter steel secondary tank surrounds the (22.9 m-diameter steel primary tank. This forms a 0.78 m-wide annular space between the primary and secondary tanks. The secondary tank wall joins the primary tank dome at the upper haunch area. These two tanks are enclosed in a reinforced concrete shell. The secondary liner also is constructed of carbon steel varying in thickness from 0.01 to 0.013 m. The bottom of the secondary tank is fabricated from 0.01 m steel plate. The secondary tank lower knuckle is made of a 0.013 m steel plate that extends about 0.6 m from the floor and is welded to a 0.01 m wall plate. The resulting annular space is designed to contain primary tank leaks, and protect surrounding ground from contamination.

2.4.3 Waste Transfer Systems

The types of process and auxiliary transfer systems used in the DST Tank Farms include the following:

- Slurry lines (SL) — 0.05 m-diameter primary pipes encased in 0.1 m-diameter pipes
- Supernatant lines (SN) — 0.08 m-diameter primary pipes encased in 0.15 m-diameter pipes
- Process waste lines (PW) — 0.05 m-diameter primary pipes encased in 0.1 m-diameter pipes
- Drain lines (DR) — Direct-buried, 0.05 m- to 0.1 m-diameter pipes
- Ventilation lines (exhaust/air intake [EXH/INT]) — Direct-buried 0.1 m- to 0.6 m-diameter pipes

- Auxiliary piping; vent piping, raw water pipes, steam/condensate piping, compressed air piping.

2.4.4 Double-Shell Tank Farm Ventilation System

The primary method of contamination control for the DSTs is confinement. Confinement is achieved in the primary tanks and annuli of the tanks by proper ventilation and filtration. The first indication of a leak from the primary tank to the annulus is likely to be carried by the annulus vent system to a radiation monitor. Understanding the purpose and function of the heating, ventilation and air conditioning systems (HVAC) in the tank farms allows the operator to operate these systems safely and react appropriately in the event of an emergency.

The HVAC systems serve several purposes in the tank farm facilities. Tank farm HVAC systems are designed to remove air, moisture, and heat from primary tank and annular spaces which reduces corrosion on the outside surface of the primary tank. More importantly, it provides early detection of a leak due to its associated radiation monitoring system, alarms. This also ensures containment by sweeping air into the tank. Negative pressure or vacuum is maintained on both the primary tank and annulus of tanks. This reduces the possibility of an uncontrolled release of airborne contaminants to the environment. The air is continuously monitored and sampled upon discharge to ensure that emissions are within acceptable radiological (and in some cases, chemical) release limits.

2.4.5 Double Shell Tank Farm Facility Descriptions

2.4.5.1 241-AN Tank Farm Facilities (200 East Area)

The 241-AN Tank Farm has seven DSTs, each with a maximum capacity of 4.4×10^6 l. The tanks essentially are identical except for tank 241-AN-101, which has two additional concrete process pits (01D and 01E), and tank 241-AN-107, which has 80 risers because of the 21 airlift circulator (ALC) assemblies installed in the tank. The 241-AN Tank Farm is an integrated facility with dedicated service and ventilation equipment. The tanks are specifically designed with slurry bottoms for storage of double-shell slurry produced at the 242-A Evaporator.

241-AN also includes the 241-AN-271 Control Building. This control building functions the same way as most of the other 241-A Tank Farm control buildings. All alarms and monitors for ventilation, temperature, and leak detection are centered here. Electrical power distribution for the 241-AW Tank Farm also is routed from here. This 6.1 m by 9.8 m building is constructed of fire-resistive materials consisting of steel framing with metal-insulated sandwich panel walls and fiberglass batting with plastic backing for insulation in the steel frame roof.

Figure 2.7 Double Shell Waste Tank Elevation

39008090.23

The 241-AN Tank Farm also includes the 241-AN-273 Water Service Building. This building houses instrumentation and backflow prevention devices for the raw water, steam, and flushing lines.

Additionally, the 241-AN-701 Compressor Building is located within the farm. An air compressor within this building supplies instrument air to all of the 241-AN Tank Farm. The compressor operates automatically, feeding an 303 l capacity air tank. This air is provided to operate pneumatic instruments and as purge air that is injected into dip tubes and pressure sensing instrument legs.

2.4.5.2 241-AP Tank Farm Facilities (200 East Area)

The 241-AP Tank Farm is the most recently constructed (1983-86) and has eight 4.4×10^6 l DSTs and associated facilities. The 241-AP Tank Farm is designed to operate in a manner similar to the 241-AW Tank Farm. Liquid wastes are transferred to or from the 241-AP Tank Farm via 241-AW Tank Farm facilities.

The 241-AP-271 Instrument Control Building is located within this Tank Farm. The instrument control building houses the 241-AP Tank Farm electrical relays, alarm annunciators, motor control center, temperature display system, and heat-tracing control console. All instrumentation from the Tank Farm and electrical supplies are distributed through this building. The 241-AP Tank Farm uses a microprocessor-based digital temperature display system, while the other tank farms use portable potentiometer and manual selector switches.

The 241-AP-273 Water Service Building and the 241-AP-273 Compressor Buildings are contained within the tank farm. The service building provides all raw water for the farm, and the compressor building houses the instrument air supply.

2.4.5.3 241-AW Tank Farm Facilities (200 East Area)

The 241-AW Tank Farm has six DSTs, each capable of holding a maximum of 4.4×10^6 l. The farm is an integrated facility that has dedicated ventilation and service equipment. The 241-AW Tank Farm stores low-heat radioactive liquid waste generated by PUREX. The tanks are specifically designed for storage of 242-A Evaporator feed and have slurry bottoms.

Tank 241-AW-102 is the feed tank for the 242-A Evaporator and is used for all waste concentration operations. Tank 241-AW-101 was designed to be used as an alternate feed tank. Any waste designated for concentration is pumped to feed tank 241-AW-102 for transfer to the 242-A Evaporator.

In addition to the six tanks, the 241-AW Tank Farm includes the 241-AW-271 Control Building, the 241-AW-273 Compressor Building, and the 241-AW-273 Water Service Building. These buildings provide necessary services for the 241-AW Tank Farm.

2.4.5.4 241-AY and AZ Tank Farm Facilities (200 East Area)

The aging waste facilities, of which 241-AY and AZ are a part, are located in the 200 East Area of the Hanford Site. These farms are located in a complex of tank farms known as the PUREX Plant 241-A Tank Farm complex.

Aging waste was transferred from PUREX to the 241-AY and AZ Tank Farms through either a primary line or a backup line. The primary line was routed through the 241-AX-155 diversion box to one of the two aging waste facilities. The tank design used in the 241-AY and AZ Tank Farms reflects a departure from the basic design used in all previous tanks. This design features a heat-treated, stress-relieved primary steel liner and a nonstress-relieved outer steel liner, both inside a reinforced concrete shell. These tanks also differ from other DSTs by containing two major support systems and a subsystem. These additional systems, along with or in addition to air lift circulators, steam coils, and exhaust condensers, allow the tanks to receive and store high-heat generating wastes with a minimum probability of a loss of integrity.

The 241-AY Tank Farm also contains the 241-AY Control Room and the 241-AY-801 Instrument Building.

2.4.5.5 241-SY Tank Farm Facilities (200 West Area)

The 241-SY Tank Farm consists of three tanks and is the only DST farm located in the 200 West Area. Tank 241-SY-102 had air lift circulators identical in design to those in the 241-AW Tank Farm. The air lift circulators are out of service and the risers have been blanked off.

2.5 Waste Transfer Systems

Waste is transferred through a system of underground pipelines from generators in the 200 East and 200 West Areas to storage units in the 200 Areas and to the DSTs. Cross-site waste transfer systems exist to transfer waste between 200 East and 200 West Areas. Pipelines transporting waste normally are buried at least 0.9 m below grade to provide shielding from radiation emitted by the waste. Any lines not buried at least 0.9 m underground have concrete shielding. These transfer lines are interconnected by a series of routing facilities commonly called diversion boxes, Figure 2.6. Diversion boxes are below grade concrete structures that provide a series of nozzles for connections of jumpers to permit the routing of liquid waste from one buried line to another. Jumpers are rigid pipe structures with fittings that can be connected to wall nozzles routing from tank farm to tank farm or processing facility to processing facility.

2.6 Evaporator/Crystallizer

2.6.1 242-A (200 East Area)

The 242-A Evaporator is located in the 200 East Area of the Hanford Site. Four principal structures make up the evaporator facility:

- 242-A Building, the main process building
- 242-AB Building, the adjacent control room building
- 242-A-81 Building, the water services building
- 207-A Retention Basins (including 207-A Building)

The evaporator is designed to reduce waste volume and, thus, the number of DSTs required to store liquid wastes generated at the Hanford Site. The evaporator uses evaporative concentration to reduce the volume of liquid wastes. The evaporator process generates two product streams: a liquid stream, called double-shell slurry feed (DSSF) and a product concentrate (PC) stream.

The waste feed is concentrated in the evaporator vessel to a specified concentration, creating DSSF and water vapor. The evaporator vessel has a working volume of ~94,600 l. The DSSF is transferred from the Evaporator through encased underground piping to valve pits and subsequently is distributed to DSTs in the 200 East Area. The gasses or water vapor are passed through one primary and two secondary condensers creating the PC and a gaseous effluent. The gaseous effluent is filtered and released to the environment via the vessel vent exhaust system. The PC is collected in a PC tank, C-100 and passed through an ion exchange column before being discharged to the Liquid Effluent Retention Facility (LERF). The cooling water from the condensers is discharged to pond 216-B-3, also known as B-Pond.

The Evaporator is made up of the following rooms: the pump room, which contains the process recirculation lines and process jumpers for primary confinement of the feed and slurry; the evaporator room, which contains the evaporator vessel, recirculation loop, and reboiler for confinement of the slurry; the condenser room, containing the condenser and the confinement for the PC; the load-out and hot-equipment storage room, where failed equipment is decontaminated and packaged for disposal and also contains the ventilation system; the aqueous makeup room, for receipt, makeup, and storage of chemical solutions; the HVAC room, containing the HVAC equipment; and the control room, containing all monitoring and control room systems.

2.6.2 242-S (200 West Area)

The 242-S Evaporator Building was originally constructed to process waste by reducing the volume through evaporation and crystallization. The facility had a similar mission as the 242-A Evaporator located in the 200 East Area. The 242-S facility no longer processes waste. It has been put into Shutdown/Standby Mode III and is not expected to be used again. The facility is still operated as a control room for the three tank farms within the 241-S Tank Farm complex including the 241-SY and SX Tank Farms. The facility is 28.3 m by 25.3 m by 18.9 m high, and constructed mostly of reinforced concrete with a concrete built up roof. The facility maintains offices,

lunchroom, clothing storage area, and the control room. The 242-S Evaporator is discussed in this section only as it pertains to the 241-SY Tank Farm.

The facility is usually manned 24 hours per day. The building is protected by a wet pipe automatic sprinkler system.

A general alarm to the control room from the 241-SY-271 Instrument Building, indicates that there is a potential problem in the 241-SY Tank Farm. Specific alarms are relayed only to the Computer Automated Surveillance System (CASS) with the responsibility to notify appropriate personnel.

The facility has two 7031-g/cm² (gage) compressors to provide instrument air to the tank farm.

2.7 204-AR Unloading Facility

This facility is a rectangular, concrete, two-story building with exterior dimensions of 7.8 m high, 19.5 m long and 12.2 m wide. The exhaust stack is 18.3 m high and is the route of the facility ventilation system after filtration through two HEPA filters. The facility serves as a radioactive liquid waste unloading facility for newly generated liquid wastes. Waste is delivered to the 204-AR by either a railroad tank car or a tank trailer. Liquid waste is pumped from the car or trailer to TK-1, a 5680 l catch tank. The spill or overflow will be caught by a catch tank pit. The facility has two chemical solutions to adjust pH of the incoming liquids, sodium nitrite and 50% sodium hydroxide.

3.0 IDENTIFICATION AND SCREENING OF HAZARDS

3.1 Radioactive Hazards

The radiological concentration for the Tank Farm waste was determined based on an evaluation of waste tank sample data. The evaluation of sample data resulted in mean and percentile activity concentration for each nuclide represented in the waste tank sample data. For the purposes of this hazards assessment, the 100% inventory was conservatively selected to represent the source term used for determining event consequences. For example, the 100% activity concentration for each radioisotope can be thought of as representing a single tank containing the highest activity concentration for each nuclide found in the sample data for all tanks.

Figure 2.8 Maps, Distances, and Facility Details

Figure 2.9 Cutaway View of the 242-A Evaporator-Crystallizer Facility

RCP8005-149
PS-90-110

This approach results in a very conservative source term with a built in "safety factor." The safety factor accounts for uncertainty in the sample data, as well as uncertainty in how the waste in various tanks will be treated in the future. Table 3-1 presents the 100% source term used in this hazards assessment. The Threshold Planning Quantity (TPQ) for the important isotopes described in section 4 are all exceeded when considering the total amount of liquid wastes and further analysis is required.

Table 3.1 Tank Farm Radiological Concentrations: 100th Percentile Activities

Nuclide	Activity Concentration		TPQ
	Bq/L ^a	Ci/L	Bq
¹⁴ C	2.3 E+05	6.2 E-06	1.85E+15
⁶⁰ Co	1.3 E+09	3.5 E-02	1.85E+14
⁷⁵ Se	1.7 E+04	4.6 E-07	3.7E+14
⁹⁰ Sr	3.0 E+12	8.1 E+01	3.33E+12
⁹⁰ Y	3.0 E+12	8.1 E+01	3.33E+12
⁹⁵ Zr	0	0	1.85E+14
⁹⁹ Tc	1.2 E+10	3.2 E-01	3.7E+14
¹⁰⁶ Ru	2.4 E+05	6.5 E-06	7.4E+12
¹²⁵ Sb	1.5 E+08	4.1 E-03	3.7E+14
¹²⁹ I	6.4 E+06	1.7 E-04	3.7E+14
¹³⁴ Cs	1.7 E+07	4.6 E-04	7.4E+13
¹³⁷ Cs	1.0 E+11	2.7 E+00	1.11E+14
¹⁴⁴ Ce	1.6 E+03	4.3 E-08	1.11E+13
¹⁴⁷ Pm	5.7 E+07	1.5 E-03	1.48E+14
¹⁵⁴ Eu	1.5 E+10	4.1 E-01	1.48E+13
²³⁷ Np	3.2 E+07	8.7 E-04	7.4E+10
²³⁸ Pu	1.9 E+08	5.1 E-03	7.4E+10
^{239/240} Pu	4.4 E+08	1.2 E-02	7.4E+10
²⁴¹ Pu	3.7 E+09	1.0 E-01	7.4E+10
²⁴¹ Am	1.1 E+10	3.0 E-01	7.4E+10

Nuclide	Activity Concentration		TPQ
^{242m} Am	0.0 E+00	0.0 E+01	7.4E+10
²⁴³ Am	0.0 E+00	0.0 E+01	7.4E+10
²⁴² Cm	3.0 E+03	8.1 E-08	2.22E+12
²⁴⁴ Cm	6.0 E+07	1.8 E-03	1.48E+11
¹⁵⁵ Eu	7.5 E+07	2.0 E-03	1.11E+14

^aSource: SD-WM-SARR-016, Appendix B, Table 6.

The isotopes that have the major contribution to the Effective Dose Equivalent are the lung and bone seekers. Two HUDU runs were made, the first with all the isotopes from Table 3.1 and the second with only ⁶⁰Co, ⁹⁰Sr, ⁹⁰Y, ¹³⁷Cs, ²³⁸Pu, ^{239,240}Pu, ²⁴¹Pu, ²⁴¹Am. There was no difference in the result and only these isotopes will be used for the remainder of the document.

Table 3.2 Nominal Tank Crust Activity

Isotope	Activity (Bq/kg)	Activity (Ci/kg)
⁹⁰ Sr	1.3 E+9	3.4 E-2
⁹⁰ Y	1.3 E+9	3.4E-2
⁹⁹ Tc	1.1 E+7	3.0 E-4
¹²⁹ I	1.1 E+7	2.9 E-4
¹³⁷ Cs	1.7 E+10	4.5 E-1
²³⁷ Np	1.9 E+7	5.1 E-4
²³⁹ Pu	5.9 E+5	1.6 E-5
²⁴⁰ Pu	3.7 E+1	1.0 E-9
²⁴¹ Am	5.6 E+6	1.5 E-4

The 204-AR facility is described in section 2.6. The average waste activity in a rail car is shown in Table 3.3.

Table 3.3 Rail Car Inventory^a

Isotope	Activity (Bq/gal)	Activity (Ci/gal)
⁹⁰ Sr	3.3 E+6	8.9 E-5
⁹⁰ Y	3.3 E+6	8.9 E-5
¹³⁴ Cs	4.1 E+3	1.1 E-7
¹³⁷ Cs	3.2 E+4	8.7 E-7
¹⁴⁴ Ce	6.3 E+3	1.7 E-7
¹⁵² Eu	6.3 E+3	1.7 E-7
¹⁵⁴ Eu	1.1 E+6	3.0 E-5
²³⁸ Pu	5.0 E+4	1.4 E-6
²³⁹ Pu	8.5 E+4	2.3 E-6
²⁴¹ Am	2.9 E+7	7.9 E-4

^a WHC-SD-WM-SARR-006, Rev. 0

3.2 Non-Radioactive Hazards

Many reagents must be stored for use in a variety of different locations and forms. These reagents are often toxic chemicals. The chemicals are segregated and stored to minimize chemical incompatibilities under applicable OSHA safety regulations. Although many chemicals in the Tank Farms inventory are classed as "Extremely Hazardous Substances" by 40 CFR 355, Appendix A, the quantities are very small fractions of the specified TPQ. Table 3.4 is a listing of the chemicals in the Tank Farms as well as the individual TPQ. Nitric acid will be analyzed since it is in excess of the TPQ.

Table 3.4 Comparison of Extremely Hazardous Chemical Inventory with TPQ Values

Substance	Amount	TPQ
Nitric Acid*	2123 kgs	453.6 kgs
Ammonia	1.8 kgs	227 kgs
Acetone	0.63 kg	453.6 kgs
Sodium Hydroxide	2903 kgs	None listed

* This represents a typical Tank Farm inventory only.

4.0 HAZARD CHARACTERIZATION

4.1 Radioactive Hazards

4.1.1 Strontium and Cesium

Since most of the High Level Waste (HLW) at the Hanford Site is 25 to 50 years old, ^{90}Sr and ^{137}Cs are the dominant fission product radiological health hazards at this point in time. Both are beta emitters with half-lives of approximately 30 years. Additionally, both ^{90}Sr and ^{137}Cs have relatively short half-life daughters that rapidly build up to transient equilibrium concentrations with the parent nuclides. This means that before the parent is significantly decayed or expelled from the body, the daughter products have reached transient equilibrium concentrations. The daughter of ^{137}Cs is the metastable isotope $^{137\text{m}}\text{Ba}$, which emits a 0.662-MeV gamma-ray in its decay to stable ^{137}Ba . This gamma-ray is the dominant radiation hazard in almost all radiation transport calculations involving Hanford Site HLW. Compared to the inhalation dose of $^{137}\text{Cs}/^{137\text{m}}\text{Ba}$, $^{137\text{m}}\text{Ba}$ is also a significant contributor to dose through ground shine.

The daughter of ^{90}Sr is ^{90}Y , which is a beta emitter. Because of its relatively short half-life (64 hours), ^{90}Y builds up to transient equilibrium within days. Since the submersion dose due to a respirable aerosol cloud of $^{90}\text{Sr}/^{90}\text{Y}$ is more than 10,000 times less than the dose due to the inhaled aerosols, ^{90}Sr and ^{90}Y are primarily inhalation hazards.

Cesium is rapidly and almost completely absorbed into the blood and cleared from the lung. Available evidence indicates that cesium is distributed uniformly in the body. Strontium is also easily absorbed and cleared and primarily settles in the bone. The International Commission on Radiological Protection ICRP-30 (ICRP 1979) model assumes ^{90}Sr to be evenly distributed throughout the bone.

4.1.2 Uranium

In terms of mass, there is a significant quantity of uranium (U) in HLW tanks (i.e., several metric tons per tank in many cases). The toxicological rather than the radiological effects of uranium are usually the primary concern due to the low specific activity (disintegration rate per unit mass) of ^{238}U and ^{235}U . One curie of naturally occurring uranium has a mass of approximately three metric tons. The remaining uranium isotopes, which have a higher specific activity, are such a small fraction of the uranium isotopic mix (i.e., totaling less than 0.1 percent) that they also can be ignored from a radiological standpoint.

4.1.3 Cobalt

Another radionuclide present in some Hanford Site HLW tanks is ^{60}Co (Co). This isotope is not a fission product, but it is formed through neutron

activation of naturally occurring ^{59}Co . The cobalt comes from the wearing of alloy steels used in valve seats, bearings, etc. In almost all cases the radiological hazard of ^{60}Co in Hanford Site HLW tanks is overshadowed by ^{137}Cs , including the effects of shielded gamma-rays. In fact, for the past several years, $^{137\text{m}}\text{Ba}$, the metastable daughter product of ^{137}Cs , has been the only significant gamma-ray source originating from HLW used in safety analysis and shielding calculations.

4.1.4 Plutonium

The plutonium (Pu) contained in Hanford Site HLW tanks originated from reprocessing of discharged fuel from the nine Hanford Site production reactors over a period of approximately 45 years. The fissile isotope ^{239}Pu was the main plutonium isotope of interest. However, in making ^{239}Pu , other isotopes of plutonium are created as well through the n-gamma (n,γ) reaction, including the undesirable nonfissile ^{240}Pu . The mass ratio of the plutonium isotopes is a function of the reactor, fuel burn-up, and decay time.

Two types of plutonium, differentiated by the amount of ^{240}Pu , were produced at the Hanford Site. Fuels grade plutonium produced at the Hanford Site is nominally 12 percent ^{240}Pu . Weapons grade plutonium is nominally 6 percent ^{240}Pu .

Absorption of plutonium from the gastrointestinal tract is low. Data emphasize the complexity of the retention of plutonium compounds in the lung. Plutonium absorbed in the blood stream is deposited principally in liver and skeleton.

4.1.5 Americium

The radioisotope ^{241}Am (Am) is a potentially major contributor to an inhalation or ingestion dose from Hanford Site HLW. It is the beta decay product of ^{241}Pu . Although it takes approximately 70 years to reach transient equilibrium, due to competing effects with the decay of ^{241}Pu , 95 percent of the peak health hazard occurs approximately 20 years after discharge from the reactor. Approximately 40 percent of characterized Hanford Site double-shell tanks (DSTs) have ^{241}Am as the dominant potential inhalation dose contributor. Americium-241 is also important because of its probability of emitting a number of low energy gamma and x-rays. For this reason, the dose rate at the surface of a canister of fresh plutonium oxide can actually increase over several years.

Experiments on animals indicate that compounds of americium are more rapidly cleared from the lung and absorbed from the gastrointestinal tract than are compounds of plutonium. Like plutonium, americium settles primarily in the bone and liver. The ICRP model assumes americium to be uniformly distributed over the bone surfaces at all times following its deposition in the skeleton.

4.2 Non-Radiological Hazards

4.2.1 Ammonia

Ammonia is a colorless gas with a pungent, suffocating odor. It is a very strong base and forms ammonium hydroxide upon contact with moisture. Ammonia's toxic effects arise generally from its strong caustic properties. Breathing ammonia can irritate the lungs, causing coughing and/or shortness of breath. Higher exposures can cause a build-up of fluid in the lungs with severe shortness of breath. Exposure to ammonia can severely burn the skin and eyes, leading to permanent damage. Because ammonia may be harmful or fatal if inhaled, several regulatory and scientific organizations have recommended exposure limits, including OSHA, ACGIH, and NIOSH. These organizations include the Occupational Safety and Health Administration (OSHA), the American Conference of Governmental Industrial Hygienists (ACGIH), and the National Institute of Occupational Safety and Health (NIOSH). Table 4.1 presents ammonia's physical properties and recommended exposure limits.

Table 4.1 Physical Properties of Concentrated Ammonia

<u>Physical Properties:</u>	<u>Exposure limits:</u>
Molecular Weight = 17.0	25 ppm OSHA & ACGIH TWA
Specific Gravity = 1.39	35 ppm OSHA & ACGIH STEL
Melting Point = -78 °C	300 ppm IDLH
Boiling Point = -33.4 °C	25 ppm Emergency Response Planning Guide-1
Vapor Pressure = 400 mmHg @ -45 °C	200 ppm ERPG-2
	1000 ppm ERPG-3

4.2.2 Acetone

Acetone is a colorless liquid, and has a fragrant mint-like odor. It is classified by the Department of Transportation as a flammable liquid. Acetone is moderately toxic by various routes. It is a skin and severe eye irritant. Acetone affects humans by inhalation, and ingestion. Most problems result in skin irritation, and headache from prolonged exposure through inhalation. Acetone is a hazard due to fire and explosion danger. It can react vigorously with oxidizing materials. Potentially explosive reactions can occur with nitric acid and sulfuric acid. Acetone is a routine by-product of in vessel activity and normally released as part of the process effluent.

Table 4.2 Physical properties of Acetone (C₃H₆O)

Molecular weight	=	58.09
Melting Point	=	-94.6 °C
Boiling Point	=	56.48 °C
Vapor Pressure	=	400 mmHg @ 39.5 °C

Exposure Limits for Acetone include:

1000 ppm OSHA PEL
 750 ppm ACGIH TLV:TWA (1780 mg/m³)
 1000 ppm ACGIH STEL (2380 mg/m³)
 590 mg/m³ NIOSH REL:TWA

No ERPG values established for Acetone.

Source Term: 1.6×10^{-3} mg/l (1.6 mg/m³)

4.2.3 Nitric Acid

Nitric acid is a clear liquid that is both an oxidizer and a corrosive. It reacts vigorously with combustibles (or readily oxidizable materials), organic solvents, metal powders, carbides, cyanides, sulfides, and alkalies. It releases hydrogen on contact with many metals. Contact of concentrated nitric acid with combustible materials may increase the hazard from fire and may lead to an explosion. It decomposes at fire temperatures producing irritants and toxic gases including oxides of nitrogen. Contact can cause severe eye and skin burns. Because HNO₃ may be harmful or fatal if inhaled, several regulator and scientific organizations have recommended exposure limits. It is immediately dangerous to life and health (IDLH) at airborne concentrations of 100 ppm or greater. Other exposure limits include time-weighted average (TWA), short-term exposure limits (STEL) and emergency response planning guidelines (ERPG).

Table 4.3 Physical Properties of Concentrated HNO₃

Molecular weight	=	63.01
Specific Gravity	=	1.51
Melting Point	=	-42 °C
Boiling Point	=	83 °C
Vapor Pressure	=	8-11 mmHg @ 25 °C
	=	17-25 mmHg @ 38 °C.

Exposure Limits for HNO₃ include:

2 ppm (5 mg/m³) OSHA & ACGIH TWA
 4 ppm (10 mg/m³) OSHA & ACGIH STEL
 2 ppm TWA NIOSH recommended 10 hour TWA
 ERPG-1: 2 ppm (Draft)
 ERPG-2: 15 ppm (Draft)
 ERPG-3: 30 ppm (Draft)
 IDLH: 262 mg/m³ (100 ppm)

The amount of nitric acid used at the 242-S facility is (400 gallons of 50 wt. %)x(11.7 lb/gal)=4680 lb (1000 lb TPQ) and it is used biennially for 5 days for decontamination solution.

Source Term: Release rate of 1.66×10^{-2} g/s

4.2.4 Sodium Hydroxide

Sodium hydroxide solution is a potentially hazardous material used in small quantities for treatment of liquid wastes. The annual inventory is approximately 500 gallons. The amount of sodium hydroxide at the 242-S facility is $(500 \text{ gallons of } 50 \text{ wt. \%}) \times (12.8 \text{ lb/gal}) = 6400 \text{ lb}$. NaOH (caustic Soda) 50% solution is corrosive to the skin and a eye irritant. effects of inhalation of mists vary from mild irritation of the nose at 2 mg/m^3 to severe inflammation of the respiratory tract. NaOH solution posses a negligible fire hazard when exposed to heat or flame.

Table 4.4 Physical Properties of Sodium Hydroxide Solution

Molecular Weight	=	40.00
Specific Gravity	=	1.5
Melting Point	=	5-11 °C
Boiling Point	=	140 °C
Vapor Pressure	=	13 mm Hg @ 60 °C

Exposure Limits for Sodium Hydroxide

TWA	2 mg/m^3
IDLH	250 mg/m^3
ERPG 1	2 mg/m^3
ERPG 2	40 mg/m^3
ERPG 3	100 mg/m^3

Sodium hydroxide has a low vapor pressure even at higher temperatures and therefore has a low evaporation rate. The main concerns are a pressurized mist release and reactions with other chemicals that generate toxic gases. Sodium Hydroxide in the amount of 1893 l is used biennially for 5 days for decontamination solution. Sodium hydroxide is not considered an extremely hazardous chemical but the consequences of a release of this quantity of material are enough to warrant analysis.

5.0 EVENT SCENARIOS

5.1 Radiological Releases

5.1.1 Perpheral Seal, HEPA Filter Failure - Active Ventilation

This scenario assumes that there was a corrosive degradation of peripheral seals, or failure of peripheral seals due to excessive delta pressure (Δp). Operations personnel would be alerted to the event by radiation and Δp alarms. A maximum of 4 h is expected to elapse between event occurrence and shutdown and recovery. An exhauster is assumed to be operating with a flow of 150 CFM from tank and there is a release of 10.2 l of aerosolized material. A resuspension factor of $1\text{E-}5$ is assumed. This volume

is multiplied by Table 3.1 activity to provide the release shown in Table 5.1. A typical K-1 stack is 4.75 m high, with a diameter of 0.25 m.

Table 5.1 Peripheral Seal, HEPA Filter Failure and Activity Release at Ground Level

Isotope	Activity Released (Bq)	Activity Released (Ci)
^{60}Co	1.3E+10	3.6E-1
^{90}Sr	3.1E+13	8.3E+2
^{90}Y	3.1E+13	8.3E+2
^{137}Cs	1.0E+12	2.8E+1
^{238}Pu	1.9E+9	5.2E-2
$^{239/240}\text{Pu}$	4.5E+9	1.2E-1
^{241}Pu	3.8E+10	1.0E+0
^{241}Am	1.1E+11	3.1E+0

5.1.2 HEPA Filter Failure - Active Ventilation

This scenario assumes that a failure of loaded HEPA filters occurs as result of moisture collecting on the filters. Failure can also be caused by an excessive pressure loading across the inlet face of the filter as a result of vessel pressurization or high fan vacuum. An accident is postulated where both stages of HEPA filters on a motive exhaust ventilation system fails. The stack radiation monitor fails to alarm and the filter failure is not detected until 8 hours following the accident. Failure of a vessel ventilation exhaust filter could result in the release of the radioactive particulates contained on both stages of HEPA filters. Failed filters had a radiation dose rate of $2.58\text{E-}4$ coulombs/kg/hr, equivalent to 0.0042 l of radioactive liquid waste, and $4\text{E-}03 \times$ Table 3.1 activity from dome space of tank. The activity released for this scenario is shown in Table 5.2.

Table 5.2 HEPA Filter Failure and Activity Release at Ground Level

Isotope	Activity Released (Bq)	Activity Released (Ci)
^{60}Co	1.1E+7	3.0E-4
^{90}Sr	2.5E+10	6.7E-1
^{90}Y	2.5E+10	6.7E-1
^{137}Cs	8.2E+8	2.2E-2
^{238}Pu	1.6E+6	4.2E-5

Isotope	Activity Released (Bq)	Activity Released (Ci)
$^{239/240}\text{Pu}$	3.7E+6	1.0E-4
^{241}Pu	3.0E+7	8.0E-4
^{241}Am	9.1E+7	2.5E-3

5.1.3 Release During HEPA Filter Changeout or Vehicle Collision

This release is of activity which is much less than the other scenarios in this section and will not be considered further.

5.1.4 Loss of Loop Seal - Passive Ventilation

This scenario assumes a loss of seal loop fluid from the breather filter system. The source term is based upon Track Radioactive Components (TRAC) data for the maximum concentrations in the liquid phase. This results in a total release of 0.0038 l. Table 5.3 shows the activity release for this scenario. The release occurs at ground level.

Table 5.3 Loop Seal Failure and Activity Released

Isotope	Activity Released (Bq)	Activity Released (Ci)
^{60}Co	4.9E+6	1.0E-4
^{90}Sr	1.1E+10	3.1E-1
^{90}Y	1.1E+10	3.1E-1
^{137}Cs	3.8E+8	1.0E-2
^{238}Pu	7.2E+5	1.9E-5
$^{239/240}\text{Pu}$	1.7E+6	4.6E-5
^{241}Pu	1.4E+7	4.0E-4
^{241}Am	4.2E+7	1.1E-3

5.1.5 Primary Tank Pressurization

An unfiltered pressurized release occurs. Ventilation fails to all four tanks due to primary exhaust failure. The backup exhaust does not work. Three of the four airlift circulators shut down on high pressure with one not shutting. An exhaust path is available. No tank gas release occurs but 0.1 l is released with the activity from Table 3.1 shown in Table 5.4.

Table 5.4 Primary Tank Pressurization and Activity Released

Isotope	Activity Released (Bq)	Activity Released (Ci)
^{60}Co	1.3E+8	3.5E-3
^{90}Sr	3.0E+11	8.1E+0
^{90}Y	3.0E+11	8.1E+0
^{137}Cs	1.0E+10	2.7E-1
^{238}Pu	1.9E+7	5.0E-4
$^{239/240}\text{Pu}$	4.4E+7	1.2E-3
^{241}Pu	3.7E+8	1.0E-2
^{241}Am	1.1E+9	3.0E-2

5.1.6 Waste Transfer Hazards 204-AR

The 204-AR Rail Car Unloading Facility receives a shipment of 18930 l of Table 3.3 material. During the transport of the rail car into the facility, the train is pushed into the facility puncturing the rail car, releasing all the contents. The engine derails and spills diesel fuel which mixes with the waste and burns. A release fraction of 1.7E-3 is assumed. Table 5.5 shows the activity released.

Table 5.5 204-AR Rail Car Release with Fire

Isotope	Activity (Bq)	Activity (Ci)
^{90}Sr	2.8 E+7	8.0 E-4
^{90}Y	2.8 E+7	8.0 E-4
^{134}Cs	3.4 E+4	9.4 E-7
^{137}Cs	2.7 E+5	7.4 E-6
^{144}Ce	5.3 E+4	1.4 E-7
^{152}Eu	5.3 E+4	1.4 E-7
^{154}Eu	9.4 E+6	3.0 E-4
^{238}Pu	4.3 E+5	1.2 E-5
^{239}Pu	7.2 E+5	2.0 E-5
^{241}Am	2.5 E+8	6.7 E-3

5.1.7 242-A Liquid/Airborne Release

This scenario is a failure of an exterior underground process pipe. The scenario releases 3,800 l of double shell slurry feed in the pipe encasement. A failed encasement releases the liquid waste into the onsite soil column and a pool of 760 l forms on the soil surface and the material is resuspended.

The source term is 760 l X resuspension of $1\text{E}-8/\text{s}$ X 28800 s (8 hr) = 0.22 l X Table 3.1 activity released. Table 5.6 shows the predominant isotopes and activity released.

Table 5.6 242-A Filter Breach and Release

Isotope	Activity Released (Bq)	Activity Released (Ci)
^{60}Co	2.85E+8	7.7E-3
^{90}Sr	6.55E+11	1.8E+1
^{90}Y	6.55E+11	1.77E+1
^{137}Cs	2.18E+10	5.9E-1
^{238}Pu	4.07E+7	1.1E-3
$^{239/240}\text{Pu}$	9.62E+7	2.6E-3
^{241}Pu	8.1E+8	2.2E-2
^{241}Am	2.43E+9	6.5E-2

5.2 Containment Breach

5.2.1 Waste Leak from Jumper, Connector, or DCRT - Spray Leak

This scenario assumes a breached jumper or connector results in a spray leak in a pump pit with the cover not in place. An optimum generation rate at 60 lb/in² assumes $3.95\text{E}-05\text{ m}^3/\text{s}$ of droplets, $\leq 50\text{ }\mu\text{m}$ in diameter are formed. The volume of waste material suspended in 30 min = 71 l. The activity released is 71 l X Table 3.1 activity and is shown on Table 5.7.

Table 5.7 Jumper, Connector, or DCRT Spray/Activity Released

Isotope	Activity Released (Bq)	Activity Released (Ci)
^{60}Co	9.2E+10	2.5E+0
^{90}Sr	2.1E+14	5.7E+3
^{90}Y	2.1E+14	5.7E+3
^{137}Cs	7.1E+12	1.9E+2

Isotope	Activity Released (Bq)	Activity Released (Ci)
^{238}Pu	1.3E+10	3.6E-1
$^{239/240}\text{Pu}$	3.2E+10	8.5E-1
^{241}Pu	2.6E+11	7.1E+0
^{241}Am	7.9E+11	2.1E+1

Consequences of this accident would be insignificant if the pit cover was in place to contain the leak.

5.2.2 Loss of 242-A Confinement

A jumper spray leak is assumed to occur in the pump room. The release initiated by a random failure of jumper and wall nozzle to maintain connection in the pump room.

The scenario releases 4 l/min. A 24 hour release would yield 600 l of aerosol and concentrated evaporator slurry to pump room, with 1% being (6 l) aerosolized and the remainder released to floor. Table 5.8 provides the activity released.

Table 5.8 242-A Jumper Breach and Release

Isotope	Activity Released (Bq)	Activity Released (Ci)
^{60}Co	7.8E+7	2.1E-3
^{90}Sr	1.8E+11	4.9E+0
^{90}Y	1.8E+11	4.9E+0
^{137}Cs	6.0E+9	1.6E-1
^{238}Pu	1.1E+7	3.0E-4
$^{239/240}\text{Pu}$	2.7E+7	7.0E-4
^{241}Pu	2.2E+8	6.0E-3
^{241}Am	6.7E+8	1.8E-2

5.3 Uncontrolled Chemical Reactions and Thermodynamic Occurrences

5.3.1 Hydrogen Burn

An ignition of the hydrogen gas in the vapor space of a tank is assumed to be initiated by one of several means and the resultant burn does not breach the tank integrity but the waste is released out an open riser ready for pump

change or removal. It is assumed that 1.3 kg of crust material is released. Table 3.2 activity/kg of crust results in Table 5.9 activity released.

Table 5.9 Tank Hydrogen Burn and Crust Release

Isotope	Activity Released (Bq)	Activity Released (Ci)
⁹⁰ Sr	1.8E+11	4.4E-2
⁹⁰ Y	1.8E+11	4.4E-2
⁹⁹ Tc	1.4E+7	4.0E-4
¹²⁹ I	1.4E+7	4.0E-4
¹³⁷ Cs	2.2E+10	5.8E-1
²³⁷ Np	2.4E+7	7.0E-4
²³⁹ Pu	7.7E+5	2.1E-5
²⁴⁰ Pu	4.8E+1	1.3E-9
²⁴¹ Am	7.2E+6	2.0E-4

5.3.2 Hydrogen Explosion in Dome Vapor Space

Radiolysis of water generates hydrogen which may increase to explosive range (>4 to 74% in air) in tanks not adequately ventilated. An explosion breaches any installed HEPA filter resulting in discharge to atmosphere of maximum radioactive particulate filter inventory, along with 0.024 l of liquid waste and its associated radioactive content. Table 5.10 provides the activity released for this scenario.

Table 5.10 Hydrogen Explosion in Dome Vapor Space and Release

Isotope	Activity Released (Bq)	Activity Released (Ci)
⁶⁰ Co	3.1E+7	8.0E-4
⁹⁰ Sr	7.0E+10	1.9E+0
⁹⁰ Y	7.0E+10	1.9E+0
¹³⁷ Cs	2.4E+9	6.5E-2
²³⁸ Pu	4.5E+6	1.0E-4
^{239/240} Pu	4.1E+5	3.0E-4
²⁴¹ Pu	8.9E+7	2.4E-3
²⁴¹ Am	2.7E+8	7.2E-3

5.4 Non-Radiological Scenarios

5.4.1 Release of Ammonia

An error in blending neutralized cladding removal waste (NCRW) with non-ammonia-bearing wastes leads to high ammonia concentration in TK-241-AW-102. Failure to detect or correct the blending occurs and 241-AW-102 contents are sent to the evaporator and results in elevated ammonia release. The source term is from 300 and 150 l/min, 0.4-M feed concentration which is converted to ammonia gas releasing 0.06 kg/s ammonia gas out the vent.

5.4.2 Acetone

Acetone is a routine by-product of in vessel activity and is released in a concentration of $1.6E-3$ mg/l.

5.4.3 Nitric Acid

Nitric acid in the amount of 1514 l of 50 wt. % is released at a rate of $1.7E-2$ g/s. The meteorological conditions are F Stability and a 1 m/s wind speed.

5.4.4 Sodium Hydroxide

Sodium hydroxide is used biannually for 5 days as a decontamination solution. The maximum amount on hand is 1893 l. The worst case scenario for this release is assumed to be a continuous release at a rate of 3.8 kg/min, a spill radius of 5 m, meteorological condition is F Stability and a 1 m/s wind speed.

5.5 Natural Emergencies

5.5.1 Seismic Event (Earthquake)

5.5.1.1 Seismic Activity Pipe Break/Ventilation Breach

An earthquake occurs which destroys support utilities and disrupts piping, ventilation structures, and the tank integrity is breached. Additionally, a loss of power and ventilation containment occurs which results in a loss of liquid through piping or a tank riser breach.

The vapor contains Table 3.1 activity X a resuspension factor of $4E-03$ and 45.4 l of respirable liquid. The liquid activity is 45.4 l X Ci/l from Table 3.1 plus the activity released in the vapor and the results are shown in Table 5.11.

Table 5.11 Seismic Event and Activity Released

Isotope	Activity Released (Bq)	Activity Released (Ci)
^{60}Co	5.9E+10	1.6E+0
^{90}Sr	1.4E+14	3.7E+3
^{90}Y	1.4E+14	3.7E+3
^{137}Cs	4.5E+12	1.2E+2
^{238}Pu	8.6E+9	2.3E-1
$^{239/240}\text{Pu}$	2.0E+10	5.4E-1
^{241}Pu	1.7E+11	4.5E+0
^{241}Am	5.0E+11	1.4E+1

5.5.1.2 SST Dome Failure - Seismic

It is assumed that a seismic event causes a structural failure which collapses the waste tank dome with radionuclide release to the atmosphere.

It is assumed that 14 kg of solids with particulate diameters less than 10 μm could be expected to be entrained in the air following the accident. At least half the entrained solid is expected to be particles of soil and debris from the collapsed dome. This leaves 7 kg of solidified waste made airborne from dome failure which is equivalent to the fission products associated with 60 liters of liquid solution from Table 3.1. The activity released from the SST in a seismic induced dome failure event are shown in Table 5.12.

Table 5.12 SST Dome Failure/Seismic Event Release

Isotope	Activity Released (Bq)	Activity Released (Ci)
^{60}Co	7.8E+10	2.1E+0
^{90}Sr	1.8E+14	4.9E+3
^{90}Y	1.8E+14	4.9E+3
^{137}Cs	6.0E+12	1.6E+2
^{238}Pu	1.1E+10	3.1E-1
$^{239/240}\text{Pu}$	2.7E+10	7.2E-1
^{241}Pu	2.2E+11	6.0E+0
^{241}Am	6.7E+11	1.8E+1

5.5.1.3 Thermal Roll-over

A seismic event causes destruction of ventilation ductwork, loss of power and the ALCs are down for 20 hrs. The solids in the tanks settle causing a temperature rise in the waste material. There is an inadvertent, rapid ALC restart resulting in a large mass of the heated solids lifted into the liquid. The liquid vaporizes causing a steam bump, resulting in a 1 l release. Table 3.1 X 1 l activity is shown in Table 5.13.

Table 5.13 Thermal Roll-over With ALC Failure and Activity Released

Isotope	Activity Released (Bq)	Activity Released (Ci)
^{60}Co	1.3E+8	3.5E-2
^{90}Sr	3.0E+12	8.1E+1
^{90}Y	3.0E+12	8.1E+1
^{137}Cs	1.0E+11	2.7E+0
^{238}Pu	1.9E+8	5.1E-3
$^{239/240}\text{Pu}$	4.4E+8	1.2E-2
^{241}Pu	3.7E+9	1.0E-1
^{241}Am	1.1E+10	3.0E-1

5.5.1.4 242 Evaporator Seismic Event

This scenario involves a loss of confinement as a result of an earthquake which is of sufficient magnitude to collapse the 242 Evaporator structure. The source term is 0.33 l of double shell slurry, 1.85E+10 Bq (equivalent to 3E-3 l of liquid waste) released from the building and filter loading of four filter banks (3.8E+8 Bq (equivalent to 1E-4 l of liquid waste)). Table 5.14 shows the activity released from this scenario.

Table 5.14 242-A Evaporator Seismic Event and Activity Released

Isotope	Activity Released (Bq)	Activity Released (Ci)
^{60}Co	4.3E+8	1.2E-2
^{90}Sr	1.0E+12	2.7E+1
^{90}Y	1.0E+12	2.7E+1
^{137}Cs	3.3E+10	9.0E-1
^{238}Pu	6.3E+7	1.7E-3
$^{239/240}\text{Pu}$	1.5E+8	4.0E-3

^{241}Pu	1.2E+9	3.3E-2
^{241}Am	3.7E+9	1.0E-1

5.5.2 Tornado/High Winds/Thunderstorm

Some damage is expected if high winds or a tornado strike the Tank Farm complex, but the offsite impact is not expected to be significant. The survivability varies with the building affected. The buildings have experienced two wind storms in recent years with gust to 3.6E+1 m/second (1972) and 3.4E+1 m/second (1990) with no damage. A graded precautionary approach is recommended for high winds at the tank farm complex.

5.5.3 Volcanic Ashfall/Snowfall

The Hanford Site is in a region subject to snowfall as well as ashfall from volcanic eruptions. The three major volcanic peaks closest to the project are: Mt. Adams about 1.6E+2 km away, Mt. Rainier, and Mt. St. Helens approximately 1.9E+2 km away.

Important historical ash falls affecting this location were from eruptions of Glacier Peak about 12,000 years ago, Mt. Mazama about 6,000 years ago, and Mt. St. Helens about 3,600 years ago. The most recent ashfall resulted from the May 18, 1980 eruption of Mt. St. Helens. Table 5.16 below indicates the estimated ash depth deposited at the Hanford site from past volcanic eruptions in the region. The ash weight from the Mt Mazama event would probably have exceeded the design roof loading of most older Hanford buildings and roof failure would have been probable. However, the ash loading from the other eruptions would have been well below the roof loading limit. An emergency declaration is suggested if ash or snow accumulations could cause actual roof structural damage. There would be ample warning of an approaching large ash fall and the facility could be placed in a stable condition.

Table 5.16 Estimated Ash Depth at 200 Area from Major Eruptions

Volcano	Time	Depth of Ash	Equivalent Roof Loading	
			Dry (psf)*	Wet (psf)*
Glacier Peak	12,000 B.P.	0.025 m	6	8.4
Mt Mazama	6,000 B.P.	0.15 m	36	50
Mt. St. Helens	3,600 B.P.	0.025 m	6	8.4
Mt. St. Helens	1980	0.013 m	3	4.2

* pounds per square foot

B.P. = Before present

5.5.4 Range Fire

The Hanford Site is in a semiarid region with sagebrush and grasses growing between areas. Range fires periodically occur and can sweep over large regions before they are controlled. The summer months are historically the most likely time for a large fire to occur because of the combustible condition of the natural grasses.

The tank farm complex would probably not be affected by a range fire since the ground near the buildings and tanks is devoid of vegetation. Furthermore, many of the buildings are concrete and, therefore, not particularly susceptible to a fire initiated from outside the building.

5.5.5 Flood

The Probable Maximum Flood (PMF), calculated by the Corps of Engineers, is based on the concurrence of the worst of several natural phenomena, including a record snowfall in the Columbia River watershed, no melting of this snow until late spring, then warm, heavy rain. This hypothetical flood would have a flow of $2.4 \text{ E}9 \text{ l/hr}$ and is estimated to be well below the level of the tank farm facilities. No emergency level declaration should be made.

5.6 Security Events

The following events have not been analyzed but are discussed and given a consequence.

5.6.1 Explosive Device

If confirmed physical damage as a result of a detonation of an explosive device occurs, in which there is a potential loss of confinement/containment of hazardous or radioactive materials in any of the tank farm facilities, declaration of an event is required.

5.6.2 Sabotage

A confirmed physical damage as a result of sabotage, resulting in potential loss of confinement/containment of hazardous materials to any of the tank farm facilities requires declaration of an event.

5.6.3 Hostage Situation

A confirmed hostage situation occurring within any tank farm facility requires declaration of an event.

5.6.4 Armed Intruder

A confirmed armed intruder(s) located within any of the tank farm facilities requires declaration of an event.

5.6.5 Aircraft Crash

This event is assumed to be initiated by a plane crash into a tank farm facility housing hazardous material, accompanied by a fire. The same inventory and meteorological conditions as the seismic/fire event would be expected with the same consequences.

6.0 EVENT CONSEQUENCES

6.1 Calculation Models

Consequences of the events and conditions identified in Section 5.0 were estimated using two primary computational models. The Emergency Prediction Information (EPI) code was used to calculate the source term and dispersion from nitric acid spills and NOx gas releases, while the GENII program was used in the SARs for radiological dose calculations and the dispersion calculation for uranium toxicity evaluation. The Hanford Unified Dose Utility (HUDU) computer code. This code is the primary emergency response tool for radiological releases on the Hanford Site and in the Unified Dose Assessment Center (UDAC). It employs a straight line Gaussian plume model, Pasquill-Gifford stability classes, and ICRP 26 and 30 Aerodynamic Mean Activity Diameter (AMAD). Release source terms considered only the respirable fraction, nominally 0.1 percent (DOE-STD-0013-93) unless otherwise specified.

The EPI program was developed by Homman Associates, Inc. for use in hazardous material emergency planning and response. The program has five source models:

- Continuous Release
- Term Release
- Area Continuous
- Area Term
- Liquid Spill

The liquid spill option calculates the source term from the pool. The area continuous and area term options are also spills but the user must supply the source term. The EPI program uses both the plume and puff Gaussian dispersion models depending on the duration of the release. The program users manual documents the features of the program. The specific options and parameters used to calculate the consequences of the nitric acid spills and NOx gas releases are documented below.

Release of radionuclides into the environment occurs either through a facility stack, or by loss of facility integrity. By convention, release heights less than 10 meters default to ground level releases. In these analyses plume rise is not considered, producing conservative dose estimates.

6.2 Receptor Locations

Two receptor locations are evaluated for purposes of comparing with the emergency classification criteria: a maximum onsite individual at the facility boundary and a maximum offsite individual at the offsite boundary.

For tank farm releases, the maximum onsite individual is the hypothetical onsite receptor located 100 meters from the release regardless of the meteorological conditions. In addition to being the most conservative choice, this simplifies the analyses by allowing use of a single onsite receptor distance rather than the varying distances from each tank to the facility boundary (i.e., tank farm fence).

The maximum offsite individual is the hypothetical receptor at the site boundary location. The chosen distance for this individual is the shortest distance, or 12.5 km. The receptor locations for chemical releases are the same as those for radiological releases.

6.3 Radiological Releases

6.3.1 Peripheral Seal, HEPA Filter Failure - Active Ventilation

The released activity, Table 5.1, even though out a stack is considered a ground level release when using HUDU, meteorological conditions are F Stability, 1 m/s wind speed, and 20°C temperature. The 100 m Effective Dose Equivalent (EDE) is $1.7\text{E}+2$ Sv, and the 12.5 km EDE is $9.7\text{E}-2$ Sv. This requires a GENERAL Emergency be declared since the site boundary EDE is greater than 0.01 Sv.

6.3.2 HEPA Filter Failure - Active Ventilation

The released activity, Table 5.2, even though out a stack is considered a ground level release when using HUDU. The HEPA filters are loaded to the maximum 0.001 Sv/hr and the contents expelled. Meteorological conditions are F Stability, 1 m/s wind speed, and 20°C temperature. The 100 m EDE is $1.3\text{E}-1$ Sv, and the 12.5 km EDE is $7.0\text{E}-5$ Sv. This requires a SITE AREA Emergency be declared since the facility boundary EDE is greater than 0.01 Sv.

6.3.3 Loss of Loop Seal - Passive Ventilation

The released activity, Table 5.3, is considered a ground level release when using HUDU. Meteorological conditions are F Stability, 1 m/s wind speed, and 20°C temperature. The 100 m EDE is $5.8\text{E}-2$ Sv, and the 12.5 km EDE is $3.0\text{E}-5$ Sv. This requires a SITE AREA Emergency be declared since the facility boundary EDE is greater than 0.01 Sv.

6.3.4 Primary Tank Pressurization

The released activity, Table 5.4, is considered a ground level release when using HUDU. Meteorological conditions are F Stability, 1 m/s wind speed, and 20°C temperature. The 100 m EDE is $1.6\text{E}+0$ Sv, and the 12.5 km EDE is $9.0\text{E}-4$ Sv. A tank pressurization event with an actual radioactive material release requires a SITE AREA Emergency be declared since the facility boundary EDE is greater than 0.01 Sv.

6.3.5 204-AR Waste Transfer From Rail Car With Fire

The released activity, Table 5.5, is considered a ground level release when using HUDU. Meteorological conditions are F Stability, 1 m/s wind speed, and 20°C temperature. The 100 m EDE is $3.0\text{E}-2$ Sv, and the 12.5 km EDE is $1.8\text{E}-4$ Sv. This requires an SITE AREA Emergency be declared since the facility boundary EDE is greater than 0.01 Sv.

6.3.6 242-A Liquid/Airborne Release

The released activity, Table 5.6, is considered a ground level release when using HUDU. Meteorological conditions are F Stability, 1 m/s wind speed, and 20°C temperature. The 100 m EDE is $3.4+0$ Sv, and the 12.5 km EDE is $2.0\text{E}-3$ Sv. This requires a SITE AREA Emergency be declared since the facility boundary EDE is greater than 0.01 Sv. Dividing the 3.4 Sv by the 8 hr this scenario equals $4.25\text{E}-1$ Sv/hr. The operation of the pump for one or more hours equates to a SITE AREA Emergency since this EDE is greater than 0.01 Sv at the facility boundary.

6.3.7 Waste Leak from Jumper, Connector, or DCRT - Spray Leak

The released activity, Table 5.8, is considered a ground level release when using HUDU. Meteorological conditions are F Stability, 1 m/s wind speed, and 20°C temperature. The 100 m EDE is $1.1\text{E}+3$ Sv, and the 12.5 km EDE is $6.4\text{E}-1$ Sv. This requires a GENERAL Emergency be declared since the site boundary EDE is greater than 0.01 Sv. The transfer pit cover is considered off and the transfer occurs for at least 30 minutes. Dividing the facility boundary EDE by 30 minutes equals 0.4 Sv/min or still a GENERAL Emergency.

6.3.8 Loss of 242-A Confinement

The released activity from a leaking jumper, Table 5.9, is considered a ground level release when using HUDU. Meteorological conditions are F Stability, 1 m/s wind speed, and 20°C temperature. The release is assumed to occur for 24 hours. The 100 m EDE is $9.4\text{E}-1$ Sv, and the 12.5 km EDE is $5.5\text{E}-4$ Sv. This requires a SITE AREA Emergency be declared since the facility boundary EDE is greater than 0.01 Sv. Dividing the facility boundary EDE by 24 hr equals 0.04 Sv/hr. Further dividing the facility boundary EDE by 60 min/hr equals $7.0\text{E}-4$ Sv/min. The release would have to be ≥ 1.5 minutes to be above the ALERT LEVEL Emergency EDE.

6.3.9 Hydrogen Burn

The released activity, Table 5.10, is considered a ground level release when using HUDU. Meteorological conditions are F Stability, 1 m/s wind speed, and 20°C temperature. The 100 m EDE is $5.6\text{E-}2$ Sv, and the 12.5 km EDE is $3.0\text{E-}5$ Sv. This requires a SITE AREA Emergency be declared since the facility boundary EDE is greater than 0.01 Sv.

6.3.10 Hydrogen Explosion in Dome Void

The released activity, Table 5.11, is considered a ground level release when using HUDU. Meteorological conditions are F Stability, 1 m/s wind speed, and 20°C temperature. The 100 m EDE is $3.82\text{E-}1$ Sv, and the 12.5 km EDE is $2.2\text{E-}4$ Sv. This requires an SITE AREA Emergency be declared since the facility boundary EDE is greater than 0.01 Sv.

6.4 Non-Radiological Releases

6.4.1 Release of Ammonia

The amount of ammonia exhausted out the vent is $3.9\text{E-}4$ ppm calculated for 100 m downwind. The ERPG-1 limit is 25 ppm, hence this hazard will not be considered further.

6.4.2 Acetone

The amount normally exhausted from the vessel ventilation system (1.6 mg/l) results in a concentration that is below the Threshold Limit Value-Time Weighted Average (TLV-TWA) value of 1780 mg/m³, and the TLV-short term exposure limit (STEL) value of 2380 mg/m³. This hazard will not be considered further.

6.4.3 Nitric Acid

The calculated concentration at 100 m is 0.3 ppm. The draft ERPG-1 level is 2 ppm, hence this hazard will not be considered further.

6.4.4 Sodium Hydroxide

An area, continuous release of NaOH is not a significant hazard since the vapor pressure for this material is large. This hazard will not be considered further.

6.5 Natural Emergencies

6.5.1 Earthquake

6.5.1.1 Seismic Activity Pipe Break/Ventilation Breach

The released activity, Table 5.12, is considered a ground level release when using HUDU. Meteorological conditions are F Stability, 1 m/s wind speed, and 20°C temperature. The 100 m EDE is $7.3\text{E}+2$ Sv, and the 12.5 km EDE is $4.3\text{E}-1$ Sv. This requires a GENERAL Emergency be declared since the site boundary EDE is greater than 0.01 Sv.

6.5.1.2 SST Dome Failure - Seismic

The released activity, Table 5.13, is considered a ground level release when using HUDU. Meteorological conditions are F Stability, 1 m/s wind speed, and 20°C temperature. The 100 m EDE is $9.4\text{E}+2$ Sv, and the 12.5 km EDE is $5.5\text{E}-1$ Sv. This requires a GENERAL Emergency be declared since the site boundary EDE is greater than 0.01 Sv.

6.5.1.3 Thermal Roll-over

The released activity, Table 5.14, is considered a ground level release when using HUDU. Meteorological conditions are F Stability, 1 m/s wind speed, and 20°C temperature. The 100 m EDE is $1.6\text{E}+1$ Sv, and the 12.5 km EDE is $9.2\text{E}-3$ Sv. This requires a SITE AREA Emergency be declared since the facility boundary EDE is greater than 0.01 Sv.

6.5.1.4 242 Evaporator Seismic Event

The released activity, Table 5.15, is considered a ground level release when using HUDU. Meteorological conditions are F Stability, 1 m/s wind speed, and 20°C temperature. The 100 m EDE is $5.2\text{E}+0$ Sv, and the 12.5 km EDE is $3.0\text{E}-3$ Sv. This requires a SITE AREA Emergency be declared since the facility boundary EDE is greater than 0.01 Sv.

6.5.2 Tornado/High Winds/Thunderstorm

Some damage is expected if high winds or a tornado strike the Tank Farm complex, but the offsite impact is not expected to be significant. The survivability varies with the building. The buildings have experienced two wind storms in recent years with gust to $3.6\text{E}+1$ m/second (1972) and $3.4\text{E}+1$ m/second (1990) with no damage. A graded precautionary approach is recommended for high winds at the Tank Farm complex beginning with an ALERT LEVEL Emergency.

6.5.3 Volcanic Ashfall/Snowfall

As a precaution, it is suggested that an ALERT LEVEL Emergency be declared if a plume of ash is observed in the 200 East or West Area. The Alert Emergency is based on the potential degradation of safety at the facility.

6.5.4 Range Fire

As a precaution, it is suggested that an ALERT LEVEL Emergency be declared if a range fire or intra 200 East or West Area fire threatens a Tank Farm facility. The Alert Emergency is based on the potential degradation of safety at the facility.

6.6 Security Contingencies

6.6.1 Explosive Device

An ALERT LEVEL Emergency shall be declared if confirmed physical damage as a result of a detonation of an explosive device, in which potential loss of confinement/containment of hazardous materials, occurs in any of the Tank Farm facilities.

6.6.2 Sabotage

An ALERT LEVEL Emergency shall be declared if confirmed physical damage as a result of sabotage, results in potential loss of confinement/containment of hazardous materials to any of the Tank Farm facilities.

6.6.3 Hostage Situation

An ALERT LEVEL Emergency shall be declared if a confirmed hostage situation is occurring within the Tank Farm Complex.

6.6.4 Armed Intruder

An ALERT LEVEL Emergency shall be declared if confirmed armed intruder(s) are located within any of the Tank Farm facilities.

6.6.5 Aircraft Crash

Assuming that this scenario is similar to the seismic event with pipe breaks, a ground level release, meteorological conditions of F Stability, 1 m/s wind speed, and 20°C temperature, and using Table 5.12 source term, the resultant 100 m EDE is $7.3E+2$ Sv, and the 12.5 km EDE is $4.3E-1$ Sv. This requires a GENERAL Emergency be declared since the site boundary EDE is greater than 0.01 Sv.

7.0 EMERGENCY PLANNING ZONE

The Emergency Planning Zone (EPZ) is an area within which special planning and preparedness efforts are warranted since the consequences of a severe accident could result in Early Severe Health Effects. DOE order 5500.3A endorses the EPZ concept and requires that the choice of an EPZ for each facility be based on an objective analysis of the hazards associated with the facility. The Emergency Management Guide on Hazards Assessments provides several pages on guidance on establishing the size of the EPZ. The suggested approach is to determine the emergency classification of the events analyzed in the Hazards Assessment and then base the EPZ size on the larger of the default size for each emergency class for the maximum distance that an Early Severe Threshold is exceeded. A final step is to make adjustments to the area, if necessary, based on reasonableness tests in the guidance document. For example, the selected EPZ should conform to natural and jurisdictional boundaries where reasonable. The selection of the EPZ for the Waste Tank facilities is described below.

7.1 The Minimum EPZ Radius

Radiological

External or uniformly distributed internal emitters	1 Sv
Thyroid	30 Sv
Skin	12 Sv
Ovary	1.7 Sv
Bone Marrow	1.65 Sv
Testes	4.4 Sv
Other Organs	55 Sv

Non-Radiological

A peak concentration of the substance in air that equals or exceeds the ERPG-3 value, or equivalent.

Conclusion

The highest emergency classification for the Waste Tank facility is a general emergency for a waste tank explosion. The default EPZ size is the larger of five (5) km or the distance to the calculated levels associated with the Early Severe Health Effects determined in the hazards assessment. All the reasonableness tests will be applied to the larger area and will be discussed in section 7.2.

This hazards assessment contains a review of the worst postulated event for each of the above categories and the associated radiological and non-radiological consequences for the postulated event. The event with the worst calculated consequences is a jumper leak in an uncovered diversion box and release of large amounts of waste material.

The postulated consequences for the events identifies a maximum distance at which Early Severe Health Effects concentrations are calculated to be of a distance of about 9.7 km for radiological events. This assessment is consistent with definition of the minimum EPZ for events classified as a General Emergency. Since there are a number of Unreviewed Safety Questions associated with Waste Tank Facilities it is recommended that the minimum EPZ for 200 Area Waste Tank facilities has been defined as a radius of 16.1 km with 200 East and 200 West Areas as the center of an ellipse. This EPZ will be evaluated on an annual basis and as more information and characterization is completed of Hanford Waste Tanks.

7.2 Tests of Reasonableness

The radial distance selected above defines the minimum EPZ size that should be considered. Other factors should also be considered and the size and shape adjusted accordingly so that:

- (1) Are the maximum distances to PAG/ERPG-level impacts for most of the analyzed accident scenarios (i.e., all but the most severe consequence scenario for each hazardous material) equal to or less than the EPZ radius selected?

The EPZ bounds all analyzed accident scenarios, and includes the most severe events postulated.

- (2) Is the selected EPZ radius large enough to provide for extending response activities outside the EPZ if conditions warrant?

The EPZ radius is large enough to include response activities beyond the EPZ if conditions warrant.

- (3) Is the EPZ radius large enough to support an effective response at and near the scene of the emergency.

Yes, the EPZ radius extends enough to support this effort.

- (4) Does the proposed EPZ conform to natural and jurisdictional boundaries where reasonable, and are other expectations and needs of the offsite agencies likely to be met by the selected EPZ?

The EPZ does not conform to natural and jurisdictional boundaries at this point in time. The geopolitical boundaries associated with all Hanford EPZs were defined during FY 94 in conjunction with the State of Washington and the local county emergency management organizations, and will be approved during FY95.

- (5) What enhancement of the facility and site preparedness stature would be achieved by increasing the selected EPZ radius?

This situation is the primary reason for extending the proposed EPZ beyond the range of the ESHEs distances. The interim EPZ for the Waste Tank facilities was identified as 16.1 km in FY 92, and it has enhanced facility and site preparedness stature through additional planning and coordination.

8.0 EMERGENCY CLASSES, PROTECTIVE ACTIONS, AND EMERGENCY ACTION LEVELS

8.1 Emergency Classes

A goal of the DOE emergency preparedness system is to quickly classify the severity of an accident. Preplanned actions are then implemented for each emergency class. The emergency classification is based, in part, on projected dose and concentration values at the facility and Hanford site boundaries for pre analyzed accident scenarios. The emergency classification criteria are shown in Tables 8.1 and 8.2 below.

Table 8.1 Radiological Release Criteria

<u>Emerg. Category</u>	<u>Criteria*</u>
Alert	> 0.001 Sv committed dose equivalent at facility boundary > 0.005 Sv thyroid (worker) dose at facility boundary > 0.05 Sv skin dose at facility boundary
Site Area	≥ 0.01 Sv committed dose equivalent at facility boundary > 0.05 Sv thyroid (worker) dose at facility boundary > 0.5 Sv skin dose at facility boundary
General	≥ 0.01 Sv committed dose equivalent at site boundary > 0.05 Sv thyroid (infant) dose at site boundary > 0.5 Sv skin dose at site boundary

Table 8.2 Non-Radiological Release Criteria

<u>Emerg. Category</u>	<u>Criteria*</u>
Alert	> ERPG 1 at facility boundary
Site Area	≥ ERPG 2 at facility boundary
General	≥ ERPG 2 at site boundary

*The criteria apply to a peak concentration of the substance in air. If ERPG values have not been established for a substance, alternative criteria specified in the Emergency Management Guide for Hazards Assessments shall be used.

There are also general criteria for emergency classification in addition to the numerical values in the tables above. The threshold between reportable occurrences and the Alert classification is difficult to establish based solely on a numerical value. The following general criteria apply in addition to the airborne release concentration values specified in the tables above.

ALERT

An ALERT LEVEL Emergency shall be declared when events are in progress or have occurred which involve an actual or potential substantial degradation of the level of safety of the facility with an increased potential for a release.

In general, the ALERT classification is appropriate when the severity and/or complexity of an event may exceed the capabilities of the normal operating organization to adequately manage the event and its consequences.

SITE AREA

A SITE AREA emergency shall be declared when events are in progress or have occurred which involve actual or likely major failures of facility functions needed for protection of workers and the public.

GENERAL

A GENERAL EMERGENCY shall be declared when events are in progress or have occurred that involve actual or imminent catastrophic failure of facility safety systems with a potential for loss of confinement or containment integrity.

There is additional emergency classification guidance in the Emergency Management Guide on Event Classification and Emergency Action Levels. The Hazards Assessment in the following sections is based primarily on a comparison of calculated consequences with the numerical criteria in the tables above. However, some recommendations are provided based on the more general emergency classification criteria.

8.2 Emergency Action Levels

The facility accidents, trigger events, and recommended emergency action levels are provided in Appendix A.

9.0 MAINTAINANCE AND REVIEW OF THIS HAZARDS ASSESSMENT

The Operating Contractor, Manager of Emergency Preparedness, is responsible for ensuring that this Hazards Assessment is regularly reviewed and maintained current.

10.0 REFERENCES

AIHA, 1991, Emergency Response Planning Guidelines, American Industrial Hygiene Association ERPG Committee, American Industrial Hygiene Association, Akron, Ohio.

Dentler, M. L., 1993, "Hanford Emergency Response Planning Guidelines for Chemicals," Hanford Local Area Network (HLAN) file, updated as new values become available (most recent version as of 5/25/93 is 1/13/93).

DOE, 1991b, Planning and Preparedness for Operational Emergencies, DOE Order 5500.3A, U.S. Department of Energy, Washington, D.C.

DOE, July 1993, Recommended Values and Technical Bases for Airborne Released Fractions (ARFs), Airborne Release Rates (ARRs), and Respirable Fractions (RFs) at DOE Non-Reactor Nuclear Facilities, DOE-STD-0013-93, U.S. Department of Energy, Washington, D.C.

DOE-0223, Emergency Plan Implementing Procedures, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

Homann, 1988, Homann Associates, Inc., EPI code(TM), Copyright 1988. (The latest version owned by WHC Emergency Preparedness is Rev. 4.1.)

Huang, C. H., 1991a, Evaluation of Aerosolization from Fan-Type Spray Leaks, WHC-SD-GN-TI-30004, Westinghouse Hanford Company, Richland, Washington.

Huang, C. H., 1991b, The Estimates of Aerosolization Rate from a Spray Leak for Hazard Classification, WHC-SD-WM-SA-017, Westinghouse Hanford Company, Richland, Washington.

Napier, B. A., et al., 1988, GENII - The Hanford Environmental Radiation Dosimetry Software System, PNL-6584, Pacific Northwest Laboratory, Richland, Washington.

Scherpelz, R. I., February 1991, HUDU - The Hanford Unified Dose Utility Computer Code, PNL-7636, Pacific Northwest Laboratory, Richland, Wa.

WHC-SD-WM-ISB-001, Rev. 0, August 1993, Hanford Site Tank Farm Facilities Interim Safety Basis, Westinghouse Hanford Co., Richland, WA.

WHC-SD-WM-SARR-006, Rev. 0, June 1994, 204-AR Unloading Facility Accelerated Safety Analysis, Westinghouse Hanford Co., Richland, WA.

APPENDIX A Tank Farm EMERGENCY ACTION LEVELS

September 28, 1994

No. 1A
FACILITIES EMERGENCY EVENTS
(sheet 1 of 9)

RADIATION RELEASE

Initiating Condition	Emergency Action Level	Event Classification
A HEPA filter failure at the Tank Farms	A confirmed or indicated HEPA filter failure at Tank Farm facility stack as indicated by a Dp reading less than 0.1 inches Water Gauge (in. wg.) AND CAM alarm.	ALERT LEVEL EMERGENCY
A HEPA filter failure at the Tank Farms	A confirmed or indicated HEPA filter failure at Tank Farm facility stack as indicated by a Dp reading less than 0.1 inches Water Gauge (in. wg.) AND Exhauster running	SITE AREA EMERGENCY
A HEPA filter failure at the Tank Farms	A confirmed or indicated HEPA filter failure at Tank Farm facility stack as indicated by a Dp reading less than 0.1 inches Water Gauge (in. wg.) AND Exhauster running AND Stack alarm	GENERAL EMERGENCY

No. 1B
FACILITIES EMERGENCY EVENTS
(sheet 2 of 9)

RADIATION RELEASE

Initiating Condition	Emergency Action Level	Event Classification
A loss of the Loop Seal.	The seal Dp is lost as documented in control room.	ALERT LEVEL EMERGENCY
A loss of the Loop Seal.	The seal Dp is lost as documented in control room. AND Contamination is measured in environment above background.	SITE AREA EMERGENCY

Note: No General Emergency class identified.

September 28, 1994

No. 1C
FACILITIES EMERGENCY EVENTS
(sheet 3 of 9)

RADIATION RELEASE

Initiating Condition	Emergency Action Level	Event Classification
A tank pressurization occurs.	An exhauster fails to operate AND tank pressurization occurs as measured by increase in Dp.	ALERT LEVEL EMERGENCY
A tank pressurization occurs.	An exhauster fails to operate AND tank pressurization occurs as measured by increase in Dp AND contamination is measured in environment above background.	SITE AREA EMERGENCY

Note: No General Emergency class identified.

No. 1D
FACILITIES EMERGENCY EVENTS
(sheet 4 of 9)

RADIATION RELEASE

Initiating Condition	Emergency Action Level	Event Classification
204-AR Rail Car waste release.	Tank Car waste transfer occurring AND confinement loss occurring.	ALERT LEVEL EMERGENCY
204-AR tank waste release.	Tank waste transfer occurring AND confinement loss occurring with fire.	SITE AREA EMERGENCY

Note: No General Emergency class identified.

September 28, 1994

No. 1E
FACILITIES EMERGENCY EVENTS
(sheet 5 of 9)

RADIATION RELEASE

Initiating Condition	Emergency Action Level	Event Classification
242-A airborne release.	Under ground transfer pipe looses confinement and pump is operating.	ALERT LEVEL EMERGENCY
242-A airborne release.	Under ground transfer pipe looses confinement and pump is operating AND Pump operates ≥ 10 minutes.	SITE AREA EMERGENCY

Note: No General Emergency class identified.

No. 1F
FACILITIES EMERGENCY EVENTS
(sheet 6 of 9)

RADIATION RELEASE

Initiating Condition	Emergency Action Level	Event Classification
Jumper, Connector, or DCRT Spray Leak	Pit cover is off and transfer occurring.	ALERT LEVEL EMERGENCY
Jumper, Connector, or DCRT Spray Leak	Pit cover is off and transfer occurring AND confinement is lost for <30 seconds.	SITE AREA EMERGENCY
Jumper, Connector, or DCRT Spray Leak	Cover pit is off and transfer occurring AND confinement is lost for ≥ 30 seconds.	GENERAL EMERGENCY

September 28, 1994

No. 1G
FACILITIES EMERGENCY EVENTS
(sheet 7 of 9)

RADIATION RELEASE

Initiating Condition	Emergency Action Level	Event Classification
Loss of 242-A confinement.	Evaporator feed confinement lost in facility AND confinement lost for ≥ 1.5 minutes.	ALERT LEVEL EMERGENCY
242-A airborne release.	Evaporator feed confinement lost in facility AND confinement lost for > 15 minutes.	SITE AREA EMERGENCY

Note: No General Emergency class identified.

No. 1H
FACILITIES EMERGENCY EVENTS
(sheet 8 of 9)

RADIATION RELEASE

Initiating Condition	Emergency Action Level	Event Classification
Hydrogen burn occurs without waste tank confinement	Riser is open AND hydrogen burn occurs.	ALERT LEVEL EMERGENCY
Hydrogen burn occurs without waste tank confinement	Riser is open AND hydrogen burn occurs AND contamination above background measured in vicinity of riser.	SITE AREA EMERGENCY

Note: No General Emergency class identified.

September 28, 1994

No. 11
FACILITIES EMERGENCY EVENTS
(sheet 9 of 9)

RADIATION RELEASE

Initiating Condition	Emergency Action Level	Event Classification
Hydrogen explosion occurs in waste tank dome void.	Explosion occurs as heard or felt AND HEPA filter Dp lost.	ALERT LEVEL EMERGENCY

Note: No Site Area or General Emergency classes identified.

No. 2A
NATURAL EMERGENCIES
 (sheet 1 of 7)

SEISMIC EVENT

Initiating Condition	Emergency Action Level	Event Classification
A seismic event occurs in the 200 Areas.	An event felt by personnel in the Tank Farm Complex, with some breakage of windows and disturbance of facilities.	ALERT LEVEL EMERGENCY
A seismic event occurs in the 200 Areas.	An event felt by personnel in the Tank Farm Complex, with some breakage of windows and disturbance of facilities AND pipes or containment systems broken containing radioactivity or hazardous material.	SITE AREA EMERGENCY
A seismic event occurs in the 200 Areas.	An event felt by personnel in the Tank Farm Complex, with some breakage of windows and disturbance of facilities AND pipes or containment systems broken containing radioactivity or hazardous material AND contamination above background measured in environment.	GENERAL EMERGENCY

September 28, 1994

No. 2B
NATURAL EMERGENCIES
(sheet 2 of 7)

SEISMIC EVENT

Initiating Condition	Emergency Action Level	Event Classification
A seismic event occurs in the 200 Areas.	An event felt by personnel in the Tank Farm Complex, with some breakage of windows and disturbance of facility objects.	ALERT LEVEL EMERGENCY
A seismic event occurs in the 200 Areas.	An event felt by personnel in the Tank Farm Complex, with some breakage of windows and disturbance of facility objects AND SST dome failure observed.	SITE AREA EMERGENCY
A seismic event occurs in the 200 Areas.	An event felt by personnel in the Tank Farm Complex, with some breakage of windows and disturbance of facility objects AND SST dome failure observed AND contamination above background measured in environment.	GENERAL EMERGENCY

No. 2C
NATURAL EMERGENCIES
(sheet 3 of 7)

SEISMIC EVENT

Initiating Condition	Emergency Action Level	Event Classification
A seismic event occurs in the 200 Areas.	An event felt by personnel in the Tank Farm Complex, with some breakage of windows and disturbance of facility objects AND ALC not operating.	ALERT LEVEL EMERGENCY
A seismic event occurs in the 200 Areas.	An event felt by personnel in the Tank Farm Complex, with some breakage of windows and disturbance of facility objects AND tank contents heat up AND ALC restarts.	SITE AREA EMERGENCY

Note: No General Emergency classes identified.

September 28, 1994

No. 2D
NATURAL EMERGENCIES
(sheet 4 of 7)

SEISMIC EVENT

Initiating Condition	Emergency Action Level	Event Classification
A seismic event occurs in the 200 Areas.	An event felt by personnel in the Tank Farm Complex, with some breakage of windows and disturbance of facility objects.	ALERT LEVEL EMERGENCY
A seismic event occurs in the 200 Areas.	An event felt by personnel in the Tank Farm Complex, with collapse of the 242-A facility AND loss of containment of liquid wastes.	SITE AREA EMERGENCY

Note: No General Emergency classes identified.

No. 2E
NATURAL EMERGENCIES
(sheet 5 of 7)

TORNADO/HIGH WIND

Initiating Condition	Emergency Action Level	Event Classification
Tornado or high winds observed in 200 Areas.	A tornado or high winds are observed in area of the Tank Farm Complex and verified by calling Hanford Meteorological Station.	ALERT LEVEL EMERGENCY

Note: No Site Area and General Emergency classes identified.

No. 2F
NATURAL EMERGENCIES
(sheet 6 of 7)

ASH/SNOW FALL

Initiating Condition	Emergency Action Level	Event Classification
Volcanic ash or heavy snow fall occurs in 200 Areas.	Volcanic ash or a heavy snow fall suddenly occurs and is threatening the Tank Farm Complex.	ALERT LEVEL EMERGENCY

Note: No Site Area and General Emergency classes identified.

No. 2E
NATURAL EMERGENCIES
(sheet 7 of 7)

RANGE FIRE

Initiating Condition	Emergency Action Level	Event Classification
Range Fire enters 200 Areas and is threatening to involve the Tank Farm Complex facilities.	A range fire observed to have entered the Tank Farm Complex.	ALERT LEVEL EMERGENCY

Note: No Site Area and General Emergency classes identified.

September 28, 1994

No. 3A
SECURITY CONTINGENCIES
(sheet 1 of 5)

EXPLOSIVE DEVICE

Initiating Condition	Emergency Action Level	Event Classification
Explosive device in a Tank Farm facility.	A confirmed explosive device is located within or a confirmed explosion is noted in any Tank Farm facility.	ALERT LEVEL EMERGENCY

Note: No Site Area or General Emergency classes identified.

No. 3B
SECURITY CONTINGENCIES
(sheet 2 of 5)

SABOTAGE

Initiating Condition	Emergency Action Level	Event Classification
Confirmed sabotage to a Tank Farm facility.	Confirmed damage to confinement/containment of radioactive or hazardous materials.	ALERT LEVEL EMERGENCY

Note: No Site Area or General Emergency class identified.

September 28, 1994

No. 3C
SECURITY CONTINGENCIES
(sheet 3 of 5)

HOSTAGE SITUATION

Initiating Condition	Emergency Action Level	Event Classification
Hostage situation.	A confirmed hostage situation is occurring within the Tank Farm Complex.	ALERT LEVEL EMERGENCY

Note: No Site Area or General Emergency classes identified.

No. 3D
SECURITY CONTINGENCIES
(sheet 4 of 5)

ARMED INTRUDER

Initiating Condition	Emergency Action Level	Event Classification
Armed intruder(s) within a Tank Farm Complex facility.	A confirmed armed intruder(s) are located within a Tank Farm facility.	ALERT LEVEL EMERGENCY

Note: No Site Area or General Emergency classes identified.

September 28, 1994

No. 3E
SECURITY CONTINGENCIES
(sheet 5 of 5)

AIRCRAFT CRASH

Initiating Condition	Emergency Action Level	Event Classification
An aircraft crash has occurred at or near one of the Tank Farm facilities.	An aircraft crash has occurred AND has or is likely to have an adverse affect on the facility's safety or has or is likely to release radioactive/hazardous material to the environment.	ALERT LEVEL EMERGENCY

Note: No Site Area or General Emergency classes identified.