DISTRIBUTION SHEET

To	From	Page 1 of 1
DISTRIBUTION	SM STAHL	Date 12-22-94
Project Title/Work Order		EDT No. N/A
SAFETY EVALUATION OF INTERIM STABILIZATION OF NON-STABILIZED SINGLE-SHELL WATCHLIST TANKS		ECN No. 605010

Name	MSIN	Text With All Attach.	Text Only	Attach./ Appendix Only	EDT/ECN Only
SM STAHL	H4-61	X			
KD GIBSON	H4-61	X			
TE RAINEY	R4-02	X			
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RE RAYMOND	R2-54	X			
CENTRAL FILES (2)	L8-04	X			
OSTI (2)	L8-07	X			

ENGINEERING CHANGE NOTICE

Page 1 of 3

1. ECN 605010

Proj. ECN

2. ECN Category (mark one) Supplemental [] Direct Revision [x] Change ECN [] Temporary [] Standby [] Supersedure [] Cancel/Void []	3. Originator's Name, Organization, MSIN, and Telephone No. S. M. Stahl/8D111/H4-61/376-8022		4. Date December 22, 1994
	5. Project Title/No./Work Order No. N51G2	6. Bldg./Sys./Fac. No. Tank Farms	7. Approval Designator N/A
	8. Document Numbers Changed by this ECN (includes sheet no. and rev.) WHC-SD-WM-TI-656, Rev. 0	9. Related ECN No(s). N/A	10. Related PO No. N/A

11a. Modification Work [] Yes (fill out Blk. 11b) [X] No (NA Blks. 11b, 11c, 11d)	11b. Work Package No. N/A	11c. Modification Work Complete N/A Cog. Engineer Signature & Date	11d. Restored to Original Condition (Temp. or Standby ECN only) N/A Cog. Engineer Signature & Date

12. Description of Change

The report has been changed to incorporate results of Tank Farms Accelerated Safety Analysis, update program plans for resolution of Watch List Tank safety issues affecting interim stabilization, and to reflect the revised interim stabilization schedule.

13a. Justification (mark one)		Criteria Change	[X]	Design Improvement	[]	Environmental	[]
As-Found	[]	Facilitate Const.	[]	Const. Error/Omission	[]	Design Error/Omission	[]

13b. Justification Details

Results of Accelerated Safety Analysis provided changes which could affect interim stabilization plans for Watch List Tanks, and changes to the TPA Milestones resulted in changes to the interim stabilization schedule.

14. Distribution (include name, MSIN, and no. of copies)

(See attached EDT 142214.)

RELEASE STAMP

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DATE DEC 22 1994

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A-7900-013-2 (06/94) GEF095

A-7900-013-1 (06/92)

15. Design Verification Required	16. Cost Impact				17. Schedule Impact (days)	
	ENGINEERING		CONSTRUCTION			
[] Yes	Additional []	$ N/A	Additional []	$ N/A	Improvement	[]
[X] No	Savings []	$ N/A	Savings []	$ N/A	Delay	[]

18. Change Impact Review: Indicate the related documents (other than the engineering documents identified on Side 1) that will be affected by the change described in Block 12. Enter the affected document number in Block 19.

SDD/DD	[]	Seismic/Stress Analysis	[]	Tank Calibration Manual	[]
Functional Design Criteria	[]	Stress/Design Report	[]	Health Physics Procedure	[]
Operating Specification	[]	Interface Control Drawing	[]	Spares Multiple Unit Listing	[]
Criticality Specification	[]	Calibration Procedure	[]	Test Procedures/Specification	[]
Conceptual Design Report	[]	Installation Procedure	[]	Component Index	[]
Equipment Spec.	[]	Maintenance Procedure	[]	ASME Coded Item	[]
Const. Spec.	[]	Engineering Procedure	[]	Human Factor Consideration	[]
Procurement Spec.	[]	Operating Instruction	[]	Computer Software	[]
Vendor Information	[]	Operating Procedure	[]	Electric Circuit Schedule	[]
OM Manual	[]	Operational Safety Requirement	[]	ICRS Procedure	[]
FSAR/SAR	[]	IEFD Drawing	[]	Process Control Manual/Plan	[]
Safety Equipment List	[]	Cell Arrangement Drawing	[]	Process Flow Chart	[]
Radiation Work Permit	[]	Essential Material Specification	[]	Purchase Requisition	[]
Environmental Impact Statement	[]	Fac. Proc. Samp. Schedule	[]	Tickler File	[]
Environmental Report	[]	Inspection Plan	[]		[]
Environmental Permit	[]	Inventory Adjustment Request	[]		[]

19. Other Affected Documents: (NOTE: Documents listed below will not be revised by this ECN.) Signatures below indicate that the signing organization has been notified of other affected documents listed below.

Document Number/Revision	Document Number/Revision	Document Number Revision
N/A		

20. Approvals

Signature	Date	Signature	Date
OPERATIONS AND ENGINEERING		ARCHITECT-ENGINEER	
Cog. Eng. S. M. Stahl *S.M. Stahl*	12/22/94	PE	
Cog. Mgr. K. D. Gibson *K.D. Gibson*	12/22/94	QA	
QA		Safety	
Safety		Design	
Environ.		Environ.	
Other		Other	
See EDT 142214 for approval signatures.			
		DEPARTMENT OF ENERGY	
		Signature or a Control Number that tracks the Approval Signature	
		ADDITIONAL	

ENGINEERING DATA TRANSMITTAL

~~Page 1 of~~ ~~1. EDT~~ ~~142214~~

2. To: (Receiving Organization) Waste Tank Plant Engineering	3. From: (Originating Organization) TWRS Safety Analysis and Nuclear Engineering	4. Related EDT No.: 142209
5. Proj./Prog./Dept./Div.: Tank Waste Remediation System	6. Cog. Engr.: S. M. Stahl	7. Purchase Order No.: N/A
8. Originator Remarks:		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: December 30, 1994

15. DATA TRANSMITTED

(A) Item No.	(B) Document/Drawing No.	(C) Sheet No.	(D) Rev. No.	(E) Title or Description of Data Transmitted	(F) Approval Designator	(G) Reason for Transmittal	(H) Originator Disposition	(I) Receiver Disposition
1	WHC-SD-WM-TI-656		1	Safety Evaluation of Interim Stabilization of Non-Stabilized Single-Shell Watchlist Tanks	N/A	1	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 2. Release 3. Information 4. Review 5. Post-Review 6. Dist. (Receipt Acknow. Required)	1. Approved 2. Approved w/comment 3. Disapproved w/comment 4. Reviewed no/comment 5. Reviewed w/comment 6. Receipt acknowledged

17. SIGNATURE/DISTRIBUTION (See Approval Designator for required signatures)

(G) Reason	(H) Disp.	(J) Name	(K) Signature	(L) Date	(M) MSIN	(J) Name	(K) Signature	(L) Date	(M) MSIN	(G) Reason	(H) Disp.
1	1	Cog.Eng. S. M. Stahl	[signature]	12/21/94	H4-61	R. E. Raymond	[signature]		R2-54	3	6
1	1	Cog. Mgr. K. D. Gibson	[signature]	12/21/94	H4-61	Central Files (2)			L8-04		
		QA				OSTI (2)			L8-07		
		Safety									
		Env.									
1	1	T. E. Rainey	[signature]	12/21/94	R4-02						
1	1	D. B. Engelman (Stickney)	[signature]	12/29/94	R1-49						

18.	19.	20.	21. DOE APPROVAL (if required)
S. M. Stahl [signature] 12/21/94 Signature of EDT Originator / Date	R. R. Stickney [signature] 12/29/94 Authorized Representative for Receiving Organization / Date	K. D. Gibson [signature] 12/21/94 Cognizant Manager / Date	Ctrl. No. N/A [] Approved [] Approved w/comments [] Disapproved w/comments

RELEASE AUTHORIZATION

Document Number:	WHC-SD-WM-TI-656, Rev. 1
Document Title:	Safety Evaluation of Interim Stabilization of Non-Stabilized Single-Shell Watch List Tanks
Release Date:	12/22/94

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

APPROVED FOR PUBLIC RELEASE

WHC Information Release Administration Specialist:

Niki Solis 12/22/94

Niki Solis

SUPPORTING DOCUMENT

2. Title Safety Evaluation of Interim Stabilization of Non-Stabilized Single-Shell Watch List Tanks	3. Number WHC-SD-WM-TI-656	4. Rev No. 1

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5. Key Words

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12/22/94 D. Doles

6. Author

Name: S. M. Stahl

Signature: Shelen M. Stahl

Organization/Charge Code 8D111/N51G2

7. Abstract

The report provides a summation of the status of safety issues associated with interim stabilization of Watch List SSTs (organic, ferrocyanide, and flammable gas), as extracted from recent safety analyses, including the Tank Farms Accelerated Safety Analysis efforts.

9. Impact Level N/A

10. RELEASE STAMP

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RECORD OF REVISION	(1) Document Number WHC-SD-WM-TI-656	Page 1

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Safety Evaluation of Interim Stabilization of Non-Stabilized Single-Shell Watch List Tanks

CHANGE CONTROL RECORD

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0	EDT# 142209, 9/30/94		
Rev. 1 RS	(7) Replacement of Revision 0.	S. M. Stahl S M Stahl	K. D. Gibson K.D. Gibson 12/22/94

SAFETY EVALUATION
OF INTERIM STABILIZATION OF NON-STABILIZED
SINGLE-SHELL WATCH LIST TANKS

S. M. Stahl

December 30, 1994

DISCLAIMER

Prepared for United States Department of Energy

Westinghouse Hanford Company
P.O. Box 1970
Richland, Washington 99352

EXECUTIVE SUMMARY

The results of completed safety analyses related to the hazards associated with Interim Stabilization of Watch List Single-Shell Tanks (SSTs) were reviewed to identify and summarize conclusions regarding the safety of interim stabilization, and to highlight applicable limitations, restrictions, and controls.

The scope of this review was restricted to SSTs identified on the Watch List in the categories of flammable gas, ferrocyanide, and organic salts. High heat tanks were not included in the scope. A Watch List tank is defined as an underground storage tank containing waste that requires special safety precautions because it may have a serious potential for release of high level radioactive waste because of uncontrolled increases in temperature or pressure. Special restrictions have been placed on these tanks by "Safety Measures for Waste Tanks at Hanford Nuclear Reservation," Section 3137 of the *National Defense Authorization Act for Fiscal Year 1991*, November 5, 1990, Public Law 101-510, (also known as the Wyden Amendment). A total of twenty-eight tanks are on the Watch List which are subject to interim stabilization.

Interim Stabilization and Emergency pumping of Watch List Tanks that develop leaks is supported by technical analyses that justify that emergency pumping can be performed safely, and is the preferred alternative to permitting the tanks to leak their contents to the soil structure. Applicable controls and restrictions necessary to maintain safety must be followed to maintain waste stability during and after interim stabilization for the Watch List Tanks.

Ferrocyanide Watch List SSTs have been evaluated as safe for emergency pumping and interim stabilization. These activities are not expected to adversely affect the long term waste stability of ferrocyanide tanks.

Flammable Gas Watch List SSTs can be emergency pumped and interim stabilized safely, provided that stated controls are followed during and following interim stabilization. Applicable controls include monitoring of the tanks' headspace to maintain flammable gas concentrations below 25% of the Lower Flammability Limit (LFL), and preventing the introduction of ignition sources in the tank headspace. Approval for pumping of flammable gas tanks is dependent upon DOE acceptance of the Accelerated Safety Analysis (WHC 1994a) results pertaining to flammable gas tanks. This approval would support interim stabilization of flammable gas and organic tank, 241-U-107.

Organic Salt Watch List SSTs require evaluation on a tank by tank basis prior to emergency pumping or interim stabilization to determine if the post-stabilized condition of the tank is expected to meet applicable safety criteria. An evaluation is under development to provide the rationale for making a decision on the advisability of interim stabilization of organic tanks. The evaluation will use sample data from each tank. The sample data will include vapor space sampling and supernate grab samples taken prior to initiation of interim stabilization. The tank's organic vapor content, waste total organic carbon content, and predicted post-interim stabilized waste moisture content are primary indicators that will be used to make a decision on the advisability of interim stabilization.

Relative to organic tanks 241-U-106 and 241-U-107 (also a flammable gas tank) which are scheduled to be interim stabilized in 1995, vapor space sampling and grab sampling are scheduled to be completed by the end of April, 1995 per WHC-EP-0182-78 (Hanlon 1994). Vapor space sampling for 241-U-111 is to be completed in March, 1995. Grab sampling for 241-U-111 has been completed. The Preliminary Safety Criteria for Organic Watch List Tanks at the Hanford Site is to be available February, 1995 as is the PNL TOC Moisture Report. The PNL TOC Moisture Report will be used to analyze tank sample data and predict the TOC and moisture content of waste (supernate and sludge) in the tank. Additional refinements are needed for saltcakes due to a lack of sample data, and possible differences between core sample results and post-interim stabilized waste conditions. A predictive supernate/saltcake model is being developed to provide improved predictions of fuel and moisture retention in these saltcakes. The Supernate/Saltcake Model, which will be used to predict the post-interim stabilized condition of the waste remaining in the tanks, is expected to be available in draft form by April 30, 1995. This compilation of information will be used to support the Interim Stabilization decision for tanks 241-U-106, 241-U-107, and 241-U-111.

SAFETY EVALUATION
OF INTERIM STABILIZATION OF NON-STABILIZED
SINGLE-SHELL WATCH LIST TANKS

TABLE OF CONTENTS

1.0 INTRODUCTION

1.1 PURPOSE AND SCOPE

This report provides results of a review of recently completed safety analyses related to hazards associated with Interim Stabilization of Single-Shell Tanks (SSTs) that are included on the Hanford Site Waste Tank Watch List. The purpose of the review was to identify and summarize conclusions regarding the safety of interim stabilization of Watch List SSTs, and to highlight applicable limitations, restrictions, and controls.

The scope of this review was restricted to SSTs identified on the Watch List in the categories of flammable gas, ferrocyanide, and organic salts. High heat tanks were not included in the scope. A Watch List tank is defined as an underground storage tank containing waste that requires special safety precautions because it may have a serious potential for release of high level radioactive waste because of uncontrolled increases in temperature or pressure. Special restrictions have been placed on these tanks by "Safety Measures for Waste Tanks at Hanford Nuclear Reservation," Section 3137 of the *National Defense Authorization Act for Fiscal Year 1991*, November 5, 1990, Public Law 101-510, (also known as the Wyden Amendment). The Watch List categories apply to tanks as follows:

- Flammable Gas - Tanks with potential for hydrogen or flammable gas accumulation above the flammability limit.
- Ferrocyanide - Tanks containing > 1000 gram-mole of ferrocyanide.
- Organic Salt - Tanks containing concentrations of organic salts > 3 weight % total organic carbon (TOC). Tanks identified as now or previously containing floating organic layers have also been added to the Watch List.
- High-Heat - Tank 241-C-106 (Estimated Heatload is 110,000 BTU/hr).

A total of twenty-eight tanks are on the Watch List which are subject to interim stabilization. See Table 2.1-1 for identification of the non-interim stabilized Watch List SSTs by category of limitations.

Included within this report is the following information:

- Identification of the status of non-interim stabilized Watch List SSTs by category of limitations
- Summation of results of current safety analyses with respect to hazards to liquid removal
- Identification of applicable limitations, restrictions, and controls required for interim stabilization of the Watch List tanks
- Identification of the current interim stabilization plan, including identification of tanks presently excluded from interim stabilization activities.

1.2 SUMMARY AND CONCLUSIONS

Emergency pumping of Watch List Tanks that develop leaks is supported by technical analyses that justify that emergency pumping can be performed safely, and is the preferred alternative to permitting the tanks to leak their contents to the soil structure. Interim stabilization of the Watch List Tanks that have not developed leaks can also be performed safely provided applicable controls and restrictions are followed. The effects on long term stability of the waste that remains in the tank following interim stabilization has not been substantiated in all cases.

Safety analyses have been performed by WHC to identify and evaluate hazards associated with emergency pumping and interim stabilization activities for Watch List Tanks. Results of recent analyses as they relate to emergency pumping and interim stabilization of the Watch List Tanks are summarized within the context of this document. The question as to whether or not interim stabilization activities could affect tank safety for the Watch List Tanks varies with the Watch List categories. The following provides a brief status of evaluation results:

1.2.1 Flammable Gas Tanks

Emergency pumping and interim stabilization of Flammable Gas Watch List Single-Shell Tanks can be performed safely, provided that stated controls are followed. However, the effect of interim stabilization on stability of the waste remaining in the tank is an issue that requires further evaluation. Interim stabilization may make the waste more prone to retaining flammable gases, with potential for larger episodic gas releases. However, if stated controls are followed, the tanks can be interim stabilized safely and remain safe in the post-interim stabilized condition.

1.2.2 Ferrocyanide Tanks

SSTs identified on the Ferrocyanide Watch List have been evaluated as safe for emergency pumping and interim stabilization. These activities are not expected to adversely affect the long term waste stability of ferrocyanide tanks.

1.2.3 Organic Salt Tanks

Emergency pumping and interim stabilization of Single-Shell Organic Watch List Tanks, with the possible exception of tank 241-C-103, can be performed safely, provided that stated controls are followed. However, the effect of interim stabilization on stability of the waste remaining in the tank is an issue that requires further evaluation. Tank 241-C-103 has a floating organic layer that presents an unanalyzed hazard relative to interim stabilization activities. Organic tanks that previously contained floating organic liquid layers which were subsequently removed, may have waste surfaces more prone to combustion following interim stabilization. Waste moisture retention levels within organic tanks following interim stabilization may not be sufficient to determine that the organic tanks are "conditionally safe."

2.0 BACKGROUND AND DESCRIPTION

2.1 BACKGROUND

Westinghouse Hanford Company (WHC) is committed to removing pumpable radioactive liquid waste from Single Shell Tanks (SSTs) for transfer to sound Double Shell Tanks (DSTs) and waste reduction facilities. The transfers are planned in order to minimize environmental damage as may be caused by loss of tank integrity in the SSTs, and subsequent leaking of the highly radioactive liquid to the soil structure. The process to be used is called interim stabilization. Of the existing 149 SSTs, to date 106 tanks have been declared to be interim stabilized. A schedule has been established to provide for interim stabilization of the remaining SSTs. Several of the SSTs that remain to be interim stabilized are classified as Watch List Tanks.

Watch List Tanks are identified in WHC-EP-0182-78 (Hanlon 1994), *Tank Farm Surveillance and Waste Summary Report*, Latest Edition. Table 2.1-1 provides the current identification of the non-interim stabilized Watch List SSTs by category of limitations.

2.2 ACTIVITIES NECESSARY TO PUMP FLAMMABLE GAS WATCH LIST TANKS

There are several activities required to prepare a Watch List SST for pumping. These activities are either intrusive or non-intrusive into the dome space of the tank. A flow chart has been prepared (Figure 1) to illustrate the key (minimum) activities that are involved in pumping Flammable Gas Watch List Tanks. Other Watch List Tanks require similar activities, though not necessarily the same, prior to interim stabilization. These activities and specific routes are described for each SST in the *Single-Shell Tank Leak Emergency Pumping Guide* (Wiggins 1994) and in the *Operational Summary for Single-Shell Tank Farm Waste Transfer*, (Almodovar 1994a).

2.3 SUMMARY DESCRIPTION OF INTERIM STABILIZATION OF WATCH LIST SSTs

2.3.1 Component Description

In general, the process facilities and equipment needed for salt well pumping for transferring waste from SSTs are:

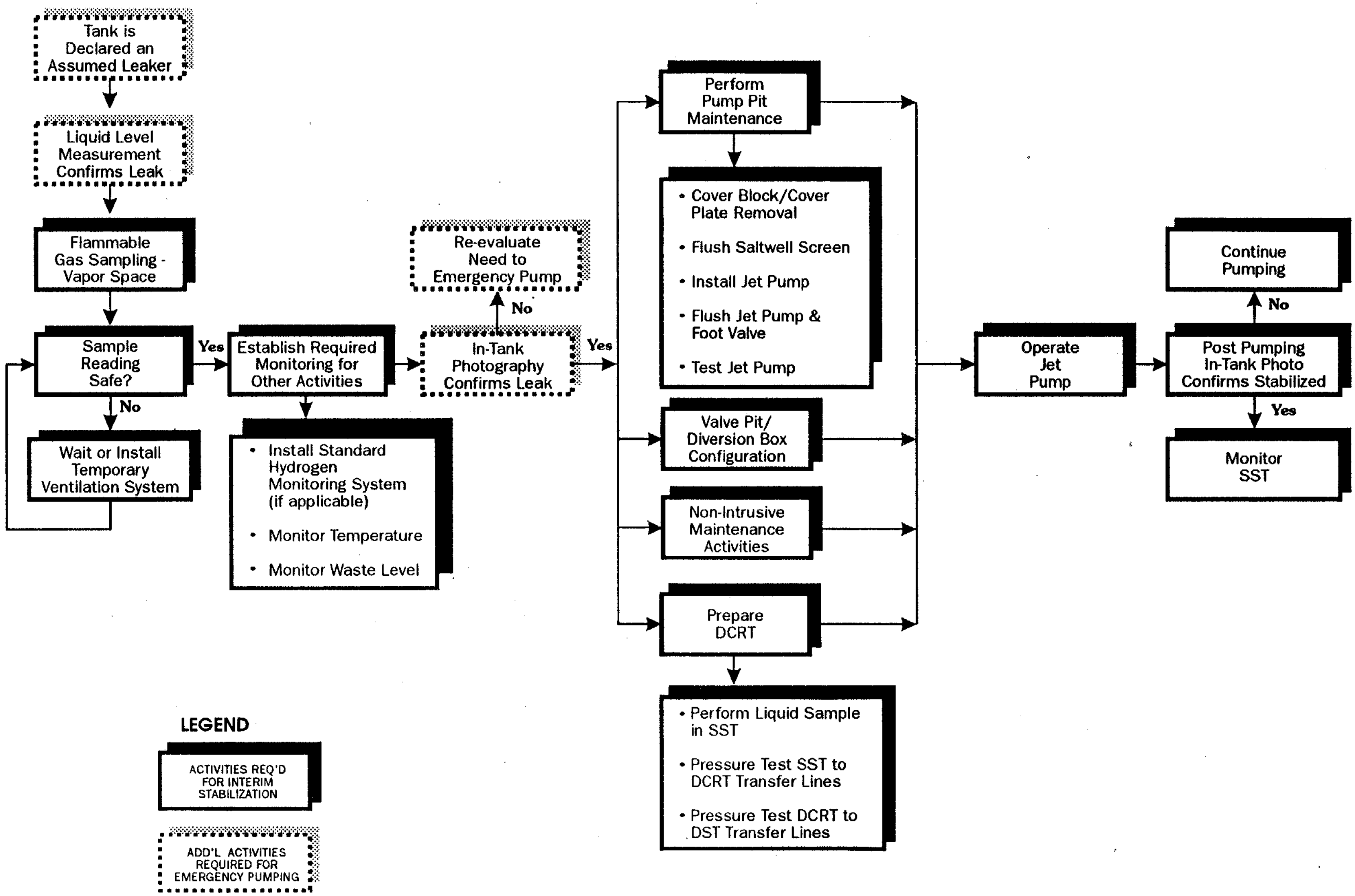
- Single-Shell waste storage tanks
- Pump pit
- Salt well screen
- Jet pump assembly
- Submersible pump assembly (Optional)
- Transfer piping
- Underground pipes.
- Overground pipes.
- Valve pits
- Double-Contained Receiving Tanks
- Double-shell waste storage tanks

Table 2.1-1
Non-Interim Stabilized Single-Shell Watch List Tanks

FLAMMABLE GAS	ORGANICS	FERROCYANIDE	HIGH HEAT
A-101	A-101		
AX-101			
		BX-106	
		BY-103	
		BY-105	
		BY-106	
	C-102		
	C-103		
			C-106
S-102	S-102		
S-111	S-111		
S-112			
SX-101			
SX-102			
SX-103	SX-103		
SX-104			
SX-105			
SX-106	SX-106		
		T-107	
T-110			
	T-111		
U-103	U-103		
U-105	U-105		
	U-106		
U-107	U-107		
U-108			
U-109			
	U-111		

Interim Stabilization not supported by existing analyses.

Figure 1. Logic Diagram for the Minimum Activities Required to Pump a Flammable Gas Single-Shell Tank



2.3.1.1 Single-Shell Waste Storage Tanks. Waste containment in the original tank design was achieved by a reinforced concrete shell with a liner of mild carbon steel covering the bottom and sidewalls. The tanks are 23 m (75 ft) in diameter and were constructed to hold 4.5 to 9 m (15 to 30 ft) of liquid, for a nominal capacity of 2 million to 3.8 million L (530,000 to 1 million gal); 16 smaller receiver tanks are each 6 m (20 ft) in diameter with the same basic design and can hold 208,000 L (55,000 gal). All the tanks have a minimum of 2 m (6.5 ft) of earth cover for shielding and heat dissipation from radioactive decay. Figure 2 illustrates the four single-shell waste tank designs used at the Hanford Site.

2.3.1.2 Pump Pit. The dome of the SST is built with several risers of different diameters, one of which protrudes into the pump pit. A pump pit is a concrete structure located above the tank dome near the center of the tank. The pump pit contains transfer and agitator pumps and jumper connections to the transfer lines and valves.

Tank waste flow from the SST is routed through the pump pit to a double-contained receiver tank (DCRT) using a standard Tank Farm transfer procedure.

Each transfer pump pit is equipped with a leak detector, which will detect the leak in the pits. Additional leak detectors are provided in valve pits along the transfer route, which could detect leaks through the primary pipe.

2.3.1.3 Salt Well Screen. The salt well system is a 25.4 cm (10 in.) diameter salt well casing consisting of a stainless steel salt well screen welded to a schedule 40 carbon steel pipe. The casing and screen are inserted into the 30.5 cm (12 in.) tank riser located in the pump pit. The stainless steel screen portion of the system extends through the tank waste to near the bottom of the tank. The salt well screen portion of the casing is an approximately 3 m (10 ft.) length of 25.4 cm (10 in.) diameter, 300-series, stainless steel pipe with screen openings (slots) of 1.3 mm (0.050 in.) (400 mesh). The salt well screen may extend above the tank waste. Therefore, the salt well may be open to the tank's atmosphere. The function of the salt well screen is to minimize the size and amount of solids pumped.

2.3.1.4 Jet Pump Assembly. A jet pump assembly, with foot valve, is mounted to the base of two pipes which are located inside of the salt well screen and extend from the top of the well to near the bottom of the well casing (Figure 3). Also inside of the salt well screen are specific gravity and weight factor dip tubes.

The components of the jet pump system located within the pump pit include a centrifugal pump to supply motive fluid to the down-hole jet assembly, flexible or rigid jumpers, a flush line, and a flow meter. The flexible or rigid jumpers contain piping, valves, pressure and limit switches. There is a drain in the bottom of the pump pit which empties into the tank and is normally open.

Figure 2. Single-Shell Tank Configuration

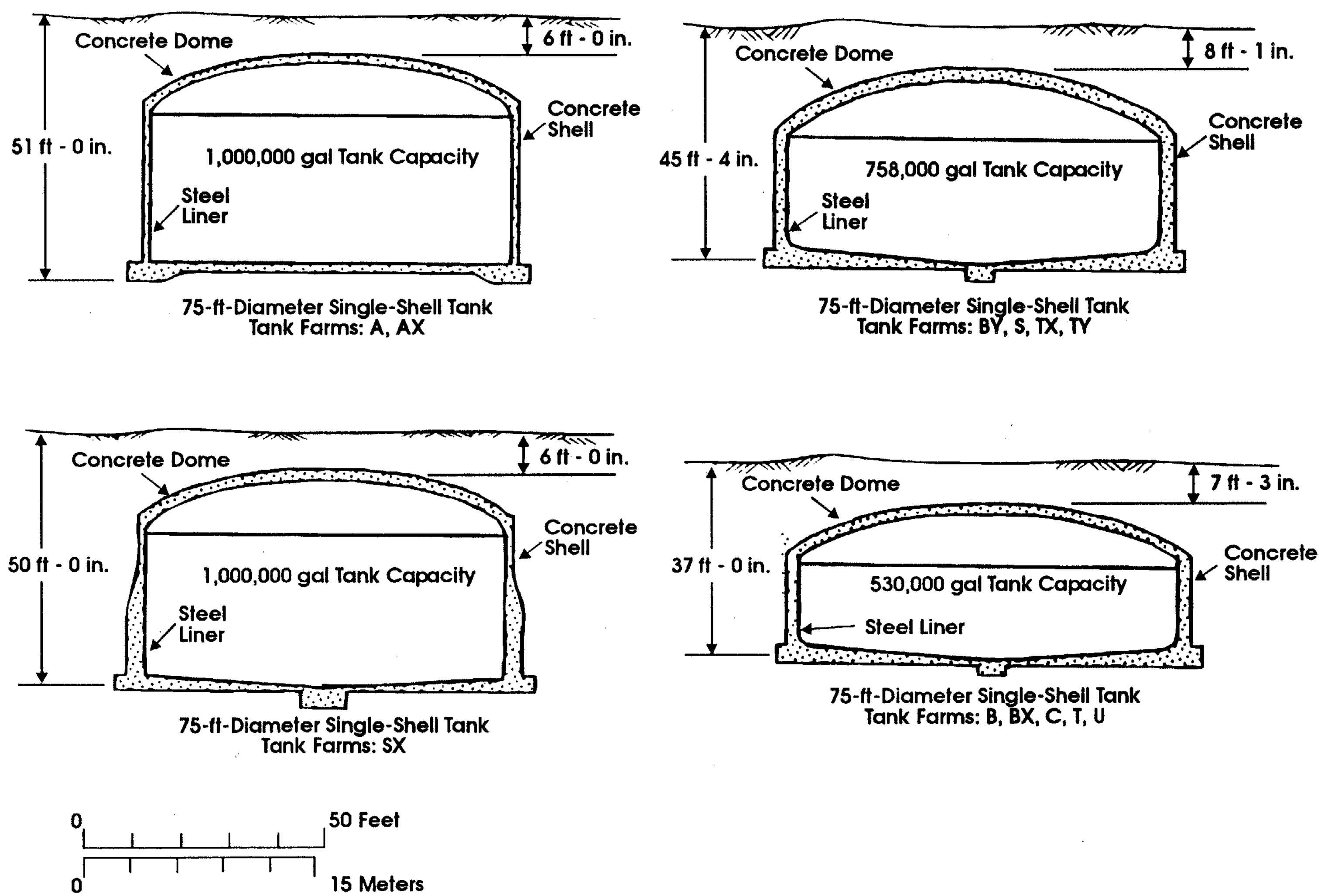
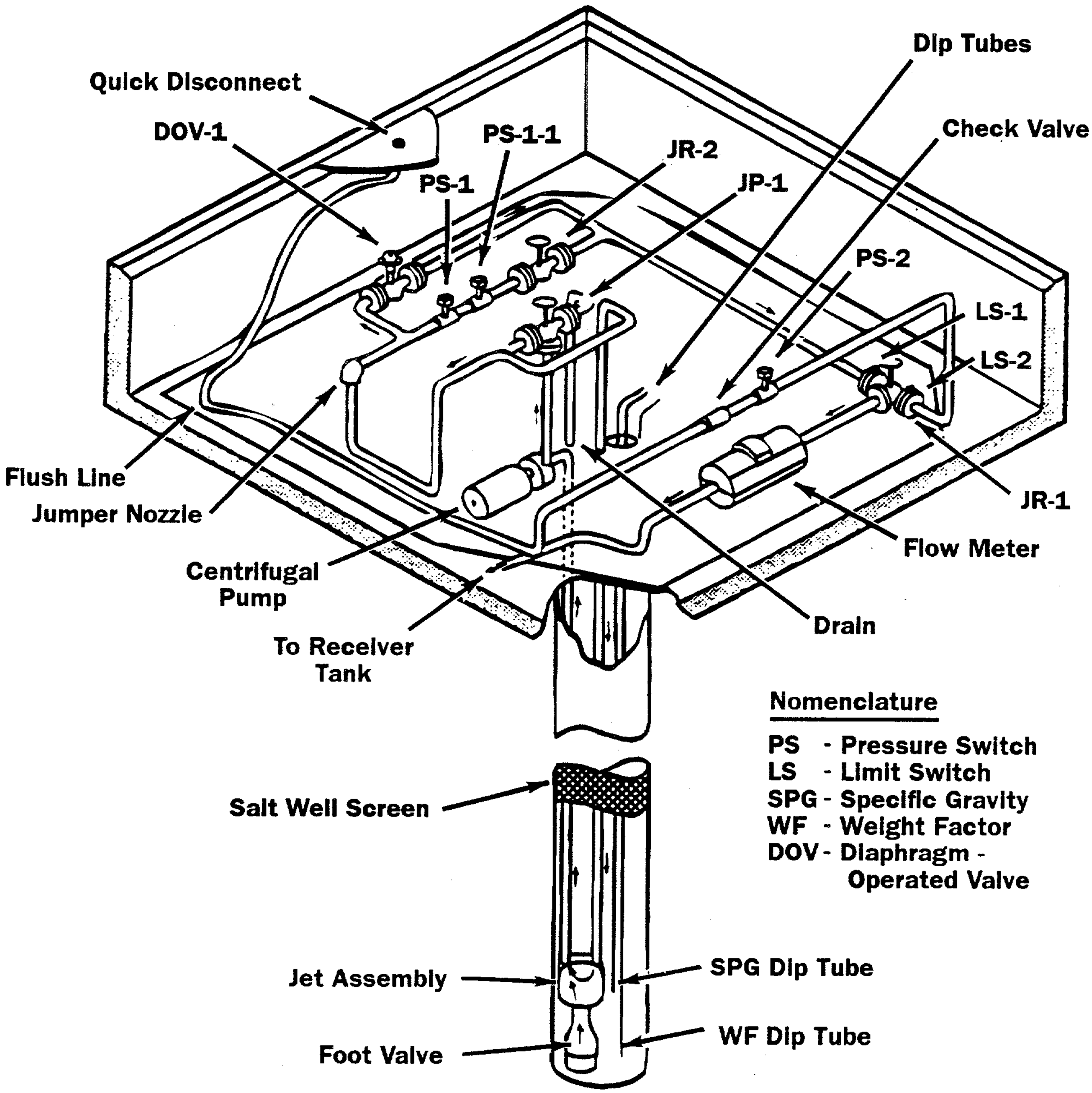


Figure 3. Typical Saltwell Jet Pump Configuration



The combination of the centrifugal pump and jet assembly are needed to raise the interstitial liquid from the depth of approximately 12 to 15 m (40 to 50 feet) from the salt well screen into the pump pit. The centrifugal pump, rated at approximately 114 L/min (30 gal/min) at 2.1E5 Pa (30 psig), pressurizes power fluid to the jet assembly located in the salt well screen. The power fluid passes through a nozzle within the jet assembly and acts to convert fluid pressure head to velocity head, thereby reducing the pressure within the jet assembly chamber. The reduction in pressure allows the interstitial liquid to enter the jet assembly chamber and mix with the power fluid. Velocity head is converted to pressure head above the nozzle, lifting power fluid and interstitial liquid to the pump pit. Pumping rates vary from .2 to about 19 liters per minute (0.05 to 5.0 gal/min).

Raw water is used to fill the salt well jet pump system loop and prime the pump for operation. A recirculation loop permits the prime to be maintained on the pump while pumping at very low rates. The energy used to operate the pump can heat up the recirculated liquid about 17°C (30°F) above tank ambient temperatures.

Important instrument and control systems located at the SST associated with salt well pumping include leak detection, jet pump system controls including limit switches and safety interlocks, and weight factor/specific gravity measurement.

Dip tubes, extending from the pump pit into the salt well casing below the level of the liquid waste, measure the weight factor and specific gravity. Air is forced down the tubes at enough pressure to bubble out. The air pressure required to result in bubbling is used to make the measurements desired. Using the weight factor and specific gravity measurements, the liquid level in the salt well screen can be determined. Controllers are set to control the liquid level a fixed amount above the jet intake.

2.3.1.5 Submersible Pump. Another method for transferring liquid from the tank uses a submersible pump. The salt well submersible pump is mounted on a transfer pipe extending up through the tank and the adapter flange to the pump pit. The submersible pump has a 3.7 kilowatt (5 hp) motor, driven by 480 volt, three phase power. The motor itself is below the pump intake and is submersed in the liquid being pumped. The pump is rated at 150 liter per minute (40 gal/min) at 40 m (130 ft) total dynamic head, for liquid with a specific gravity of 1.7. The pump motor is cooled by the liquid being pumped. The minimum specified velocity past the motor is 7.6 cm/s (0.25 ft/s). To aid in the flow past the motor, the pump has a flow director (shroud) installed.

Using a submersible pump has not been addressed in existing safety documentation for Flammable Gas Watch List SSTs and is currently not an approved method of pumping.

2.3.1.6 Underground Transfer Lines. Liquid waste is transferred from a single-shell tank (SST) to a Double-Contained Receiver Tank (DCRT) and then to a double-shell tank (DST) via existing underground pipes, when possible.

Underground waste transfer lines used at Hanford are of three general types: pipes in a concrete encasement, pipes within a pipe, and direct buried pipes. Both double encased and direct buried lines will be used in the transfer of salt well effluent. The primary pipe in both types of double encased transfer lines is made from either carbon steel or stainless steel.

The pipe-in-pipe encasement usually drains to a leak detector that alarms immediately if a leak occurs. In addition, leak test chambers are provided at various locations along the transfer line. All transfer lines are sloped for drainage.

Direct-buried transfer lines are made of carbon steel. These lines are typically 2.5 to 7.6 cm (1 to 3 inch) diameter welded pipe. They are buried under 1 m (3 ft) of ground cover, either in shallow trenches or at ground surface level. Direct-buried lines are pressure-tested annually.

The design life of all salt well pumping transfer lines is five years but they have been in service for over ten years. To minimize leaks, Tank Farm procedures require these lines to be tested within a year of use since all these lines have exceeded their design life.

2.3.1.7 Overground Transfer Lines. Some of the SSTs that require waste transfer do not have any piping or have failed transfer systems. A temporary Overground Transfer (OGT) system has been developed to accomplish tank transfers. The temporary OGT system uses jet or submersible pumps, and overground piping with shielding.

The proposed overground system will consist of a primary pipe inside a secondary containment. The primary pipe is a 2.5 cm (1 in) diameter, ethylene-propylene diene monomer (EPDM)-lined, stainless-steel-wrapped, flexible hose. The secondary containment is a 5 or 7.6 cm (2 or 3 in) diameter steel pipe.

2.3.1.8 Valve Pit. When several tanks are undergoing simultaneous pumping to a receiver vessel, the flow is routed to a valve pit. In the valve pit, the flow from the sending tank's transfer lines is manifolded to the receiving tank line using a series of valves and jumper connections. Two- and three-way valves are built into each jumper to divert the flow where needed. Valve pits are concrete boxes with heavy cover blocks. Each valve pit is equipped with leak detection that is interlocked to corresponding pumps and has a drain line connected to a flush pit.

2.3.1.9 Double-Contained Receiver Tanks. A double-contained receiver tank (DCRT) is a short term storage facility that consists of a receiver tank and related equipment. A DCRT features an underground concrete structure that contains a filter, a pump pit, and a vault in which a catch tank is installed. The DCRT is used for interim storage of liquid waste and as a valve pit for waste transfer operations.

2.3.1.10 Double-Shell Waste Storage Tanks. Double-shell tanks (DST) are underground storage tanks and are used to store hazardous waste. DSTs are fabricated as three concentric tanks. The primary tank is a steel tank which sits on a concrete insulating pad. The secondary tank is also a steel tank and is 1.5 m (5 ft) larger in diameter. The outer tank is a concrete shell and provides additional containment, radiation shielding, and structural support. These serve as the destination facility for all waste transfers from SSTs prior to subsequent transfer to receiving DSTs.

2.3.2 Waste Transfer Systems

During interim stabilization, waste transfers move liquid waste from one location to another using a preplanned, preestablished route in response to loss of tank integrity, processing requirements, and changing storage needs. Waste can be redistributed among DSTs through the underground pipeline network. Waste transfers into SSTs are not permitted.

Detailed descriptions of waste transfer facilities and associated SSTs are contained in the *Hanford Site Tank Farm Facilities Interim Safety Basis*, (Leach and Stahl 1993). Detailed information related to transfer operating procedures and processes is provided in the Accelerated Safety Analysis, WHC-SD-WM-SAR-065 (WHC 1994a). A detailed description of transfer routes, transfer lines, and transfer equipment is provided in the *Single-Shell Tank Leak Emergency Pumping Guide* (Wiggins 1994).

2.3.2.1 Single-Shell Tank Farm Waste Transfer System. The management and handling of radioactive waste at the Hanford Site have focused on reducing the volume of liquid in the underground tanks. Part of this liquid waste reduction strategy is based upon pumping as much of the drainable liquid as practicable from the SSTs to minimize the volume of liquid available to leak into the ground. This Interim Stabilization effort uses either submersible pumps (not currently authorized for Flammable Gas Watch List SSTs) or saltwell jet pumps to remove the supernatant liquid from the tanks and saltwell jet pumps to remove the remaining interstitial pumpable waste liquid (Figure 4).

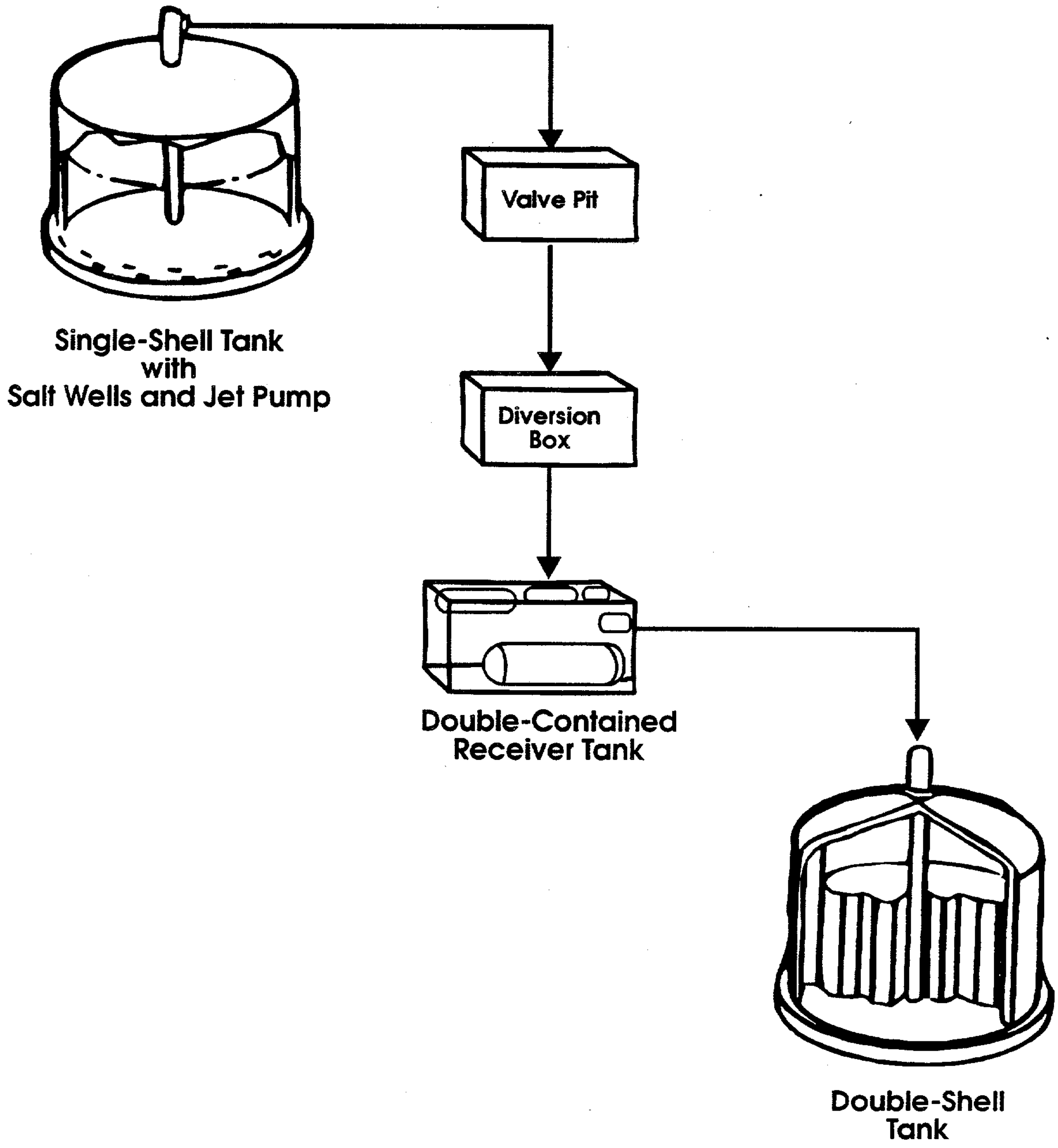
Waste transfers from the SSTs will use either existing pipelines or newly installed overground waste transfer piping. Existing pipelines include both double-encased pipe-in-pipe or pipe-in-concrete encasement designs, and single-encased piping. Existing piping has been either buried in trenches or laid at ground level and covered with a layer of soil. Overground transfer piping is double-encased, laid at or near ground level, and shielded.

2.3.2.2 Double-Shell Tank Farm Waste Transfer System. All transfers between or into DSTs are made through lines encased with either another pipe or a concrete encasement (exception: SN247 from 241-AX-B valve pit to 241-AN-101 is direct buried). Leak detectors are installed so that a leak in the primary line or in pits that the transfer is routed through can be detected. Interlocks and alarm systems are present to shutdown the operation and alert personnel of the condition.

2.3.2.3 Cross-Site Transfer System. The cross-site waste transfer system includes six cross-site waste process transfer lines. Four of the six transfer lines have failed pressure tests. All planned transfers though the cross-site transfer system will be processed through DST 241-SY-102.

Piping to be used is encased in concrete. Additionally, 58 encasement test risers (TRs) are spaced regularly along the concrete encasement between the 241-UX-154 and 241-ER-151 diversion boxes. The TRs provide access to the encasement void space for leak detection. The encasement slopes in both directions from the 241-EW-151 Vent Station and drains into catch tanks at each diversion box. Catch tank contents can be transferred to a designated DST and held for later processing.

Figure 4. Typical Single Shell Transfer System



2.4 ACTIVITIES REQUIRED TO PUMP SSTs

These are the minimum activities required to verify and operate the SST waste transfer system within established safety and environmental guidelines. These activities may or may not be intrusive to the tank dome space. Those activities deemed non-intrusive can be performed using standard Tank Farm procedures and activities established for single-shell Watch List Tanks (OSD-T-151-00030).

2.4.1 Required Tank Intrusive Activities

These are the minimum tank intrusive activities required to verify and operate the SST waste transfer system within established safety and environmental guidelines.

2.4.1.1 Flammable Gas Sampling. Procedures for gas sampling are covered in existing Tank Farm procedures. One of several approved gas sampling systems uses an open cart and a vacuum system consisting of an electrical motor and metal bellows. The bellows is considered intrinsically safe for hydrogen environments (Class 1 - Group B). The electrical motor is rated Class 1 - Group D, which is not intrinsically safe for hydrogen, but since the motor is not in contact with the gas stream and it is in the open air, it is considered safe in the system. The vacuum system is used to draw tank gases through an organic vapor monitor (OVM) and colorimetric indicator tubes (Draeger Tubes). The OVM is used to measure total organic concentrations in the tank vapor. The Draeger Tubes are used to identify individual toxic gases that could possibly be present (e.g., nitrogen dioxide, hydrogen cyanide, ammonia, etc.). Provisions are made in the system to measure Lower Flammability Limit (LFL) at any time, and to obtain separate grab samples.

Flammable gas sampling is required to verify that the dome space or pump pit is safe to perform an activity (i.e. the vapor space is below 25% of the LFL).

2.4.1.2 Liquid Level Monitoring. The operation of liquid level monitoring equipment may require entry in the tank dome space. Equipment used may be: manual tape, conductivity probe (zip cord), FIC gauge, ultrasonic device, or Enraf equipment. The energy level of the first three types of equipment is safe for a hydrogen environment (Scaief 1991). The ultrasonic device has not been evaluated for flammable gas Watch List tanks. The Enraf meets Class 1, Division 1, Group B (hydrogen environment) requirements of the National Electric Code. Some tanks may use liquid observation wells to obtain liquid levels using gamma/neutron to measure the interstitial liquid level.

Liquid level measurements are needed to monitor the amount of liquid being pumped from the tank during a waste transfer. Liquid level is also used to verify the requirement to pump the tank during emergency pumping. The waste level may also indicate when a gas release event is imminent and may be used as a control during other activities.

2.4.1.3 Liquid Sampling. Liquid sampling (bottle on a string) is a standard tank farm procedure. A 100 ml glass sampling bottle with a rubber stopper is placed in a 5 cm (2 in) steel pipe sleeve and manually lowered on a stainless steel wire to the supernate waste. (The liquid sample may be taken at the dip tube or any open riser.) The weight of the pipe sleeve submerges the bottle. The wire is looped through the top of the rubber stopper and tied to the neck of the bottle. After lowering the bottle to the proper level, a quick jerk removes the rubber stopper and the bottle fills with liquid supernate. After a bottle is filled, the bottle is manually pulled to the surface by a worker wearing protective gloves.

Liquid sampling is required to assure compatibility of the contents of the tank with the destination double-shell tank.

2.4.1.4 Perform In-Tank Photography. In-Tank still photography uses a standard Tank Farm procedure. The system to be utilized is a standard Hasselblad Camera and Flash Unit mounted in a metal frame. The system is suspended in the tank by a flexible support hose containing wiring going to the camera and flash unit. Power to the flash unit is supplied by a portable generator on the ground surface above the tank. The wiring is sealed but not intrinsically safe. The camera and flash unit are manually lowered into the tank to a level controlled by an adjustable safety stop (top hat) at the top of the riser. Contamination control to the camera system is implemented by lining the riser with a disposable plastic sleeve.

Photographs of the tank waste is required to verify the integrity of the tank, to calculate the amount of liquid available to pump, and validate that the remaining post-pumping liquid meets interim stabilization requirements.

2.4.1.5 Flush Saltwell Screen. Standard Tank Farm procedure provides instructions for flushing saltwell screens with the 1.3 cm (1/2 in) interior water line. Flushing of the saltwell screen with hot or cold water is occasionally necessary to unplug the saltwell screen so that jet pump production can be increased. A water truck supplies water for the flushing. The amount of water added to a tank (a maximum of 1892 L or 500 gal) is minimized and controlled by standard Tank Farm lancing procedures. A hose is connected from the water truck to the HC-1 port on the side of the dip tube weight factor instrument enclosure. The jet pump is set to recirculation and appropriate valving positioned to perform the operation.

Lancing of the interior of the saltwell screen with an introduced water lance may also be necessary if flushing does not dissolve enough saltcake for effective pumping operations.

Flushing of the saltwell screen removes salt crystal buildups on the saltwell screen. It is required to assure that the interstitial and supernate liquid content of the waste is able to reach the jet pump/foot valve for pumping.

2.4.1.6 Install Jet Pump. Installation of the jet pump is accomplished similar to the installation of the saltwell screen. The whole jet pump unit, shown in Figure 3, is installed as one unit with the foot valve and dip tubes inserted inside of the saltwell screen. Flushing of the saltwell screen is required prior to the insertion of a jet pump.

2.4.1.7 Flushing of the Jet Pump and Foot Valve. A flush of the jet pump and foot valve would be needed prior to jet pump testing and operation. A standard tank farm procedure will be used to perform this flushing operation.

This will require less than 190 L (50 gal) of water. The actual amount of water used will be metered and recorded.

This activity removes salt crystal buildups in the jet pump foot valve and is required to assure that the jet pump is operational and performs efficiently.

2.4.1.8 Flush Dip Tubes. Flushing the dip tubes is a standard Tank Farm procedure. This activity removes salt crystal buildup in the dip tubes and is required to assure that the dip tubes are clear of debris.

The dip tubes are required to measure specific gravity and weight factor which are used to monitor liquid level and volume of the waste being transferred. Weight and volume of the liquid transferred out of the SST is balanced against the weight and balance of the liquid entering the DCRT or DST.

2.4.1.9 Testing and Operating the Jet Pump. Jet pump testing should follow successful completion of vapor sampling of the pump pit and pressure testing of the transfer lines. A process memo or work package will require appropriate 1) lock and tag steps, and 2) the activation, according to procedure, of recirculation of the jet pump system prime water. Valve JP-1 will be set at "Recirculation" and valve JR-1 will be set at "Flush" (Figure 3).

An ultrasonic flow meter may be used to determine operation and flow generated by operating the jet pump assembly. The cover plate will be replaced over the pump pit during jet pump operation. This will allow evaluation of the centrifugal pump motor and jet pump, but the jumper itself will not transfer any fluid.

The jet pump will be operated for no more than 5 minutes, with a maximum flow rate of about 5 gallons per minute. This would circulate approximately 25 gallons. Problems identified at this point will be identified to engineering. Corrective action will be accomplished as required. Retesting of the jet pump is permissible provided the controls of this safety evaluation are complied with.

The jet pump will first be tested in recirculation mode. Raw water will flow down and back up the transfers pipes. This will cause minimal disturbance to the supernate in the bottom of the saltwell screen and negligible disturbance to the tank.

Operating the jet pump for waste transfer is identical to the operational testing of the pump with the valve settings configured for waste transfer.

2.4.2 Required Non-Intrusive Activities

These are activities required for preparing the tank for pumping and do not intrude into the tank dome space. Since these non-intrusive activities do not violate the integrity of the Watch List tank, they can be performed using standard tank farm operating procedures.

2.4.2.1 Cover Block/Cover Plate Activities. Cover blocks are concrete blocks used to cover instrument and pump pits on waste tanks to provide radiation and spray release shielding. They are usually a few feet thick, several feet in length and width, and weigh several thousand pounds. Steel lifting bails are exposed on the top surface to provide crane manipulation of the blocks. Cover block bails which are suspected of being structurally defective are inspected and tagged.

A block may have plastic, rubber, or asbestos moisture guards around the underside of the top lip, but this does not make it air tight. Some cover blocks have steel pipe access sleeves, several inches in diameter, that have removable cover plates.

Cover plates are one inch thick steel plates that temporarily replace concrete blocks over pump pits during waste transfers to provide easy access to pipe valves in the pit. The cover plates have trap doors installed over valve locations. The valves are operated from the surface by an extension arm. Cutting of the trap door openings and welding on the trap doors is not permitted while the cover plate is on the pump pit.

Removal of the cover block or cover plate is required to gain access to the jet pump, the maintenance of leak monitoring equipment, for the installation of jumper lines, and other pump pit activities that may be required. This activity is consider a critical lift (Bajwa and Farley 1994).

2.4.2.2 Perform Transfer Line Pressure Testing. Prior to any activity in the central pump pit, the pump pit is tested for flammable gases using a combustible gas meter via access ports. Cover blocks are then removed to access valves and jumper blocks in the pit. Flushing is performed in the central pump pit to ensure that the drain lines in each pump pit function. A tanker truck will supply the flushing water. Process jumper blanks may be installed in the pump pits to prevent inadvertent transfers. Valves in the pump pit and at the DCRT are adjusted. A cover plate may temporarily be installed on the pump pit to provide easier access to the pump pit valves during pressure testing.

After a transfer line is filled with clean water, the line will be pressurized to 1.4E6 Pa (200 psig) with a hand pump. Transfer lines to be tested at one time may include any or all of the intermediate lines between the pump pit, the valve pits, the diversion boxes and the DCRT. Following the pressure test, valves are opened to allow the water in the line to drain back to the DCRT. Finally, all valves and jumpers are returned to their normal position, and cover blocks are replaced.

Line pressurization is required to verify the integrity of the system to ensure that the liquid being pumped from the tank will arrive safely to the DCRT and/or DST. This is usually performed in two steps: line pressurization from the SST to the DCRT and line pressurization from the DCRT to the DST.

2.4.2.3 Valve Pit/Diversion Box Configuration. When several tanks are undergoing simultaneous pumping to a receiver vessel, the flow is routed to a valve pit. In the valve pit, the flow from the sending tanks' transfer lines is manifolded to the receiving tank line by using a series of valves and jumper connections. Two and three way valves are built into each jumper to divert the flow where needed. Valve pits are concrete boxes with heavy cover blocks. Each valve pit is equipped with leak detection that is interlocked to corresponding pumps and has a drain line connected to a flush pit.

Diverting liquid flow from one tank to another using valve pits usually does not require major jumper changes. Although multi-valve, multi-connector jumpers reduce radiation exposure and field time (less frequent jumper changes); valving mistakes that misroute process solution are more frequent with these types of jumpers.

Valve pit jumpers and diversion box jumpers may be different. The difference is that a diversion box jumper generally connects only two nozzles; a valve pit jumper can connect to several wall nozzles, each leading to a different outlet with two- and three-way valves built-in to divert the flow where needed. The valve handles are above the top of the cover blocks or cover plates and extend on shafts through penetrations in the cover blocks or cover plates to reach the valve stems inside the valve pits. The cover blocks or cover plates and valve handles have a flow diagram painted on them to assist the operator in valving to the correct tank.

Jumper installation is required to configure the transfer system to pump the liquid waste to the appropriate DCRT and DST.

2.4.2.4 Maintenance Activities. These non-intrusive activities are diverse and dependent upon the condition of the equipment at the specific tank. Most of these activities are covered by a specific Tank Farm procedure. Several of these tasks may include maintenance of the leak detection system, maintenance of various instrumentation, establishing electrical power, establishing pressurized air, establishing raw water, etc.

These activities will be required to provide necessary support to other interim stabilization activities.

2.4.2.5 Double-Contained Receiver Tank (DCRT) Activities. There are many activities that may be required to ready the DCRT for the interim stabilization process. These activities follow established Tank Farm procedures for DCRTs. Since the DCRTs are used as a temporary holding receptacle during interim stabilization, these activities could affect the overall pumping process.

2.5 ACTIVITIES REQUIRED TO SUPPORT PUMPING ACTIVITIES

These activities are activities that are required for certain categories of Watch List Tanks, but not all. This section also includes activities that may be required to perform other tank intrusive activities.

2.5.1 Support Related Tank Intrusive Activities

2.5.1.1 Installation of Standard Hydrogen Monitoring System (SHMS). The standard hydrogen monitoring system was developed to be operated in a class 1, division 1, group B (hydrogen) atmosphere. All of its components meet the National Fire Protection Association National Electric Code requirements for operating in a hydrogen environment.

The standard hydrogen monitoring system is designed to provide online monitoring of gas samples for hydrogen content and to allow for more detailed laboratory analyses of grab samples. The system is designed for use on any tank. Alarms will provide audible and visual indications that the system needs to be maintained, or that the hydrogen level in the tank is above a preset percentage of the lower flammability limit.

The SHMS is a method for continuous monitoring of the vapor space for the presence of hydrogen gas. This may be required to identify a gas release event or to determine whether the tank is to remain a Flammable Gas Watch List.

- **Installation**

The standard hydrogen monitoring system has been designed to be installed in four different configurations: on the exhaust header, on a gas probe assembly, on a multifunction instrument tree assembly, or on a modified riser flange. For single-shell tanks, the standard hydrogen monitoring system will be installed on gas probe assemblies.

The probe assembly consists of a supply line and return line for use with the standard hydrogen monitoring system, a water-jacketed supply line and a return line for use with the vapor monitoring system, and a temperature probe to measure the temperature of the vapor space. The temperature probe is necessary because a large number of single-shell tanks do not have functioning thermocouples in the vapor space region of the tank.

The gas probe assembly has specific design features that allow it to be connected to or disconnected from the standard hydrogen monitoring system. Installation on the gas probe assembly is a simple operation of connecting tubing from the assembly to the environmentally controlled system enclosure, and connecting return tubing from the enclosure to the return line on the gas probe assembly. After the tubing is connected to the fitting, a protective cover is placed over the fitting to prevent damage. Valving that is already installed on the gas probe assembly will be used to isolate the standard hydrogen monitoring system from the tank environment until after the standard startup procedure has occurred. After the system has been leak tested and calibrated, the valving will be opened to allow sampling of the tank vapor space.

- **Operation**

The operation of the standard hydrogen monitoring system will permit the continuous sampling and monitoring of the tank gases for hydrogen. In addition, gas samples can be obtained for complete gas species analysis at a laboratory. Several modifications to the standard hydrogen monitoring system have been proposed. These include installing a gas chromatograph inside the environmentally controlled enclosure for continuous monitoring of other gases that might be generated (in particular, ammonia and/or methane). Another modification might include automatic grab sampling of the tank vapor space if a preset hydrogen concentration limit is exceeded.

2.5.1.2 Install, Operate, and Removal of In-Tank Video. This activity involves installation, operation, and removal of a video camera and light system similar to the system currently in use in 241-SY-101 and -SY-103. The video system is designed for the inspection of the interiors of storage tanks, and has many safety features. The video system used must meet National Fire Protection Association, Inc., Article 496, Type X purging or other acceptable methods of complying with the requirements of the National Electric Code (NEC), Article 501 for Class 1, Division 1, Group B (hydrogen atmospheres).

In-tank video monitoring may be required for the performance of other in-tank activities or for the monitoring of the waste.

2.5.1.3 Install Saltwell Screen. Saltwell screen pipes are installed in 30 cm (12 in) risers located in the central pump pit of each tank. The installation involves pre-lancing the tank saltcake layer with a water lance prior to receiving the 25.4 cm (10 in) diameter saltwell screen. The lancing assembly weights about 160 kg (350 pounds), and is installed and removed with a crane.

Tank Farm procedures provide instructions for installing saltwell screens and dip tubes in single-shell tanks after pre-lancing. Prior to breaking pump pit confinement for any activity, testing with a combustible gas meter is performed for flammable gases in the pump pits, by checking access ports or cracks. The tank vapor space is also checked for flammability via FIC or HEPA ports, or partially open risers.

Saltwell screens are made from 25 cm (10 inch) o.d. schedule 40 stainless steel pipe, with a 47 cm (19 inch) diameter top flange. This pipe weighs about 60 kilograms per meter (40 lbs/ft), thus a typical 14 m (45 ft) saltwell screen would weigh about 840 kg (1800 pounds). The bottom 6 m (20 ft) of the saltwell screen pipe is cut with 1.3 mm (.050 in) wide slots. On the inside of the saltwell screen pipe, a 1.3 cm (1/2 in) diameter and a 2 cm (3/4 in) pipe extend from the top to the bottom of the saltwell screen pipe. The 1.3 cm (1/2 in) pipe is open to the inside bottom of the saltwell screen bottom, and provides flushing functions. The 2 cm (3/4 in) pipe supplies installation jetting water to the bottom of the saltwell screen pipe, as described below.

The saltwell screen pipe has two .6 mm (1/4 in) thick steel bottom plates separated by a 2.5 cm (1 in) gap. The bottom plate has seven .6 mm (1/4 in) diameter holes to distribute jetting water received into the gap from the 2 cm (3/4 in) water pipe.

Installing a saltwell screen may be required if there is not one currently in place.

2.5.1.4 Installation and Operation of Forced Ventilation System. If the LFL is above 25% of the LFL or some other activity related need for it, forced ventilation may be employed to dissipate the flammable mixture.

2.5.1.5 Removal of Existing Equipment. It is reasonable to expect that some of the existing equipment used to perform various operations may no longer be serviceable. Since there are a limited number of risers or accesses into the tank, removal of this equipment could be required. The existing equipment may extend into the saltcake and the removal of this equipment could provide a substantial disturbance to the tank waste.

2.5.2 Support Related Non-Intrusive Activities

2.5.2.1 Repair/Replace Transfer Lines. Failed transfer lines will be identified by pressure tests. Given a failed transfer line, an alternate route, if possible, will then be selected. If there is no alternate route, there may be an activity to repair or replace the existing line(s), or overground transfer lines may be used.

2.5.2.2 Overground Transfer Line Installation. Overground transfer lines are double contained transfer piping that is laid on top of the ground. Berming is added for shielding. A detailed evaluation of installing and operating overground transfer lines can be found in WHC-SD-WM-SAR-034 (Bajwa 1994), Addendum 1, and WHC-SD-WM-SARR-009 (Bajwa and Farley 1994).

Overground transfer lines may be required to pump to the target DST, especially if the existing transfer lines have failed and can't be repaired.

2.5.2.3 Jet Pump Pit Activities. The probable tasks for pump pit activities are replacement of the pressure switches, testing the limit switches, leak detector calibration or repair, operational testing of jumper instruments, operational testing of the diaphragm operating valve, flushing of the jet pump and foot valve, and flushing of the saltwell screens. The flushing operations are tank intrusive as discussed in section 2.4.1.

The method for performing these pump pit maintenance activities without lifting the jet pump would use standard Tank Farm procedures since it is not intrusive into the Watch List SST. (Lifting the pump assembly out of the pump pit to perform these activities is considered intrusive).

- **Pressure Switch Replacement**

Pressure switch replacement, PS-1, PS-1-1, and PS-2 (Figure 3) on the jet pump jumpers may be required.

A non-intrusive method for switch replacement would be to remove the jet pump jumper from the jet pump assembly and raising the jumper unit only out of this pump pit. After the jumpers have been elevated to grade level, they will be set on timbers. The existing pressure switches will be replaced with new switches.

The switches will not be functionally tested after installation. The new switches will be bench calibrated and will replace existing switches. Containment on the jumper may be broken if it is necessary to replace the diaphragm seal (part of the switch assembly).

- **Testing of the Limit Switches**

Testing the limit switches, LS-1 and LS-2 (Figure 3), requires operating the valves on the jumpers from stop to stop to verify that the motor controller changes operational state when the valves are in the appropriate position. This testing will be performed before the pump pit cover plate is removed and the jet pump and jet pump jumper assemblies are lifted out of the pump pit.

If the limit switches fail or the switches are inoperable, the switches will be replaced. This will be accomplished in a similar manner as the pressure switches and when the jet pump jumper assembly is out of the pump pit for pressure switch replacement.

- **Leak Detector Calibration Repair**

Pit leak detector calibration may be performed for Watch List tanks. If the leak detector is inoperable, the old detector will be removed from the pit and a new one installed.

Process blanks will be installed on the appropriate line to ensure isolation and correct configuration for the SST waste transfer. Since these lines are to be boundaries to the proposed transfer system route, leak detection requires monitoring at these points. Operability of the leak detection at these pump pits will be verified. Leak detector replacement will be performed as necessary for these pump pits.

- **Operational Testing of Jumper Instruments**

Calibrate or restore the flow convertor transmitter (CVT), or flowmeter, by using a raw water source and valving it through the jumper and out the discharge (either to the transfer line, or into a temporary container) or by using a simulated (mock) signal and metering the output (preferred method).

- **Diaphragm Operated Valve (DOV)**

The operability of the Diaphragm Operated Valve (DOV) (Figure 3) will be verified and calibrated. Dip tube signals are simulated by the use of manometers attached to weight factor and specific gravity instrumentation. Regulated air pressure is applied to the valve and the position of the DOV is checked and adjusted. Air pressure will be supplied by either the Tank Farm compressed air or by a portable air compressor.

2.6 ACTIVITIES REQUIRED TO FURTHER CHARACTERIZE TANKS

There may be a requirement to perform activities that will provide additional information on the behavior of a Watch List SST. These activities may not be involved with the actual pumping of a Watch List SST but may provide answers to the uncertainties surrounding the behavior of the waste in these tanks, modify the controls for other activities, and provide additional information on the characteristics of the waste once interim stabilized.

2.6.1 Install Thermocouple Trees (TCT)

Current solution temperature data for shipping and receiving tanks is required to be reviewed prior to waste transfers to ensure that the temperature difference between the two tanks does not cause a violation of operating limits for tank temperature gradients. Installed thermocouple trees may be used for this purpose. Standard jetting and Ultra-High Pressure (UHP) Jetting are the most common methods used to install a thermocouple tree:

- **Standard Jetting**

After hooking up the 4.14E5 Pa (60 psi) water pump to the TCT and tank truck, the tree will be lifted to a vertical position by the use of a pump lift stand (strongback) to prevent bending the pipe. The crane will slowly swing the instrument tree over the open riser and slowly lower the tree into the tank. After reaching a point where the TCT nozzle is a couple of feet above the waste, jetting water will be turned on and the tree lowered to the waste surface. The water is turned on before touching the waste so the orifice in the nozzle does not get plugged. Jetting through the waste will then proceed by displacement and/or dissolving the waste. Waste penetration by jetting is expected to take from 30 to 90 minutes in the tanks containing saltcake, and 15 to 30 minutes in tanks containing only sludge.

- **UHP Jetting System**

The TCT will first be positioned on a horizontal rack near the appropriate riser. After the intensifier is hooked up to the water supply tank and the TCT, and with a valve at the top of the TCT turned off, the intensifier and UHP connecting hoses will be tested for leaks at 2.55E8 Pa (37,000 psig). Following this test, the valve at the top of the tree will be opened to check the TCT piping and the UHP nozzle. During the nozzle test, a safety shroud will be positioned around the nozzle to prevent workers from contacting the UHP jetting stream. The UHP system will be run for several minutes to assure reliable operation of the system. For additional safety, operations personnel will stand a few meters away from the UHP nozzle during testing. When reliable operation is assured, the UHP water will be turned off.

The TCT will then be raised to a vertical position over the open riser, and lowered into the tank until the nozzle touches the solid waste. Only then will the UHP water again be turned on, in order to prevent aerosol generation of waste as the nozzle approaches the waste surface. There is no danger of plugging the orifices, as they are extremely small and the UHP water would eject any fine material. With this method, the water will cut through the saltcake waste rather than dissolving its way through. Optimum cutting during penetration occurs when the nozzle is rotated back and forth about ± 45 degrees at about 10 cycles per minute. Optimum waste penetration and flushing of waste cuttings (about 30 cm/min (1 ft/min)) will be implemented by crane controls.

The TCT length will be based on configuration drawings that will attempt to keep the TCT bottom 5 cm (2 in) off the tank bottom. The only force that will be applied to the jetting nozzle during insertion, with either the standard pressure system or the ultra-high pressure system, is the weight of the TCT itself.

Jetting will continue until one of the following takes place:

1) The TCT flange rests on the riser flange.
2) The bottom of the TCT rests on the bottom of the tank.
3) An obstruction is encountered.
4) Control limits on jetting water are reached.

If jetting continues until the TCT flange rests on the riser flange, it will be assumed that the bottom of the TCT is approximately 5 cm (2 in) off the bottom. The TCT flange will then be secured to the riser flange using appropriate bolts, and the crane and water injection system disconnected.

If the bottom of the tank is encountered before the TCT flange rests on the riser flange, 15 cm to 61 cm (6 to 24 inch) long permanent riser extenders will be added to the TCT to raise the TCT off the tank bottom. The new TCT bottom position would then be greater than 0 but less than 15 cm (6 in) off the bottom of the tank.

Temperature monitoring is one of the indicators to indicate that a gas release is imminent for 241-SY-101. Monitoring the change in temperature may be necessary to determine the activity of the waste in the tank in other Watch List SSTs.

2.6.2 Perform Push-Mode or Rotary-Mode Core Sampling

The first step for push-mode or rotary-mode core sampling is set up of the equipment. This involves positioning the Core Sampling truck, exhauster, nitrogen supply trailer, service trailer, generator, and cask stand near the tank. Appropriate power supplies are connected, and the core sampling truck is leveled. The exhauster and nitrogen purge are required for rotary-mode drilling.

Core sampling is performed with a core sampling truck which has a rotary platform and a stationary work platform mounted on the rear of the truck. Push-mode or rotary-mode core sampling may be performed with the same system. There are two sets of equipment mounted on opposite sides of the rotary platform. One set of equipment is the shielded sample receiver unit that functions to place empty samplers into and remove full samplers from the drill string. The other set of equipment is the drill unit that functions to push the drill string and sampler into the material being sampled. The gasoline engine that supplies power to the drill unit is mounted on the rotary platform between the drill unit and the shielded sample receiver unit. The control console and electric hoist are mounted on the rotary platform on opposite sides from each other.

For push-mode, the concentric drill bit, sampler, and drill casing are pushed around the sample of waste, which ends up inside of the sampler. For rotary-mode, the drill bit is rotated while being pushed as above, and the bit purged with nitrogen to keep the bit < 150 °C (302 °F). Automatic purge and exhauster safety controls will shut down the drill for anomalous conditions. Individual sample segments are 2.5 cm (1 in) in diameter and up to 48 cm (19 in) in length.

After coring each segment, the sampler is pulled up through the drill casing with a pull rod, the sampler transferred into a shielded receiver, and the receiver sealed. For each additional segment, another sampler is attached to the pull rod, lowered to the bottom of the drill casing, and the drill casing lowered another 48 cm (19 in). Retrieval of each additional segment is the same as described above.

2.6.3 Perform Auger Sampling

The auger sampler will make use of a guide tube that will extend from the top of the riser to the waste surface. The guide tube may be installed manually or with a crane. A retrieval container will contain the auger bit, the first auger rod segment, and a floating sleeve. The retrieval container is manually raised and attached to the bushing on the guide tube via the cam connector. Operating procedures can be found in the work plan. The auger assembly weighs approximately 48 kg (105 lbm).

Manual installation will be performed by adding one segment at a time. Crane installation will follow existing guidelines. At least one lifting bar will be in place at all times to prevent dropping the auger assembly.

When sampling is complete, the auger assembly is removed using the reverse of the installation process. Segments are placed in plastic bags and are packed into 0.21-m^3 (55-gal) drums for decontamination and reuse or disposal.

The retrieval container will be double bagged and placed inside a 0.21-m^3 (55-gal) drum using standard Hanford packaging procedures. The drum will then be transported to the 222-S Analytical Laboratory using standard Hanford shipping procedures.

2.6.4 Installation of a Liquid Observation Well

Installation of a liquid observation well (LOW) is a standard Tank Farm procedure. The LOW varies in diameter to fit in a riser and extends almost to the bottom of the tank. Composition of the LOW is usually fiberglass or another type of composite material or carbon steel.

Lancing is required to make a hole in the saltcake and sludge. The LOW is then installed. Installation is slow and methodical using a critical lift.

This activity may be required if there is saltcake at the surface of the waste and gamma/neutron liquid level measurements are needed.

3.0 APPLICABLE ANALYSES

Several current safety analyses, including the Tank Farm Accelerated Safety Analysis (ASA), examined hazards applicable to liquid removal from interim stabilization of SSTs. Appendix A provides a brief summation of the applicable safety analyses including document abstracts, and in some cases, document conclusions. Certain of these documents provide in-depth evaluation of the hazards associated with interim stabilization of Watch List tanks. This section provides information extracted from the documents most directly applicable to the specific Watch List tank hazards for interim stabilization.

3.1 FLAMMABLE GAS TANKS

Document WHC-SD-WM-SAD-022 (Cowley 1993) titled *Hazard and Accident Initiator Evaluation for Interim Stabilization of Hydrogen Watch List Tanks*, provides identification of potential hazards associated with interim stabilization of SSTs on the Flammable Gas Watch List. Evaluation of these hazards was documented in a subsequent report.

Document WHC-SD-WM-SARR-004 (Van Vleet 1994) titled *Safety Basis for Activities in Single-Shell Flammable Gas Watch List Tanks*, provides the basis for certain activities in single-shell Flammable Gas Watch List Tanks. The document covers several interim stabilization related topics including standard hydrogen monitoring systems; vapor space sampling; still photography; instrument tree installation; saltwell screen installation; liquid observation well installation; jet pump installation, repair and removal; and auger and push mode sampling. Hazards are identified and evaluated, consequences are calculated and controls to mitigate or prevent the accidents are developed.

Certain activities required for interim stabilization of Flammable Gas Watch List Tanks were not explicitly addressed within WHC-SD-WM-SARR-004, such as flushing the jet pump, foot valves, and Dip Tubes. It is expected that these activities could be readily justified by comparison to the analyzed activities. However, there are some other hazards associated with interim stabilization of the Flammable Gas Watch List Tanks that warrant additional evaluation.

The following table identifies activities analyzed for Flammable Gas Watch List Tanks and the documented source for the conclusion that the activity has been determined to be safe or not.

Table 3.1-1
Summary of Interim Stabilization Activities for Flammable Gas SSTs

Summary of Interim Stabilization Activities for Flammable Gas Watch List Single-Shell Tanks				
Activity	Safe Activity for Flammable Gas Watch List SSTs		Activity	Safe Activity for Flammable Gas Watch List SSTs
Flammable Gas Sampling Liquid Level Monitoring	Yes[1]		Liquid Level Monitoring	Yes[1]
Liquid Sampling	Yes[8]		Perform In-Tank Still Photography	Yes[2]
Flush Saltwell Screen	Yes[1]		Install Jet Pump	Yes[1]
Flushing of the Jet Pump and Foot Valve	Yes[4]		Testing and Operating the Jet Pump	Yes[4]
Flush Dip Tubes	Yes[4]		Cover Block/Cover Plate Activities	Yes[5]
Perform Transfer Line Pressure Testing	Yes[5]		Valve Pit/Diversion Box Configuration	Yes[5]
Maintenance Activities	Yes[5]		Double-Contained Receiver Tank (DCRT) Activities	Yes[5]
Installation of Standard Hydrogen Monitoring System (SHMS)	Yes[1]		Install, Operate, and Removal of In-Tank Video	No[6]
Install Saltwell Screen	Yes[1]		Install Thermocouple Trees (TCT)	Yes[1]
Installation and Operation of Forced Ventilation System	No[6]		Overground Transfer Line Installation	Yes[1]
Repair/Replace Transfer Lines	Yes[5]		Removal of Existing Equipment	No[6]
Jet Pump Pit Activities	Yes[5]		Perform Push-Mode Core Sampling	Yes[1]
Perform Auger Sampling	Yes[1]		Lifting the Jet Pump Assembly	Yes[1]
Perform Rotary-Mode Core Sampling	No[7]		Installation of Liquid Observation Well	Yes[3]
Installation and Operation of a Submersible Pump	No[7]		Crane Installation	Yes[1]

1 WHC-SD-WM-SARR-004 (Van Vleet 1994)
2 WHC-SD-WM-SARR-004 with camera equipment currently not available
3 USQE #TF-94-0279 (Bajwa 1994)
4 USQE #TF-94-0288 (in review) (Guthrie 1994b)
5 Non-Intrusive Activities
6 Needed only on demand - requires additional analysis (USQE)
7 May need only in special circumstances - requires additional analysis (USQE)
8 USQE #TF-93-0075 (Guthrie 1993b)

Two hazards of potential significance related to interim stabilization of Flammable Gas Watch List Tanks are: 1) potential for episodic gas releases in excess of the Lower Flammability Limit during interim stabilization; and 2) stability of the waste and potential for significant episodic gas releases with ignition sources present following interim stabilization.

Recent analysis, WHC-SD-WM-SAR-065 (WHC 1994a), indicates that these issues can be adequately addressed by implementation of applicable controls during and following interim stabilization. This analysis has not yet received DOE approval, which is expected in March of 1995.

3.1.1 Episodic Gas Releases During Interim Stabilization

Hydrogen explosion in a SST dome space during interim stabilization was analyzed and deemed to be credible as documented in SD-WM-SAR-034 (Hanson and LaRiviere 1989), *Safety Analysis Report: Stabilization of Single-Shell Waste Storage Tanks by Saltwell Jet Pumping*. The calculated frequency for this accident, based upon radiolysis of water in the SSTs generating hydrogen in explosive quantities (4 to 74% in air), was calculated to be 5×10^{-5}/yr for the 149 SSTs or 3×10^{-5}/yr for one of the 89 tanks planned to be stabilized when the SAR was written.

This analysis however, did not consider flammable gas released in bulk during periodic "tank burps," such has been identified for Double Shell Tank 241-SY-101 and possibly other tanks which exhibit periodic slurry growth stages. Tank burps are caused by hydrogen which is generated within the tank waste and due to the waste viscosity, retained by the waste. The hydrogen gases accumulate and form gas pockets within the waste. Eventually, the trapped gases cause an upward pressure on the waste sufficient enough to cause a gas release. Since hydrogen monitoring equipment and liquid level monitoring instrumentation is not present in all SSTs to be interim stabilized or that have been interim stabilized, the frequency of such "tank burps" has not been quantified. Since the possibility of ignition sources within the tank dome space cannot be eliminated, interim stabilization during a postulated "tank burp" could cause an accident at greater frequencies then presently predicted considering only hydrogen radiolysis by water.

The issue of a gas release event during conduct of a tank intrusive activity is discussed in WHC-SD-WM-SARR-004 (Van Vleet 1994). Los Alamos National Laboratory (LANL) evaluated the 19 single-shell Flammable Gas Watch List Tanks (LANL 1994b). The tanks have been separated into four categories. The first category contains tanks that do not exhibit episodic behavior, nor do they exhibit long-term growth in the waste level. The second category contains tanks for which not enough data are available to evaluate the behavior. The last category contains tanks that exhibit long-term waste growth but do not exhibit episodic gas-release behavior. The following table, presents this information relative to the Flammable Gas Watch List Tanks that remain to be interim stabilized.

Table 3.1.1-1
Non-Interim Stabilized Flammable Gas Watch List Tanks by Category

TANK	NO EPISODIC RELEASE BEHAVIOR NOR LONG TERM WASTE GROWTH	NOT ENOUGH DATA TO EVALUATE BEHAVIOR	EXHIBITS EPISODIC GAS RELEASE BEHAVIOR	LONG TERM WASTE GROWTH; NO EPISODIC RELEASE BEHAVIOR
A-101			X	
AX-101		X		
S-102				X
S-111	X			
S-112	X			
SX-101		X		
SX-102		X		
SX-103	X			
SX-104		X		
SX-105		X		
SX-106	X			
T-110				X
U-103				X
U-105				X
U-107				X
U-108				X
U-109				X

Gas release potential was calculated by LANL for tanks which exhibit episodic gas release behavior, and tanks with long term waste growth indications with no episodic release behavior. Five of the tanks (A-101, S-102, U-103, U-105, and U-107) were identified as having potential for having a gas release event that exceeded the 4% by volume (of the tank dome space), Lower Flammability Limit (LFL) for hydrogen. This conclusion assumed that the gas release event consisted entirely of hydrogen. More realistically, a gas release event would consist of a release of several gases, with hydrogen estimated to be about 28% of the released volume. Using this more realistic, but still conservative gas mixture assumption, only tanks A-101 and SX-103 were predicted to be capable of a gas release event in excess of the 4% hydrogen LFL. These results however, do not include tanks AX-101, SX-101, SX-102, SX-104, and SX-105 for which not enough data were available to make an estimate.

In addition to having the potential for exceeding the hydrogen LFL during a gas release event, two tanks (A-101 and SX-103) have been identified as having the potential for exceeding the hydrogen LFL with steady state hydrogen concentrations.

Other possible causes for variations in waste surface levels have been postulated other than gas release events. However, the only way to determine if true gas-release events are occurring is to install a standard hydrogen monitoring system.

Controls have been suggested to provide assurance of safety during tank intrusive activities, such as interim stabilization, even in the case that a gas release event could occur. These controls are detailed in Section 4.2 of this report.

3.1.2 Long Term Waste Stability Following Interim Stabilization

The following discussion is a summary of the current understanding of gas release phenomena in 241-SY-101 and the current knowledge for the single-shell Flammable Gas Watch List tanks. There may not be a good correlation between the double-shell Flammable Gas Watch List Tanks and the single-shell Flammable Gas Watch List tanks due to differences in waste types, storage temperatures, ventilation rates, waste properties, etc. However, the vast majority of the flammable gas safety program work to date has focused on tank 241-SY-101. Currently, efforts are being made to instrument and sample the other five double-shell Flammable Gas Watch List Tanks. Some instrumentation and sampling is scheduled for the single-shell Flammable Gas Watch List tanks in fiscal year 1995.

Background

During the initial meeting held to develop 241-SY-101 mitigation methods there was a concern that removing the liquid (thought to be a potential mitigation scheme) above the "non-convecting" layer might result in very large but well spaced gas releases. It was recognized that the pressure of the liquid sets up the condition that the gas cannot be released until buoyancy conditions, including yield forces, are met. However, with no liquid present, the retention forces in some types of gas generating wastes (e.g., sludges) could conceivably become stronger resulting in greater accumulations prior to a gas release. Gas retention is further discussed below.

This same issue is also of concern as one considers saltwell pumping of single-shell tanks (SSTs) that are on the Flammable Gas Watch List.

Flammable Gas Generation

Several different flammable gases (ammonia, methane, hydrogen, etc.) are generated in Flammable Gas Watch List Tanks. Chemical reaction, radiolysis, and corrosion are known mechanisms for producing these products. The removal of liquid from the tanks by pumping may actually reduce the generation of flammable gases.

Little is known about the mechanisms for generating ammonia and methane. However, methane concentrations are small when compared to ammonia and hydrogen. The mechanism for generating ammonia is probably different from the way hydrogen is formed since the ammonia concentration in SY-101 varies differently than hydrogen concentrations.

Hydrogen is formed via chemical reaction and radiolysis. Delegard (1980) first considered the chemical production of hydrogen. In the mechanism, he proposed sodium aluminate and hydroxyethylene diamine triacetate (HEDTA) were necessary for the chemical production of hydrogen. The reaction rate was found to vary linearly with the concentration of sodium aluminate and HEDTA (all the way to zero). Sodium hydroxide was also found to be necessary but too much (greater than about 2M with a peak at 1.5M) resulted in the lowering of the reaction rate. He found that sodium nitrate somewhat enhanced the reaction yield, but the reaction continued in its absence. Lastly, he found that while the reaction proceeded with HEDTA, substituting ethylene diamine tetra acetate (EDTA) in place of HEDTA resulted in no reaction. That is, not all organics will react to form hydrogen.

The above was confirmed with work done at Georgia Tech (Ashby 1994). In their work, they showed that under radiation conditions, solutions of EDTA, nitriotriacetic acid (NTA), and imino diacetate (IDA), decompose to form formaldehyde. Formaldehyde reacts in basic solutions to form hydrogen. They found that because of competing reactions, more hydrogen was formed at lower concentrations of formaldehyde.

They used sodium glycolate (for HEDTA) and found that the rate of the reaction is proportional to the concentration of glycolate, aluminate, and nitrate; and inversely proportional to the hydroxide concentration. In their tests, hydroxide was present at 2M. At this concentration, Delegard (1980) also found an inverse relationship between reaction rate and hydroxide.

Lastly, they found that different organics (EDTA, HEDTA) result in the generation of different quantities of hydrogen with glycolate (not a tank constituent) being far superior and HEDTA being second.

Work was also performed at Argonne National Laboratory by Meisel et al. (Meisel 1993). Meisel was primarily interested in radiolysis but also performed some work in the area of thermal generation.

In the area of thermal generation, the following was found:

- Use of citrate as the organic results in lower generation rates for the irradiated samples as compared to the non-irradiated samples.

- The generation rate reaches a maximum at about 30 Mrad and then decreases showing the effects of "aging". In addition, Meisel found higher rates of production in non-irradiated samples than in those he preirradiated to 35 Mrad.

- The generation rate in slurry somewhat exceeds that of a solution containing the same chemicals.

Both Ashby and Meisel proposed schemes by which gas is generated. The scheme in Ashby 1994 involves an 11 step chemical process involving ions and compounds (all liquid reaction). Meisel's scheme involves radiolytic degradation of chelators, chemical reactions similar to those of Ashby and radiolysis resulting in H_2. It would therefore appear that the loss of liquid would result in a lower quantity of gas produced due to the lesser quantity of components needed for the reaction.

There appears to be an effect on gas generation due to trace components. Ashby found that small additions of Cu(II) ions to a homogeneous simulant significantly increased the initial hydrogen generation rate. Meisel found that Cr(III) ions depressed generation rate of nitrous oxide due to radiolysis but not due to chemical (Meisel's term is thermal) means.

There appears to be an effect on length of the experiment. Bryan (1994b) shows higher nitrous oxide yields for simulants containing transition metal ions (including chromium) under thermal conditions. These results are contrary to those of Meisel who found no effect. One explanation of the differences is that Bryan's results were obtained from reactions allowed to occur over periods up to four weeks, where Meisel's results were for reactions over 2 days (Bryan, 1994b). The longer term experiments allow for a greater degradation of HEDTA.

Bryan (1994b) found large differences in gas generation rates (at 90 °C) between slurries and homogenous solutions. Bryan argues that since the rates of gas generation are first order with respect to the major constituents of the waste, higher concentrations in the slurry may be the cause or the solid surfaces may be acting as catalysts. These results are in contrast to those of Meisel who found that at 60 °C the generation rates were nearly identical. Bryan also found a dependence on the size of the vessel used in the experiment.

To summarize:

- Not all organics are efficient in the thermal (i.e., chemical) generation of hydrogen.
- Sodium aluminate and an optimal amount of sodium hydroxide are necessary for the reaction. Sodium nitrite enhances the gas generation rate of the reaction.
- Slurries may be better producers of hydrogen than are solutions.

Other conclusions from review of these studies demonstrate that numerous variables affect flammable gas generation, such that it is not possible to definitively predict the effects that interim stabilization would have on gas generation rates within tank wastes following interim stabilization.

Additional data as discussed in Section 3.1.3 is needed to better understand the effects of interim stabilization on flammable gas generation in the waste that remains following interim stabilization.

Waste type data that may affect flammable gas generation rates for the SSTs on the Flammable Gas Watch List are provided in Table 3.1.2-1 and Table 3.1.2-2. Data on tank 241-SY-101 is provided for comparison.

Process Solvents

The previous section discussed the capability of some of the organics to produce hydrogen chemically. Missing from this work are the process solvents. Camnioni (1994) began to study the degradation of process solvents. He found that the complexants and TBP degraded rapidly in a radiation environment, but that hexone and NPH degraded little. This study backs the conclusions shown in Meisel (1993) that the hydrogen generating capability of organic chemicals is widely different, with that in 101-SY being nearly the most efficient producer of hydrogen.

The single shell Flammable Gas Tanks contained wastes as shown in Table 3.1.2-2. Few of the tanks probably contain the evaporated portion of their initial waste, so that the organic present in the tanks is difficult to determine.

A review of Table 3.1.2-1 and Table 3.1.2-2 is provided in Table 3.1.2-3. Table 3.1.2-1 shows that there are a few tanks with high aluminate and organic concentrations (A-101, AX-101, SX-102 and possibly U-103). Two of these tanks fall into LANL category 2 (Not enough data), one in category 3 (evidence of episodic gas release behavior) and one in category 4 (evidence of continued level growth).

Tank SX-109 contains only "R" waste. LANL categorized it as category 1, no level growth or episodic growth. This appears to confirm the fact that the hexone is not an efficient producer of hydrogen. If it is true that "R" waste is not a good producer of hydrogen and if it is true that the SST Flammable Gas Tanks in 200 West did not receive waste from the B-Plant (i.e., organics are process solvents only) then the categorization of category 2 for the SX and S tanks seems to make sense.

One might also conclude that the sustained level increase in U-105 and U-107 to U-109 comes from gas release from the CPLX waste added to these tanks. Unfortunately, for this argument, CPLX waste was also added to SX-101 to SX-106 which are category 1 and 2 tanks.

As indicated from the previous discussion, additional data (as discussed in Section 3.1.3) is needed to better understand the effects that process solvents have on flammable gas generation rates following interim stabilization.

Table 3.1.2-1
SST Flammable Gas Watch List Tank Constituents

Waste Type Data				Contents (g/L)				
Tank	Waste Type	Last Addition	Sample Date	Al	NO_2^-	OH^-	TOC[1]	Waste Type
A-101	DSSF	4/1980	4/83	61	116	NR	130	Drainable liquid
AX-101	DSSF	3/1980	8/80	42	106	48	11	Supernate
AX-103	NCPLX	2/1980	2/80	30	76	42	NR	Supernate
S-102	DSSF	4/1979	1/80	145	182	162	NR	Supernate
S-111	EB	1/1975	9/80	10	24	11	NR	Supernate
S-112	EB	1/1975	4/74	33	40	57	NR	Salt cake
SX-101	R & CPLX	2/1980	4/89	1.2	5.6	3	0.3	Drainable liquid
SX-102	DSSF	3/1980	3/80	32	102	37	12	Salt cake
SX-103	DSSF	4/1979	4/77	---- Not Valid - (Sample taken prior to last addition) ----				
SX-104	DSSF	1/1980	5/88	43	115	34	5	Drainable liquid
SX-105	DSSF	1/1980	2/77	---- Not Valid - (Sample taken prior to last addition) ----				
SX-106	DSSF	4/1980	4/79	---- Not Valid - (Sample taken prior to last addition) ----				
SX-109	R	4/1973	-------------- no data --------------					
T-110	224 & 2C	3/1974	1/75	0.01	0.3	NR	NR	Supernate
U-103	DSSF	1/1978	4/78	19	2	7	9.6	Sludge
U-107	DSSF	1/1978	12/74	---- Not Valid - (Sample taken prior to last addition) ----				
U-108	NCPLX	1/1977	8/75	---- Not Valid - (Sample taken prior to last addition) ----				
U-109	NCPLX	1/1977	11/75	---- Not Valid - (Sample taken prior to last addition) ----				
SY-101	DSS & CC	11/1980	1991	47	180	40	13-32	Sludge & liquid

Note: First two columns are from Anderson 1990
Last five columns are from Van Vleet 1993
"NR" not reported
224 = 224-U waste
2C = second cycle waste
CC = concentrated complexant
CPLX = complexed waste
DSSF = double-shell slurry feed
DSS = double-shell slurry
EB = evaporator bottoms
NCPLX = noncomplexed waste
R = REDOX high-level waste

[1] "TOC" is "Total Organic Carbon." Note that not all organic compounds (i.e., compounds containing organic carbon) are efficient producers of hydrogen. In fact some in-tank organic compounds produce negligible quantities of gas due to radiolysis and none chemically.

Table 3.1.2-2
Waste in SST Flammable Gas Tanks

Tanks	Waste Types
A-101, AX-101, AX-103	P to early 1970's P and B mid 1970's HDRL, DSSF, NCPLX late 1970's
S-102, S-111, S-112	R to early 1970's Variety to mid 1970's HDRL, DSSF, PNF in late 1970's
SX-101 to SX-106	R to early 1970's Variety to mid 1970's PNF, CPLX, DSSF in late 1970's
SX-109	R
T-110	2C, 224-2C
U-103	MW to mid 1950's R to mid 1970's Variety in mid 1970's HDRL, PNF, DSSF in late 1970's
U-105, U-107 to U-109	MW to mid 1950's CW to early 1970's Variety to mid 1970's NCPLX, CPLX, PNF in late 1970's

Waste Types and Organics:

P	PUREX high level waste and organic wash waste; Organics are TBP and NPH
B	B-Plant high level waste; Organics - Complexants (D2EHPA, HEDPA) citric acid, TBP, NPH, hydroxyacetic acid
R	REDOX high level waste; Organic is hexone
2C	Second cycle waste from the Bismuth-phosphate process at T-Plant; Organic - None
224	224-U Plant waste
MW	High level waste from the Bismuth-phosphate process from U-Plant; Organic - None
HDRL	Hanford Defense Residual Liquor from the 242-S Evaporator; Organics - any of the above that was carried through the evaporation process
DSSF	Non-complexed waste from the evaporator, concentrated until the solution was nearly saturated with sodium aluminate; Organics - all of the above as got through the evaporation process
PNF	Partial neutralized feed waste from the evaporator; Organics - See DSSF
NCPLX	Non-Complexed waste from B-Plant
CPLX	Complexed waste from B-Plant

Data Source: A History of the 200 Area Tank Farms, WHC-MR-0132,
J. D. Anderson, Westinghouse Hanford Company, Richland, Washington.

Table 3.1.2-3
Comparison of LANL and Other Studies

SST	Other Studies	LANL[1]
A-101	Similar in concentrations and waste volumes to SY-101	Appears to experience gas release events (GREs) (Category 3)
AX-101	Not much organic - small producer	Not enough data (Category 2)
S-Tanks	Without data on organic, it is hard to say, but aluminate is high. No salt-slurry. Primarily saltcake with some interstitial liquid.	S-102 (Category 4) S-111 & S-112 (Category 1)
SX-Tanks	Could produce chemically but output may be low if less than optimum organic.	SX-101, SX-102, SX-104, & SX-105 (Category 2) SX-103, SX-106, & SX-109 (Category 1)
T-110	Should not be a producer	Level increase of 4 cm (1.5 in) (Category 4)
U-Tanks	Not enough data. U-103 showed as having constituents for gas generation.	Level increase of 5 to 15 cm (2 to 6 in): U-103, U-105, U-107, U-108, & U-109 (Category 4)

[1] LANL (1994) has identified four categories for behavior of flammable gas watch list SSTs:
Category 1 - Tanks that do not exhibit episodic gas-release behavior or growth in the waste level
Category 2 - Tanks for which there is not enough data
Category 3 - Tanks that appear to have episodic gas-release behavior
Category 4 - Tanks that exhibit growth in the waste level but do not exhibit episodic gas-release behavior.

Gas Retention

Gas could be generated through chemical means or radiolysis, but is of little concern unless it is retained. Gas retention may occur because of the presence of saltcake, sludge, or slurry. Saltcake is believed to behave like a porous medium (fissures, cracks, porosity, etc.) and probably does not retain large quantities of gas. The next few paragraphs address gas retention in sludge and slurry.

Meisel (1993) found that the gas that is generated as a result of irradiation and chemical reaction is tightly held within the slurry samples. Bubbling with gas did not dislodge the gas, nor did bubbling with vigorous stirring. Even aggressive bubbling with argon only lead to appreciable thickening of the slurry. This observation is particularly important to saltwell pumping of these tanks.

Meisel (1993) found that there are loosely and tightly bound gases. The amount of gas retained as loose gas depends on dose rate and total dose with the cross over to a large fraction of tightly bound gas occurring at 50 Mrad. The tightly bound gas would not come out as a result of bubbling or use of a vacuum. Dissolution of the crystalline solids was the only mechanism which released the gas.

Bryan (1991) showed that gas bubbles can be retained in the waste by attachment to solids. The organics could be absorbed into the solid surfaces making them more hydrophobic and thus, increased the tendency for gas bubbles to adhere to the surface.

Other mechanisms put forth in Appendix 2 of LANL (1993) are entrapment of bubbles in a porous media, gas retention as a result of shear strength or high viscosity or a combination of these two.

Saltwell pumping would result in the thickening of slurries as liquid is removed. If the slurries become more dense (i.e., more composed of solid particles), or the viscosity increases, bubbles will be more likely to become entrapped. The driving forces would have to be greater to move the bubbles. Calculations are contained in Appendix BC of LANL, 1994 (Rev. 9). The LANL document showed that bubbles less than 1.3 cm (0.5 in) would be essentially unreleasable in waste with viscosity similar to SY-101. Gas retention in slurries was also shown in Meisel's experiments and those of Bryan.

Therefore, in interim stabilized tanks, gas could be held up long periods of time if the generation rate and the viscosity (either intrinsic for that waste type or as a result of a liquid loss or slurry density) were reasonably large.

Note however, that if the bubbles are simply entrapped, continued growth and the resulting expansion will result in the formation of a release path out of the slurry. This is not the case for attached bubbles. On the other hand if attached bubbles remain attached then the only forces for release is if the buoyant force overcomes the retaining or attachment forces.

While gas retention may be a concern, the concern is lessened by the fact that removal of the liquid will remove some of the reactants. The greater accumulation of solids will result in a greater fraction of the reaction being driven by solid-liquid reactions. The rates of these are usually smaller as the liquid must first dissolve some of the solid surface. While Meisel found gas generation rates in slurries the same as solutions, his slurries were not of the concentration expected after saltwell pumping.

The final waste type after pumping is saltcake for some tanks. Saltcake could act like a porous medium if the solids remain in a form with structure with finite yield strength and pores. Under this condition, the bubbles escape due to the pressure gradient against the liquid (bubbles must move the liquid away) and liquid-solid forces (capillary forces). The bubbles could become attached to the solids as well (Bryan 1994).

Sludges differ from slurries in that the radiation field in the sludge may be lower due to the removal of the soluble radionuclides. Meisel (1993) showed that irradiation is also important to gas production. A large reduction in the liquid phase would remove liquid constituents needed for the reaction as well as lessening the fraction of gas generated assuming liquid-only reactions.

Sludges differ from slurries in that it is more difficult to remove liquid. There the gas generation and retention mechanisms are similar in the post pumped condition as they are in the pre-pumped condition. Sludges also usually differ in their chemical and radionuclide composition in that most of the chemicals that do not dissolve in the liquid are found in the sludge. The effect of the above differences are not yet quantified.

Additional data as discussed in Section 3.1.3 is needed to better understand the effects of interim stabilization on flammable gas retention in the waste that remains following interim stabilization.

Tanks Already Pumped

LANL (1994) showed that for the two interim stabilized flammable gas watch list SSTs:

- AX-103 showed a level decrease of 12.5 cm (5 in) from 1981 through 1993.

- SX-109 also showed a level decrease of 2.3 cm (0.9 in) from 1981 through 1993 (SX-109 is a Flammable Gas Watch List Tank only because several SX tanks vent through it).

Table 3.1.2-1 shows that prior to pumping, AX-103 probably had constituents necessary for chemical production of hydrogen. Therefore, at least in this case, pumping did not make gas retention worse. This is not necessarily always the case.

Conclusions

Based on the information surveyed, no firm conclusion can be reached concerning the gas generation in pumped waste or the ability of this waste to retain gas. In addition it appears that neither the process solvents nor sludges were adequately studied. Additional data needs for these issues are discussed in Section 3.1.3. However, recent analysis (WHC 1994a) concludes that even with these issues, interim stabilization of the flammable gas watchlist tanks can be performed safely and that the post-stabilized condition of the tanks will remain safe provided applicable controls are followed.

3.1.3 Actions Needed to Address SST Flammable Gas Safety Issues

Recent analysis (WHC 1994a) provides a conclusion that flammable gas Watch List Tanks can safely be interim stabilized. This conclusion was based upon an assumption that applicable controls are effectively implemented.

The expected frequency for a headspace deflagration within a flammable gas Watch List tank depends on the potential for an energy source of sufficient magnitude being introduced while there is a flammable mixture in the headspace. Therefore, the potential for the deflagration will be reduced by taking measures to prevent the introduction of energy sources if the headspace gas concentration rises above the flammable limit. The applicable controls for flammable gas Watch List tanks are specified in section 4.2.

If these controls are in place for the flammable gas Watch List tanks, it would take a failure of these controls to have a hydrogen deflagration event. Failure of the flammable gas monitoring equipment, operator error, and/or a gas release event while work is being done in the tank would provide the potential for a flammable headspace atmosphere. The frequency for a combined failure to eliminate energy sources, failure to prevent a flammable headspace concentration, and presence of an energy source great enough to initiate ignition is judged to be incredible (WHC 1994a). However, additional data is needed to provide an enhanced technical basis for controls needed to maintain flammable gas Watch List tank safety.

Additional data is needed to better understand flammable gas generation mechanisms in SSTs and the effects that interim stabilization would have on the flammable gas generation mechanisms. Additional data is also needed to better understand the flammable gas retention capability of the waste following interim stabilization. This data could be obtained by the combination of waste characterization, laboratory experimentation, and tank monitoring.

Tank waste characterization of Flammable Gas Watch List Tanks may need to be performed to:

- Identify waste constituents for comparison to known flammable gas generation constituents to identify if the tanks would be prone to flammable gas generation following interim stabilization;

- Provide a basis for generation of laboratory waste simulants that could be used to predict flammable gas generating capability of the wastes in the tanks following interim stabilization;

- Identify the types and quantifies of organics present in the tanks to better predict flammable gas generation potential.

Laboratory testing of Flammable Gas waste simulants may need to be performed to:

- Predict gas generation rates in the waste form remaining (e.g., sludge, thick slurry) in the tanks following interim stabilization;

- Determine the effect of trace components on gas generation rates;

- Predict the gas retention capability of waste types expected to remain following interim stabilization, and gas release mechanisms for the waste types.

Flammable gas monitoring of the Flammable Gas Watch List Tanks may need to continue to identify:

- Unsafe flammable gas accumulation levels in the vapor spaces of the tanks;

- Trends for episodic releases of flammable gas concentrations;

- Flammable gas release rates in post-stabilized SSTs for indications of potential unstable conditions and prediction of release rates in similar tanks to be interim stabilized.

The results of these activities will provide an enhanced technical basis for applicable flammable gas Watch List Tanks controls.

3.2 FERROCYANIDE TANKS

Document WHC-SD-WM-SAD-018 (Kummerer 1993) titled *Safety Assessment for Interim Stabilization of Ferrocyanide Tanks*, provides current safety analysis supporting interim stabilization of Ferrocyanide Watch List Tanks. A related analysis is provided in USQ Evaluation Number 8-93-PMP-101-T (Milliken 1992) titled *Basis for Emergency Pumping of Tank 241-T-101 Using a Submersible Pump*, which specifically addresses hazards of interim stabilization of a Ferrocyanide Tank using a submersible pump instead of a saltwell jet pump.

It is stated in WHC-SD-WM-SAD-018 that tanks BX-106, BY-105, and T-107 fall within the established safety criteria and can be considered safe for pumping [interim stabilization]. Tanks BY-103 and BY-106 were not determined to be safe for pumping within this report due to concerns relative to waste moisture retention following interim stabilization. Subsequent to release of WHC-SD-WM-SAD-018, another report was issued (WHC-EP-0691, Postma et al. 1994b) which provided additional information relative to waste moisture retention in ferrocyanide tanks. The results of this report indicated that waste moisture retention in ferrocyanide tanks would remain relatively high following interim stabilization. Thus, the moisture retention concerns for tanks BY-103 and BY-106 were addressed, so these tanks can also be considered safe for pumping.

Hazards applicable to interim stabilization of Ferrocyanide Watch List Tanks were considered within WHC-SD-WM-SAD-018. As noted within the document, a complete assessment of the safety of interim stabilization of the Ferrocyanide Tanks had to address two difference sets of hazards:

- The hazards that could result from the change in tank contents because of interim stabilization, especially the removal of significant liquid volumes

- The hazards presented during the activities involved in the interim stabilization process.

The safety analysis of WHC-SD-WM-SAD-018 focused on the state of the ferrocyanide tanks' contents after significant volumes of liquid are removed by interim stabilization. The effect of reducing the total amount of moisture in the tank on the potential reactivity of the ferrocyanide-bearing portion of the tank was examined.

3.2.1 Ferrocyanide Reactions

Three conditions must be simultaneously present for a release caused by a ferrocyanide/nitrate explosion to occur. They are as follows:

- Ferrocyanide and oxidant must exist in sufficient concentrations to be reactive
- Moisture associated with the ferrocyanide sludge must be insufficient to quench a reaction
- The energy balance of the reactive region must be such that temperatures high enough to initiate a reaction can be reached.

The effect that interim stabilization is expected to have on each of these three conditions is discussed herewith.

3.2.1.1 Ferrocyanide/Nitrate Concentrations. The tank liquors to be removed by saltwell jet pumping are not expected to remove appreciable amounts of ferrocyanide from the sludge. The majority of liquor that drains into the saltwell is from the saltcake. Analysis of the state of wastes remaining in the tanks assumes that all the ferrocyanide remains in the sludge layer in the tank.

3.2.1.2 Moisture Removal. Sample analysis of tanks containing ferrocyanide in the TY Tank Farm indicate that the minimum water content of the sludge was about 40 wt.% (Grigsby et al. 1992). These analyses were made in 1985, about two years after the tanks were interim stabilized by saltwell jet pumping.

Results of draining and centrifuge tests on ferrocyanide sludge simulants are reported within document WHC-EP-0691 (Postma et al. 1994b) titled *Ferrocyanide Safety Program: Safety Criteria for Ferrocyanide Watch List Tanks*. As reported within WHC-EP-0691, the draining tests results indicate that the moisture content in an 8-ft deep sludge layer would remain above 40 percent after 300 years of drainage. The 40 percent value referred to applies to the upper surface of the layer. Higher moisture levels are predicted for lower positions in the layer. The centrifuge test results indicate that moisture levels have remained above 45 wt% free water in all samples, even when centrifuge speeds imposed a force of 10, 20, and 50 g's. The conclusion was that the draining and centrifuge results indicate that the moisture loss by draining is limited, and by itself, would not lead to waste dryout. Removal of pumpable liquid by saltwell jet pumping would be expected to produce similar results. The moisture content criterion, defined within WHC-EP-0691 for Ferrocyanide Tanks to be classified as Conditionally Safe, is identified as a maximum required moisture of 24 wt% free water. Since ferrocyanide waste simulant test results indicate that waste moisture content is expected to remain above 40 wt.%, the Conditionally Safe criteria is still expected to be met following stabilization.

3.2.1.3 Ferrocyanide Sludge Temperature. The temperature histories of ferrocyanide tanks that have been interim stabilized by saltwell jet pumping indicate that significant long-term temperature rises have not occurred as a result of jet pumping (Kimura and Kirch 1990).

Neither the history of temperature response from interim stabilized ferrocyanide tanks with saltcake layers nor the physical response of the tank expected from drying the saltcake supports the proposition that pumping would cause temperatures of concern in the ferrocyanide sludge. Therefore, it is concluded that the likelihood of achieving high enough temperature to dry the waste or to initiate an energetic reaction is extremely low.

3.2.2 Hazard Analysis for Interim Stabilization Activities

The conclusion stated in WHC-SD-WM-SAD-018 (Kummerer 1993) is that stabilization of the Ferrocyanide Watch List Tanks by saltwell jet pumping is judged to be adequately bounded by existing safety analysis.

It was judged to be highly unlikely that all conditions required for propagating an energetic ferrocyanide reaction exist simultaneously in any of the Ferrocyanide Watch List Tanks which have not been interim stabilized. Saltwell jet pumping is not expected to increase the likelihood of the event because changes in the composition of the ferrocyanide sludge are not expected to be significant.

3.3 ORGANIC TANKS

Document WHC-SD-WM-SAD-023 (Guthrie 1993a) titled *Hazard and Accident Initiator Evaluation for Interim Stabilization of Organic Watch List Tanks*, provides identification of potential hazards associated with interim stabilization of SSTs on the Organic Watch List.

Document WHC-SD-WM-TI-579 (Postma and Kummerer 1993) titled *Technical Basis and Guidelines for Pumping of High-Organic Waste Tanks That Develop Leaks*, provides current safety analysis with regards to emergency pumping of Organic Watch List Tanks, with the exception of tank 241-C-103. Document WHC-SD-WM-SARR-001 (Postma et al., 1994a) provides specific analysis with regards to Organic Watch List Tank 241-C-103, which contains a floating organic layer.

Conclusions stated in WHC-SD-WM-TI-579 indicate that emergency pumping of Organic Watch List tanks is the preferred option over permitting leaking SSTs to release their liquid contents to the soil structure surrounding the tanks. Hazards associated with pumping of Organic Watch List Tanks were evaluated as discussed within the context of the report.

Hazards of concern for Organic Watch List Tanks in which the liquid has been removed are as identified as follows:

- Combustion in headspace air
- Pool of organic liquid layer
- Organic-nitrate/nitrite deflagration.

A brief summation of each of these hazards is provided in report WHC-SD-WM-TI-579, with a more detailed discussion of the phenomenology provided in the report Appendix. The report also provides the anticipated effect of liquid pumpout on the identified hazards. Most of the information which follows relative to the anticipated effect of liquid pumpout on the identified hazards was extracted from this report.

3.3.1 Headspace Deflagrations

The main driver for headspace deflagrations is the formation of flammable concentrations in headspace air. Anticipated effects of liquid removal are as follows:

3.3.1.1 Headspace Volume. The removal of liquid would increase the volume of headspace air, making the LFL more difficult to achieve. This is a minor factor that tends to make deflagrations less likely after pumpout and therefore would move in the direction of enhanced safety.

3.3.1.2 Radiolytic Formation Rates. Radiolytic formation rates of flammable molecular species would likely diminish because a fraction of the ^{137}Cs would be lost along with removed water. This effect is not thought to be highly important because minimum passive ventilation rates alone are expected to keep radiolytic species well below the LFL in the prepumping case. Again, the change is toward enhanced safety.

3.3.1.3 Combustion of Organic Solvent Vapor. The contribution of organic solvent vapors to head space flammability is small (WHC-SD-WM-SARR-001, Postma et. al. 1994). Combustion vapor emanating from an organic liquid phase, as in tank 241-C-103, would be diminished by a pumpout process that removed all or nearly all of the organic. Removal by uncontrolled leaking would not have much impact on this source of combustion vapor because a fraction of the organic phase would probably remain on top of solid waste. If pumpout is done properly, safety would be enhanced.

3.3.1.4 Organic Aerosol. Organic aerosol formed by condensation would have a similar disposition as combustion vapors--efficient removal of the floating liquid would remove the aerosol source. Uncontrolled leaking would have little effect because a fraction of the liquid would probably remain at the waste-air surface. Again, the effect of pumping is to enhance storage safety.

3.3.1.5 Liquid Loss. The effect of liquid removal on episodic releases of slurry gas for the Organic Watch List Tanks also on the Flammable Gas Watch List is not evident at this time. Arguments can be made for both increases and decreases in episodic gas releases as compared to uncontrolled leaking.

Liquid loss for the other Organic Watch List Tanks not on the Flammable Gas Watch List would tend to decrease the potential for headspace deflagrations. Dome space volume would be increased, and a portion of the organics which may contribute to gas generation would be removed during pumping.

3.3.2 Organic-Nitrate Reactions

The chief concern of liquid pumpout from Organic Salt Tanks is that the loss of water could remove a factor of safety in preventing runaway or propagating reactions in solid wastes.

The concerns of pumpout are centered on the following:

- Water concentration will be reduced and as a result the overall waste composition will tend to be more reactive from a thermodynamic energy balance standpoint.

- The loss of water may cause a reduction in thermal conductivity of waste. This in turn could enhance the prospects for waste heating caused by decay heat, resulting in waste temperatures that are closer to organic-nitrate/nitrite reaction threshold temperatures.

Criteria have been defined to address the concerns of pumpout, and to categorize Organic Watch List Tanks as "safe," "conditionally safe," or "unsafe." Tanks classified as "conditionally safe" will be subject to enhanced tank monitoring. Tanks classified as "unsafe" will be subject to enhanced tank monitoring and be subject to near-term mitigation and/or remediation actions. These criteria will also be used to help make a determination that unstabilized SST Organic Watch List Tanks will not become "unsafe" due to interim stabilization. The following provides a discussion of how these criteria can be applied to make determinations for interim stabilization of Organic Watch List Tanks.

WHC-EP-0681, *Interim Criteria for Organic Watch List Tanks at the Hanford Site* (Babad and Turner 1993) provides safety criteria for Organic Watch List Tanks at the Hanford site. The interim criteria present waste parameters that could be monitored to meet applicable safety objectives. The waste parameters of importance are:

- Waste organic concentration

- Waste moisture content

- Waste temperature.

Criteria for classifying single-shell tank waste as "safe," "conditionally safe," or "unsafe" (and thereby identifying single-shell tanks to be included on the Organic Tanks Watch List) are presented within the document. The parameters within each classification must all be met, for the waste to be classified in the defined level. For example, both the waste organic concentration and waste temperature criteria must be met before an Organic Tank could be classified as "Safe." The following Table is extracted from WHC-EP-0681:

Table 3.3.3-1
Interim Criteria for Organic Watch List Tanks at the Hanford Site

Level	Waste Classification	Criteria	
		Parameter	Value
1	Safe	Waste organic concentration Waste temperature	≤5 wt.% TOC[1] (dry basis), and <149 °C
2	Conditionally Safe	Waste organic concentration Waste moisture content Waste temperature	>5 wt.% TOC[1] (dry basis), and ≥17 wt.%, and ≤90°C
3	Unsafe	Failure to meet Level 2 Criteria	

1 The interim criteria for Organic Watch List Tanks specify a TOC content of greater than 5 wt.% (dry basis) for placing a tank on the Watch List. WHC has employed the original criterion of 3.0 wt.% TOC (dry basis) to identify tanks currently on the Organics Watch List (Turner 1994) to ensure a highly conservative approach in designating Watch List Tanks based on historical information.

The technical basis supporting the interim organic Watch List tank criteria is also presented in WHC-EP-0681. The following summation information relative to the safety criteria is extracted from this document.

Tests were performed by Fauske and Associates to assess the conditions under which a mixture of sodium acetate-nitrate/nitrite salts could sustain a propagating reaction.

The test mixture with 7 wt.% TOC exhibited propagating behavior at about 300 °C. However, the test mixture with 5 wt.% TOC showed exothermic behavior close to 200 °C, but no transition to a propagating reaction. Results for the test mixture with 3 wt.% TOC were similar to those for 5 wt.% TOC. From these data Fauske and Associates, Inc. concluded that a propagating sodium acetate-nitrate/nitrite reaction is possible at about 6 wt.% TOC, but not for TOC concentrations below this value.

A best estimate for organic waste concentration within a Organic Watch List Tank to be interim stabilized would need to be determined prior to pumping to assess if the TOC (dry basis) is ≤ 3.0 wt.%. If no current waste sample analysis was available to make this determination, Table 4.12 of *Organic Carbon in Hanford Single-Shell Tank Waste* (Toth et al. 1994) which is based upon a review of laboratory analytical data performed by Pacific Northwest Laboratory (PNL), could be used.

Interim stabilization would be expected to remove a significant fraction of the waste organic concentration when the liquid is removed (Postma and Kummerer 1993). This will reduce dried solid waste reactivity as judged from a thermodynamic energy balance standpoint.

The lowest exothermic reaction initiation temperature noted in organic waste surrogate energetics testing by Fauske and Associates, Inc. and the U. S. Bureau of Mines was 171 °C as reported in WHC-EP-0681.

The last measured waste temperature for the Organic Watch List Tank would need to be determined prior to interim stabilization to assure that it is well below the exothermic reaction initiation temperature for organics. WHC-EP-0182 (Hanlon 1993) or more recent tank temperature data could be used. Possible waste heatup following interim stabilization would need to be considered.

Available temperature data from three organic tanks that have already been pumped indicate that waste temperatures have remained low and stable. Therefore, the thermal conductivity has not been significantly diminished by the removal of drainable liquid.

The weight fraction of water that would prevent a propagating sodium acetate-nitrate/nitrite reaction is $\geq$ 17 wt.% per WHC-EP-0681. It will be necessary to conclude that Organic Watch List Tanks to be interim stabilized would retain moisture above this level. What was recently done to justify emergency pumping of Organic Watch List Tank 241-T-111 as documented in USQ Evaluation TF-94-0189 (Sawtelle 1994) regarding waste energetics and waste moisture retention is an example of this.

Analysis of tank 241-T-111 sludge waste samples was conducted by PNL to determine sludge waste-water holding capacity. Centrifugation of small subsamples of the 241-T-111 core demonstrated that the sludge is able to retain high liquid levels following centrifuge. The centrifuge tests demonstrated that supernatant must be squeezed out of the sludge by high pressure (load stress) in order to become more dry. The PNL analysis concluded that sludge cannot drain below a certain equilibrium moisture content distribution under such uncontained or open-bottom boundary conditions. The PNL modeling calculations for an open-bottom boundary condition showed that the profile would retain about 71 wt% water near the surface and 70 wt% near the bottom upon achieving equilibrium. Similar results are expected following interim stabilization of 241-T-111.

Results for other Organic Watch List Tanks containing primarily sludge waste, would also be expected to be similar. However, Organic Watch List Tanks containing saltcakes would not necessarily have similar results. Moisture retention capability of Organic Watch List Tanks containing saltcake has not been determined. Additional data is needed prior to making any analytical conclusions regarding the moisture retention capability of Organic Watch List Tanks containing saltcake waste.

The effects of liquid removal for Organic Watch List Tanks not on the Flammable Gas Watch List could reduce the waste moisture retention level below the criteria needed to classify the tank as "Conditionally Safe" (Babad and Turner 1993). If it cannot be demonstrated that the waste remaining in the tank following interim stabilization would have a waste moisture content ≥ 17 wt.%, then it would need to be demonstrated that the waste organic concentration was ≤ 5 wt.% TOC (dry basis), and the waste temperature was < 149 °C (300 °F) prior to interim stabilization, and expected to remain below the criteria level following interim stabilization.

Once an Organic Watch List Tank's waste organic concentration, waste temperature, and waste moisture characteristics were known, and the effects of interim stabilization on these characteristics is evaluated, a case by case determination could be made on the advisability of interim stabilization.

The factors cited above do not address the issue of hot spots. The hot spot concern is that a local region could contain a much higher-than-average concentration of heat-producing nuclides and that this would result in local waste temperatures much higher than average. A significant increase in local temperature would decrease the safety margin with respect to runaway reactions. Hot spots are believed to be incredible (Postma et al. 1994b), although the issue is still under study.

3.3.3 Organic Solvent Fires

Organic Solvents have been introduced into waste tanks from several of the chemical separations processes used at Hanford. Most notably is the presence of normal paraffin hydrocarbons (NPH) and tributyl phosphate (TBP) that resulted from waste transfers from the PUREX process. Organic solvents present the potential for pool fires associated with floating organic layers and puddles of organic solvents on top of the waste surface, or wicked fires associated with solvent embedded in the waste near the waste surface.

3.3.3.1 Pool Fires. Pool fires are apparently a potential hazard only for tank 241-C-103. If the organic liquid were efficiently removed by pumpout, the pool fire hazard would go away. If, on the other hand, uncontrolled leakage allowed intermingling of the organic layer and nitrate/nitrite waste, the hazard could be exacerbated for the following reasons: (1) the solid waste could serve as a wick making it easier to ignite, and (2) a burning pool in contact with nitrates conceivably could initiate an organic-nitrate/nitrite reaction. The bottom line is that storage safety would be enhanced by pumping of tank 241-C-103 under conditions where the organic phase would be removed efficiently without commingling with solid waste.

A detailed analysis of hazards associated with waste storage and tank activities in SST 241-C-103 was documented in WHC-SD-WM-SARR-001 (Postma et al. 1994a). The conclusion of the safety analysis in SARR-001 was that pool fires are difficult to ignite and can be prevented with simple controls. Tank waste storage and associated activities were evaluated for hazards and pool fire ignition potential. Safety controls were specified where needed.

Provided within WHC-SD-WM-SARR-001 was a table which summarized results of this evaluation for tank intrusive operations. The table is repeated here for convenience. Details of analysis supporting the conclusions identified on the table are provided within WHC-SD-WM-SARR-001.

Table 3.3.4-1
Assessment of Hazards for 241-C-103 Tank Intrusive Activities

Tank Intrusive Activities[1]	Potential Hazards Normal Operations				Potential Hazards Operation Upsets			
	Head. Deflag	Org. Pool Fire	Org.-Nitrate Reaction		Head. Deflag	Org. Pool Fire	Org.-Nitrate Reaction	
			Org. Lay.	Slud. Lay.			Org. Lay.	Slud. Lay.
Liquid level monitoring - operation	N	N	X	X	N[5]	N	X	X
Liquid level monitor - maintenance[2]	C	C	X	X	C	C	X	X
Sludge level monitoring	C	C	X	X	C	C	X	X
Temperature monitoring - operation	X	X	X	X	N	X	X	X
Temperature monitor - maintenance	C[6]	C	X	X	C[7]	C	X	X
Still camera photography	C	C	X	X	C	C	X	X
Video camera - operation	C	N	X	X	C	C	X	X
Video camera - maintenance[2]	C	C	X	X	C	C	X	X
Portable exhauster - operation	C	X	X	X	C	X	X	X
Portable exhauster - maintenance[2]	C[8]	X	X	X	C[9]	X	X	X
Breather filter-testing/maintenance[2]	C[8]	X	X	X	C[9]	X	X	X
Sorbent bed testing/maintenance[2]	C[8]	X	X	X	C[9]	X	X	X
Pit cover block-removal/replacement	C	X	X	X	C	X	X	X
Riser flange and gasket-removal/replacement	C	C	X	X	C	C	X	X
(continued)								

Legend:
X = Hazard not present
N = No control required
C = Control(s) preclude hazard
A = Operation requires further analysis.

Assessment of Hazards for 241-C-103 Tank Intrusive Activities (continued)

Tank Intrusive Activities[1]	Potential Hazards Normal Operations				Potential Hazards Operation Upsets			
	Head. Deflag	Org. Pool Fire	Org.-Nitrate Reaction		Head. Deflag	Org. Pool Fire	Org.-Nitrate Reaction	
			Org. Lay.	Slud. Lay.			Org. Lay.	Slud. Lay.
(continued)								
Riser modifications	C	C	X	X	C	C	X	X
Waste sampling - gases, vapors, aerosols	C	C	X	X	C	C	X	X
Waste sampling - liquids	C	C	X	X	C	C	X	X
Waste sampling - push-mode core	C	C	X	X	C	C	X	X
Addition of high-level waste from inadvertent leakage	X	X	X	X	C	X	X	X
Small volume water additions into the tank[3]	X	X	X	X	X	X	X	X
Passive tank ventilation[4]	C[10]	X	X	X	C[11]	X	X	X
Liquid observation well (LOW)-installation/removal[12]	A	A	A	A	A	A	A	A
Thermocouple tree-installation/removal[12]	A	A	A	A	A	A	A	A
Transfer pump - installation/removal[12]	A	A	A	A	A	A	A	A
Salt well screen - installation/removal[12]	A	A	A	A	A	A	A	A
Removal of floating organic layer from tank[12]	A	A	A	A	A	A	A	A

Legend:
X = Hazard not present
N = No control required
C = Control(s) preclude hazard
A = Operation requires further analysis.

Assessment of Hazards for 241-C-103 Tank Intrusive Activities (Notes)

[1] A non-intrusive operation is characterized by the presence of a boundary that physically separates the instrument, equipment, or process in question from the tank's waste contents (headspace gases, vapors and aerosols/liquids/solids). An intrusive operation is characterized by the absence of such a physical boundary.

[2] Includes as appropriate:

- Instrument calibration, preventive maintenance, and repair
- Installation, removal, replacement, and modification of small-scale instruments, components, and equipment
- Installation, removal, replacement, and modification of above ground facility instruments, components, and equipment.

[3] Small volume water additions into the tank to flush instruments, enter pits, decontaminate pits, conduct routine maintenance, pressure test transfer pipelines, flush transfer pipelines, dispose of rain water and snow-melt, and to flush for equipment removal and installation purposes.

[4] Considered to be an inherently non-intrusive operation, but requires controls to prevent an increase in the concentration of radiolytically generated gases.

[5] Potential off-normal condition: instrument air to liquid level monitor shut off, thereby decreasing the tank's passive ventilation rate and increasing the concentration of radiolytically generated gases.

[6] Thermocouples can be removed from and replaced in the tank's thermocouple tree non-intrusively under normal conditions.

[7] Potential off-normal condition: due to corrosion the steel barrier separating the tank's waste contents fails, thereby creating a tank intrusive condition.

[8] Valved out of ventilation system for maintenance under normal condition.

[9] Potential off-normal condition: failure to valve out of ventilation system prior to maintenance.

[10] Tank C-103 is passively ventilated through a breather filter and sorbent bed (in series) and/or through tanks C-102 and C-101. Some passive ventilation occurs along the edges of pit covers where (at points) the integrity of the cover block seals no longer exists.

[11] Potential off-normal condition: all vents which permit the tank to passively ventilate are shut off, thereby increasing the concentration of radiolytically generated gases.

[12] This operation is not address in WHC-SD-WM-SARR-001, Revision 0.

The conclusion from review of the proceeding table is that not all hazards associated with interim stabilization of tank 241-C-103 have been adequately evaluated to support interim stabilization.

3.3.3.2 Wicked Organic Solvent Fires. A recent concern has been identified relative to waste tanks which previously contained floating organic layers from which the floating organics were removed or possibly only partially removed. There exists the possibility that the upper surface of the waste in these tanks may contain saltcake or sludge mixed with organic liquid following interim stabilization. Such an admixture could be more easily ignited than an open pool.

A USQ Evaluation (Stahl 1994) recently completed for tank 241-C-102 provided results of hazard evaluation for tank 241-C-102 which previously contained a floating liquid organic layer. The tank was subsequently partially interim stabilized. The results of this evaluation concluded that for this particular tank, interim stabilization would not cause a significant tank waste temperature increase and would decrease the waste organic content. Waste moisture content would be reduced, but the sludge waste as in C-102 would still retain significant moisture levels. Supernate pumping of tank C-102 is believed to have removed most of the liquid organic layer. Any organic liquid that may have remained is believed to have been evaporated with residual, less volatile, TPB constituents remaining on the waste surface. Photos show no liquid organic layer presently exists in tank 241-C-102. The conclusions for tank C-102 interim stabilization would not apply to Organic Watch List Tanks with a saltcake surface versus a sludge surface.

Organic tanks which previously contained a floating organic layer which now have a saltcake surface, have not been uniquely evaluated for effects of interim stabilization at this time.

The potential new hazard presented by organic solvents mixed with waste is the potential for combustion of organic solvents in air at the waste surface. The existence of a floating organic layer in tanks would not by itself be a new hazard. The potential for organic solvents to burn in air in waste tanks as a pool fire has been evaluated for the organic layer in tank 241-C-103 in WHC-SD-WM-SARR-001 (Postma et al. 1994a). However, if tanks containing an organic layer are interim stabilized, the organic my be embedded in the waste, either in interstitial pores or possible cracks and fissures in the sludges or saltcake. Burning of solvent in air when the solvent is embedded in the waste would require ignition at the waste surface, and wicking of solvent to the fire at a rate sufficient to support a sustained or spreading burning zone. The quantities of organics and the matrix provided by the sludge or saltcake could result in an accident that is not evaluated in either the ISB or WHC-SD-WM-SARR-001.

The potential hazards posed by organic solvent-waste mixtures are undergoing additional evaluation. Preliminary results of a scoping evaluation regarding the comparison of the likelihood and consequences of solvent burning in air for a pool fire versus a wicked fire are discussed below.

Solvent Fire Ignitability

The ignitability of an organic liquid layer is analyzed in WHC-SD-WM-SARR-001 (Postma et al. 1994a). Conclusions reached in that analysis are: the organic layer is primarily NPH/TBP with a measured flashpoint of 118 ± 2 °C. It would not support a pool fire unless heated (locally) appreciably from its current temperature of 40 ± 4 °C.; The organic layer is difficult to ignite as the heat supplied by a potential ignition source is dissipated by convective heat losses in the layer. It was estimated that a sustained heat source on the order of 1.2 MJ would be required to heat the layer to its flash point and thus support ignition. The presence of a wick, however, could lower the required energy of ignition as compared to an open pool.

Liquid fuels that contain water will not support a flame if the vapor evolved at the air-liquid interface contains more than approximately 30 percent water.

The ignitability of a saltcake/solvent mixture is less well studied. Information gathered from literature and previous Hanford studies indicates that:

- When kerosene was heated in an open container, the kerosene evaporated before 400 °C and there was no reaction. Kerosene was also added to saltcake and heated near an open flame; at the flash point of kerosene, the vapors ignited and burned, the saltcake temperature remained below 175 °C and did not participate in the reaction other than to serve as a wick;

- If a volatile hydrocarbon is added to a sodium nitrate based saltcake and subsequently ignited, the hydrocarbon will flame above the saltcake, reacting with environmental gaseous oxygen (assuming an adequate source is available). The saltcake will act as a wick, transporting the hydrocarbon to the surface by capillary action and evaporation will cool the saltcake to below ignition temperature [of sodium nitrate/organic mixtures at approximately 400 °C.

The ignitability of the waste in tanks that may contain organic solvent-waste mixtures, is difficult to judge without more information regarding the waste composition. Information that is important in determining the potential hazard presented by this waste includes:

1. The measured concentration of organics in the headspace air are correct and that the source of the organics is liquid organics mixed with saltcake. If liquid organics are not present, or not mixed with the saltcake, the postulation of a organic saltcake wicks fire is not appropriate. Additional information will be needed to verify if an organic solvent wicked fire hazard is present in these tanks.

2. The location and composition of organic liquid saltcake mixture, if present, needs to be considered. If the organic material is too dilute or far from the waste surface, conditions that could support a wick stabilized or spreading fire may not be present. If significant water is present in the material, fires may be prevented by inerting by water vapor.

Although, for the purposes of completing recent USQ evaluations it was conservatively assumed that waste conditions might exist that would support a wicked fire, additional information on the ignitability of these wastes is needed to evaluate if a hazard is truly present.

Scoping calculation have been performed to judge the ignitability of solvent-waste mixtures. The preliminary estimate of the energy required to ignite solvent embedded in saltcake is between 100 joules and 1,000 joules. This estimate will need to be verified by testing.

Comparing the information on the two types of organic burning phenomena leads to two conclusions; (1) that organic solvent imbedded in saltcake can, under certain conditions, burn at the surface of the saltcake, and (2) that burning on the saltcake is easier to initiate than a pool fire as less energy is required because of the wicking effect of the saltcake.

Solvent Fire Severity

The severity of solvent fires, in the form of both pool and wick stabilized fires, was evaluated in WHC-SD-WM-SARR-001. The analysis indicated that the rate at which a local flame spreads is important in determining the peak pressure generated by a pool fire in a closed tank. If a small fire (few square feet of area) were stabilized by a wick but did not spread, then heat transfer and expansion work would limit the pressure rise to minimal levels. For this case the fire would burn to O_2 extinguishment levels and the incident would be self-terminated with minimal consequences. At the other extreme, if the whole area of the pool (tank surface) could be inflamed, the peak pressure could pose a threat to tank structural integrity and, therefore, may pose a significant hazard.

A case was analyzed that modeled a solvent fire started as a small wick stabilized flame, that spread at a relatively slow rate (1 cm/sec). The fire (modeled as a pool fire) engulfed the whole tank surface in 1144 seconds. Modeling the pressure rise and venting concluded that the structural integrity of the tank could be challenged even for this case where the fire spreading rate is relatively slow. SSTs have a poor response to pressure pulses since the domes of the SSTs are not lined with steel (like the double shell tanks).

The results of the above analysis are expected to be applicable to a wicked fire involving solvent-waste mixtures.

3.3.4 Actions Needed to Address SST Organic Safety Issues

Organic Salt Watch List SSTs require evaluation on a tank by tank basis prior to emergency pumping or interim stabilization to determine if the post-stabilized condition of the tank is expected to meet applicable safety criteria. An evaluation logic is under development to provide the rationale for making a decision on the advisability of interim stabilization of organic tanks. The evaluation logic will use with sample data from each tank. The sample data will include vapor space sampling and supernate grab samples taken prior to initiation of interim stabilization. The tank's organic vapor content, waste total organic carbon content (both prior to interim stabilization and predicted TOC following interim stabilization), and predicted post-interim stabilized waste moisture content are primary indicators that will be used to make a decision on the advisability of interim stabilization.

The sample analytical data will be evaluated for use in follow-on evaluations. The data selected for follow-on evaluations will be input to a supernate-salt cake, fuel and moisture retention model being developed by the Waste Tank Organic Safety Program. The supernate-salt cake model will be used to predict the TOC and moisture content of the waste in the tank in the interim stabilized condition. The predicted post-stabilized condition of the tank will be compared against new criteria presently under development (expected to be completed by February, 1995), to predict if a tank will be "safe" or "unsafe" following interim stabilization. The results of this comparison will be used to justify interim stabilization, or to postpone interim stabilization until additional data, possibly including core sample analytical data, is obtained and evaluated.

Tanks predicted to be "safe" following interim stabilization will be interim stabilized, and additional sample data (e.g., auger samples) will be obtained following interim stabilization to confirm that the predicted post-interim stabilized condition of the tank was accurate. If accurate, long term dryout models will be employed to provide assurance that the tank will remain safe in the post-stabilized condition for long term. If sample results are different than predicted, additional analysis will be done on the post-interim stabilized condition to provide for appropriate controls necessary to maintain tank safety.

Relative to organic tanks 241-U-106 and 241-U-107 (also a flammable gas tank) which are scheduled to be interim stabilized in 1995, vapor space sampling and grab sampling are scheduled to be completed by the end of April, 1995 per WHC-EP-0182-78 (Hanlon 1994). Vapor space sampling for U-111 is to be completed in March, 1995. Grab sampling for 241-U-111 was completed. The Preliminary Safety Criteria for Organic Watch List Tanks at the Hanford Site is to be available February, 1995 as is the PNL TOC Moisture Report. The PNL TOC Moisture Report will be used to analyze tank sample data and predict the TOC and moisture content of waste (supernate and sludge) in the tank. Additional refinements are needed for saltcakes due to a lack of sample data, and possible differences between core sample results and post-interim stabilized waste conditions. A predictive supernate/saltcake model is being developed to provide improved predictions of fuel and moisture retention in these saltcakes. The Supernate/Saltcake Model, which will be used to predict the post-interim stabilized condition of the waste remaining in the tanks, is expected to be available in draft form by April 30, 1995. This compilation of information will be used to support the Interim Stabilization decision for tanks 241-U-106, 241-U-107, and 241-U-111..

In conjunction with specific activities being undertaken to support interim stabilization activities, other actions are underway. Additional actions are required to better understand the effects of interim stabilization on the stability of the waste that remains in the SSTs following pumping. In particular, (1) the effects of interim stabilization on the retained moisture in saltcakes needs to be better quantified, and (2) the potential for creating organic liquid-waste mixtures that might support wicked fires needs further evaluation, especially for tanks that contain a saltcake surface.

Retained Fuel and Moisture Following Interim Stabilization

An evaluation of available waste sample data relative to retained organic fuel and moisture is nearing completion by Battelle Pacific Northwest Laboratory (PNL). Unfortunately, the moisture data for interim stabilized saltcakes is very limited. Additional sample results for interim stabilized saltcakes would greatly enhance the estimates of retained moisture in these wastes.

A substantial amount of new sample data from pre- and post-stabilized wastes is not expected in the near term, however, so the prediction of retained organic fuel and moisture will be based, in part, upon waste models.

Fuel concentration and location in post stabilized wastes depends on several factors including the solubility of organic species in waste liquids and retention and concentration mechanisms which might cause the organic fuels to be retained in the wastes left behind in the SSTs following interim stabilization. Solubility testing with organic chemicals known to have been sent to the wastes tanks are under way. Experiments to better understand possible concentration mechanisms such as organic chemical adsorption to solid waste (sludge and salt cake) particles are also underway.

The amount and rate of moisture loss following interim stabilization is also under investigation. This phenomena is significantly influenced by tank ventilation rates and the hygroscopic behavior of the waste. Ventilation rates are being modelled by thermal hydraulic code calculations, while the hygroscopic behavior is being investigated with waste simulant experiments and evaluating historical waste sample desiccant test results. These investigations, when completed, are intended to predict the retained moisture in tank wastes for comparison to reactive chemical safety criteria. Waste whose predicted retained moisture following interim stabilization exceeds minimum moisture criteria are considered safe, and interim stabilization would be recommended. Waste with predicted moisture below minimum criteria will need further evaluation or moisture control systems to be developed and implemented.

Specific tasks underway or planned to complete the investigation include:

- Moisture Retention Modeling of Waste Sludges - This effort's goal is to model the behavior of water held in waste sludges as influenced by processes of consolidation and surface evaporation under radioactive heating. The investigation includes identifying the relevant mathematical theory, performing computer model calculations and performing simulant tests.

- Fuel and Moisture Retention Experiments and Modeling for Waste Salt Cakes - Tasks in this area are focused on determining the amount of fuel and moisture that can be expected to be retained in drained (post-stabilized) salt cakes. Salt cakes are composed primarily of relatively large (compared to sludges) crystalline particles of sodium nitrate and other waste salts. The moisture retention capability is much less than that observed for the micron sized sludge particles. Unlike sludges, where the moisture is expected to be uniformly distributed throughout the waste, salt cakes can have a very pronounced moisture gradient between the bottom of the tank and the waste surface. This behavior, however, also can cause the fuel to be non-uniformly distributed such that areas of low moisture may also be areas with little fuel. Experiments on salt cake draining phenomena, organic fuel solubility and concentration mechanisms are being coupled with theoretical modelling to develop a salt cake model that will be used to predict salt cake behavior.

- Evaluation of Available Historical Sample Information - Available historical waste sample data is being evaluated for moisture content including specific values for sludge and salt cakes. The evaluation also utilizes statistical methods to estimate the moisture content in tanks for which no sample information is available.

- Moisture Loss Rate Evaluation - An evaluation is being performed to estimate moisture loss rates and predict retained moisture including the effects of interim stabilization and ventilation of waste tanks. The starting point for moisture content evaluation is based on the results of the sample data evaluation above. Ventilation rates are being modelled by thermal hydraulic code calculations, while the hygroscopic behavior is being investigated with waste simulant experiments and evaluating historical waste sample desiccant test results.

- Moisture Retention for Waste Samples - The moisture retention properties for waste that are to be interim stabilized can be predicted by obtaining waste samples prior to interim stabilization and performing moisture retention tests.

Organic Solvent-Waste Mixtures

The possibility of creating organic solvent-waste mixtures and the hazards posed by such mixtures need to be further evaluated. Tasks that are in process or are planned to complete the investigation into these issues include:

- Evaluation of Waste Samples - Waste samples are to be obtained from tanks that may have contained organic layers prior to interim stabilization (e.g., tanks C-103, BY-107, BY-108) and analyzed for composition and potential combustibility.

- Simulant Testing for Composition - Experiments are being performed with waste simulants (sludges and saltcakes) to evaluate the possibility of creating, and determining possible compositions of wastes with organic solvents intermixed due to draining as a result of tank leaks or interim stabilization. Experiments simulate the tank waste system relative to capillary forces, waste column heights, organic solvent/aqueous liquid interfacial tension, and other governing parameters.

- Combustibility Testing With Simulants - Experiments with waste simulants are being planned to quantify the ignitability of solvent-waste mixtures. These experiments are intended to evaluate under what conditions waste-solvent mixture can support a wicked fire, if a wicked fire can spread, and if so what spreading rates can be expected.

Simulants tested will have compositions that are consistent with and bound those estimated as a result of the two tasks above.

Relative to tank 241-C-103, the main issue to address is the potential for the organic liquid to intermingle with the waste surface during interim stabilization activities. This intermingling could make the waste surface more prone to support combustion, as previously discussed. A TPA milestone has recently been added: M-40-04-T01, "Reach decision to Interim Stabilize Tank 241-C-103 With Floating Organic Layer in Place of Proceed With Removal of Floating Organic Layer," due May 15, 1995.

Relative to the other Organic Watch List Tanks which are not interim stabilized, the ability of the waste to retain sufficient moisture levels following interim stabilization in order to remain "conditionally safe" needs to be examined.

Test plans are being developed to address the issues identified. Once results are known, this information can be used as a technical basis for USQ Evaluations applicable to interim stabilization of Organic Watch List Tanks.

4.0 LIMITS, RESTRICTIONS, AND CONTROLS

4.1 GENERAL WATCH LIST TANK REQUIREMENTS

The *Hanford Site Tank Farm Facilities Interim Safety Basis* (ISB) (Leach and Stahl 1993), was approved by the Department of Energy via letter (ADT:TOB 93-TOB-209) from J. D. Wagoner, RL to T. M. Anderson, WHC received by WHC on November 18, 1993. The letter states that the Tank Farms ISB was accepted by the DOE for the purposes of Unresolved [Unreviewed] Safety Question (USQ) determinations, resolving USQ program issues and authorizing new emerging activities. Specifically, Chapter 6 and associated safety basis documentation referenced therein, was approved as the "authorization basis" in accordance with Department of Energy (DOE) Order 5480.21.

Chapter 6.0 of the Tank Farms ISB identifies applicable limitations, restrictions and controls for Watch List Tanks considered to be part of the "authorization basis." Documents specifically identified as containing applicable controls are as follows:

- WHC-SD-WM-OSR-005, *Single-Shell Tank Interim Operational Safety Requirements* (Dougherty 1994)
- LAUR-92-3196, *Safety Assessment for Proposed Pump Operation to Mitigate Episodic Gas Releases in Tank 241-SY-101* (Los Alamos National Laboratory 1994)
- OSD-T-151-00030, *Operating Specifications for Watch List Tanks* (WHC 1994b)
- WHC-SD-WM-JCO-002, *Justification for Continued Operation of Hanford Waste Tank 241-C-103 Resulting from the Separable Organic Layer Unreviewed Safety Question* (Carothers 1993)

Operating specifications are technical limits which are set on a process to prevent injury to personnel, damage to a facility or environment. OSD-T-151-00030, *Operating Specifications for Watch List Tanks*, identified controls, limits, and restrictions applicable to activities performed which could affect Watch List tanks. Details of these controls can be found in OSD-T-151-00030 which include the specification variables, specification limits, technical bases, detection/control requirements, and recovery actions. A brief summation of these controls is provided for reference purposes. However, this information is subject to change by ongoing revisions to OSD-T-151-00030, and as such, the procedure should be referred to for current requirements.

Table 4.1-1
Operating Specifications for Hydrogen/Flammable Gas Tanks
(Per OSD-T-151-00030)

HYDROGEN/FLAMMABLE GAS TANK VARIABLE	VARIABLE	SPECIFICATION LIMIT
GENERAL	Grinding, drilling, welding or other types of spark-producing activities on, or in[1], a Watch List Tank ventilation system. Installation and removal of equipment.	Requires written approval from Waste Tank Safety Assurance, Waste Tank Operations and Waste Tank Plant Engineering
	Work in primary ventilation space (including dome space) or in associated exhaust ventilation system[2].	Use spark resistant tools. Flammable gas concentrations < 20% LFL (lower flammability limit)
	[1] Work on, or in, the tank is to be interpreted as work that is performed in the tank vapor space and ventilation system (primary liner, risers and covers, ventilation ductwork, instrumentation sample line tubing) or work that is in direct contact with the outside of the boundary that could result in an ignition source inside the boundary. Limits on work on, or in, the tanks also applies to work in direct vicinity of openings to the tank vapor space that provide a direct path back inside the tank boundary. [2] Limit applies to work done inside air space of associated exhaust system, NOT on outside work. Limit does not apply to work done on parts of the ventilation system which are isolated from the tank air space by dampers, butterfly valves, blanks or other means. Testing/operation and periodic "bumping" of the mixer pump in accordance with LA-UR-92-3196 is permitted.	
SAMPLING	Liquid or Core Sampling	Written approval by Tank Waste Remediation Systems Division, Waste Tanks Safety Assurance. DOE HQ approval is required for Single-Shell Watch List Tanks.
	Flammable Gas Concentration in the Vapor Space	< 20% of the LFL (lower flammability limit)
	Tank 101-SY	Sample when low flammable gas inventory is present in the tank.
TRANSFER OF WASTE	Transfer Waste Out of a Tank	Requires written approval by Tank Waste Remediation Systems, Waste Tanks Safety Assurance and DOE. Requires sample analysis from both receiving and sending tanks.
	Planned Transfer of Waste Into a Tank	Requires written approval by Secretary of Energy.
IN-TANK INSPECTION (continued)	In-tank Inspection	Equipment design must follow the safety criteria outlined for TV camera and light assemblies

HYDROGEN/FLAMMABLE GAS TANK VARIABLE	VARIABLE	SPECIFICATION LIMIT
IN-TANK INSPECTION (continued)	• Lighting to be UL listed for use in Class 1, Division 1, Group B; a flammable hydrogen atmosphere. • All other electrical components located inside the tank that are not Class 1, Division 1, Group B will be purged and pressurized with instrument air or inert gas in accordance with the National Fire Protection Association, Inc. (NFPA), Article 496, Type X purging, to conform with the requirements of the National Electrical Code (NEC), Article 501 for use in the flammable hydrogen atmospheres. • Purge gas system to have redundant safety instruments to alarm and automatically shut off electrical power to the electrical components served by the purge gas system due to loss of gas pressure. If required by the safety classification of the equipment or the NFPA classification for the location where the equipment is installed, whichever is more stringent. • In tank 101-SY radiation shielding of the replacement plug to be equal to original 42-in. shield plug. • In-Tank inspection using a still photo camera requires approval by WTO and WTPE.	

Operating Specifications for Ferrocyanide Tanks (Per OSD-T-151-00030)

FERROCYANIDE TANK VARIABLE	VARIABLE	SPECIFICATION LIMIT
GENERAL	Operations and maintenance that can heat or dry the waste.	Level 1 - SAFE TANKS[1] No additional limits for ferrocyanide tanks. Level 2 - CONDITIONALLY SAFETY TANKS[2] No operation of equipment which could significantly heat the waste or operation of permanent exhauster systems[3] without approval of Waste Tank Plant Engineering and Waste Tank Safety Assurance.
	[1]Level 1 SAFE TANKS - A tank is classified as SAFE for interim storage if the fuel concentration of the solids, calculated on a zero free water basis, in all homogenized core sample quarter segments (see Technical Bases below for explanation) is ≤8 wt% sodium nickel ferrocyanide ($Na_2NiFe(CN)_6$) on an energy equivalent basis. Tanks not meeting this criteria are classified either CONDITIONALLY SAFE or UNSAFE. [2]Level 2 CONDITIONALLY SAFE TANKS - A tank is classified as CONDITIONALLY SAFE for interim storage if the fuel concentration of the solids, calculated on a zero free water basis, in all homogenized core sample quarter segments (see Technical Bases below for explanation) is >8 wt% sodium nickel ferrocyanide ($Na_2NiFe(CN)_6$) on an energy equivalent basis AND the free water content is ≥[4/3][fuel wt% - 8]. Free water content is based on drying of samples at 120°C for 18 hours. Tanks not meeting this criteria are classified UNSAFE. [3]Operation of exhausters used during maintenance, sampling or similar activities is permissible without approval.	

FERROCYANIDE TANK VARIABLE	VARIABLE	SPECIFICATION LIMIT
TRANSFER OF WASTE	Transfer Waste Out of a Tank	Requires written approval by Tank Waste Remediation Systems, Waste Tanks Safety Assurance and DOE*. Requires sample analysis from both receiving and sending tanks.
	Planned Transfer of Waste Into a Tank	Requires written approval by Secretary of Energy.

*[Note: Transfers of Waste Out of a Tank for either specific tanks or categories of tanks which have been previously approved by DOE and are part of the authorization bases (e.g., ISB), do not require additional DOE approval.]

Operating Specifications for Organic Tanks (Per OSD-T-151-00030)

ORGANIC TANK VARIABLE	VARIABLE	SPECIFICATION LIMIT
GENERAL	Grinding, drilling, welding or other types of spark-producing activities on, or in[1], a Watch List Tank ventilation system. Installation and removal of equipment.	Requires written approval from Waste Tank Safety Assurance, Waste Tank Operations and Waste Tank Plant Engineering
	Work in primary ventilation space (including dome space) or in associated exhaust ventilation system[2].	Use spark resistant tools. Flammable gas concentrations < 20% LFL (lower flammability limit)
	[1] Work on, or in, the tank is to be interpreted as work that is performed in the tank vapor space and ventilation system (primary liner, risers and covers, ventilation ductwork, instrumentation sample line tubing) or work that is in direct contact with the outside of the boundary that could result in an ignition source inside the boundary. Limits on work on, or in, the tanks also applies to work in direct vicinity of openings to the tank vapor space that provide a direct path back inside the tank boundary. [2] Limit applies to work done inside air space of associated exhaust system, NOT on outside work. Limit does not apply to work done on any part of the ventilation system which is isolated from the tank air space by dampers, butterfly valves, blanks or other means.	
SAMPLING	Liquid or Core Sampling	Written approval by Tank Waste Remediation Systems Division and Waste Tanks Safety Assurance.
TRANSFER OF WASTE	Transfer Waste Out of a Tank	Requires written approval by Tank Waste Remediation Systems, Waste Tanks Safety Assurance and DOE. Requires sample analysis from both receiving and sending tanks.
	Planned Transfer of Waste Into a Tank	Requires written approval by Secretary of Energy.
IN-TANK INSPECTION (continued)	In-tank Inspection Permanent Installations	Equipment design shall follow the criteria in Table 30.2.C.4-1.

ORGANIC TANK VARIABLE	VARIABLE	SPECIFICATION LIMIT
IN-TANK INSPECTION (continued)	In-Tank Inspection Temporary Installations* * For thanks also on the flammable gas Watch List, the limits for in-tank inspection of flammable gas tanks shall apply.	Equipment shall follow the criteria in Table 30.2.C.4-2.
	Table 30.2.C.4-1 - Permanent Installations • Lighting to be UL listed for use in Class 1, Division 1, Group B; a flammable hydrogen atmosphere. • All other electrical components located inside the tank that are not Class 1, Division 1, Group B will be purged and pressurized with instrument air or inert gas in accordance with the National Fire Protection Association, Inc. (NFPA), Article 496, Type X purging, to conform with the requirements of the National Electrical Code (NEC), Article 501 for use in the flammable hydrogen atmospheres. • Purge gas system to have redundant safety instruments to alarm and automatically shut off electrical power to the electrical components served by the purge gas system due to loss of gas pressure. If required by the safety classification of the equipment or the NFPA classification for the location where the equipment is installed, whichever is more stringent. • In-Tank inspection using a still photo camera requires approval by WTO and WTPE. Table 30.2.C.4-2 - Temporary Installations • The tank vapor space flammable gas PLUS organic vapor concentration shall be ≤ 25% of the LFL. The tank vapor space shall be sampled prior to initial operation of inspection equipment. If the initial vapor space concentration is below 5% of the LFL, vapor sampling shall be done as a minimum every 10 days the equipment is operated. If the initial concentration is above 5% of the LFL, vapor sampling shall be done as a minimum every 2 days the equipment is operated.	

Operating Specifications for High Heat Tank (Per OSD-T-151-00030)

HIGH HEAT TANK VARIABLE	VARIABLE	SPECIFICATION LIMIT
SAMPLING	Core or Solid Sampling	Requires written approval by Tank Waste Remediation Systems Division and Waste Tanks Safety Assurance.
TRANSFER OF WATER FOR COOLING	Transfers Into a Tank	Only water additions.

4.2 FLAMMABLE GAS TANKS

A set of controls has been developed that provides assurance that safety can be maintained during tank intrusive activities. These controls as specified in WHC-SD-WM-SARR-004 (Van Vleet 1994) are repeated here for convenience. Additional controls drafted for flushing of the jet pump, jet pump foot valve, DOV, and Dip Tubes have been added as well as controls suggested for jet pump operation and testing.

4.2.1 Generic Controls

The following standard controls apply to all activities performed in single-shell Flammable Gas Watch List tanks: A-101, AX-101, AX-103 (interim-stabilized), S-102, S-111, S-112, SX-101, SX-102, SX-103, SX-104, SX-105, SX-106, SX-109 (interim-stabilized), T-110, U-103, U-105, U-107, U-108, and U-109.

4.2.1.1 Ventilation Controls. The single-shell Flammable Gas Watch List tanks intended to be on active ventilation are those in the SX tank farm. However, there is no requirement that the active ventilation system on single-shell flammable gas watch list tanks be functional. Therefore, this section will treat all of the single-shell Flammable Gas Watch List Tanks as being passively ventilated.

- The tank ventilation system shall be operating before and during the activity, i.e., the breather filter must be functional. Exceptions to these requirements may occur occasionally for short periods while maintenance activities to the high-efficiency particulate air filters are being conducted. An example of the term "occasionally for short periods of time" is 8 hours, once a month (31 days) (Van Vleet 1994).

- On breaking tank containment in a particular riser for the first time during the activity, a 5-minute pause shall be observed. This allows any accumulated gases to be swept out of the riser.

4.2.1.2 Electrical Grounding and Bonding Controls. Note: The electrical grounding and bonding controls apply to all single-shell Flammable Gas Watch List tanks.

- The riser cover shall be removed in such a way as to prevent possible ignition of flammable gas inside the riser because of static charges or mechanical sparks. To prevent electrostatic sparks, the riser cover shall be electrically bonded to the tank in accordance with the appropriate National Fire Protection Association code requirements for the classified regions of the tank vapor space and ventilation system. Note: Because the single-shell tanks do not have a metal liner in the dome to provide electrical continuity, different risers can be at different electric potentials.

- To prevent mechanical sparks, only spark-resistant tools shall be used, except for the initial loosening (one full turn) and the final tightening (final torquing) of the bolts.

- All equipment inserted into the tank vapor space shall be electrically grounded and bonded in accordance with the appropriate National Fire Protection Association section code requirements for the classified regions of the tank vapor space and in the SX tank farm ventilation system.

4.2.1.3 Hydrogen Concentration Control. Note: The hydrogen concentration control applies to all single-shell Flammable Gas Watch List Tanks. Because no specific time of intrusion control (similar to the "window" for 101-SY) is imposed, it is important to provide real-time measurements of the hydrogen concentration while activities are being performed. Until the standard hydrogen monitoring system is installed on each tank, this control can be satisfied by monitoring the tank using a hand-held combustible-gas meter. The hand-held combustible-gas meter would be positioned so that the sample is drawn from approximately the same location as the standard hydrogen monitoring system would draw its sample, i.e., near the waste surface.

Note: There are indications that two tanks (A-101, SX-103) have the potential for having steady-state concentrations above the lower flammability limit for hydrogen. All controls on electrostatic grounding and bonding shall be rigorously followed.

- If the standard hydrogen monitoring system and gas probe assembly are not installed or are not functioning, the flammable gas concentration shall be taken at three locations before starting an in-tank activity.

  (1) The concentration shall be taken at the tank high-efficiency particulate air filter before any riser cover is removed.

  (2) After the riser bolts sealing the riser flange are loosened enough to take a gas sample from the riser, the concentration of flammable gases shall be taken at the riser opening.

  (3) After complete riser cover removal and before the activity proceeds in the tank, a final flammability test shall be conducted in the tank vapor space. This last measurement is not required for activities that do not intrude into the tank vapor space. For this analysis, this includes the ventilation and balance activities; instrument testing, calibration, repair, or replacement; and level-indicating transmitter flushing, repair, or replacement.

  At each of these locations, the following instructions shall be followed. If the combustible-gas meter reading (calibrated on methane or pentane as appropriate to the specific meter) at the location in question is $\leq$ 25 percent of the lower flammability limit, the activity may proceed. If the meter reading exceeds 25 percent of the lower flammability limit, a flow-through bulb sample shall be taken for specific gas species analysis in the laboratory, the activity shall cease, and the tank shall be placed in safe shutdown mode. The activity shall not resume until results of the flow-through bulb sample are known, and the appropriate Safety and Tank Farm Project Management approvals are received.

- The flammable gas concentration shall be measured continuously during the in-tank activities (either with the standard hydrogen monitoring system and gas probe assembly or with the hand-held combustible-gas meter). For the standard hydrogen monitoring system, this is accomplished by viewing the strip chart recorder. For the hand-held combustible-gas meter, readings shall be taken every 15 minutes.

- Activities in the tank shall cease when the flammable gas concentration exceeds a value equal to 25 percent of the lower flammable limit as read from the in-tank hydrogen monitoring probes, or the hand-held combustible-gas meter.

4.2.1.4 Respiratory Protection Controls. Note: The respiratory and protection controls apply to all single-shell Flammable Gas Watch List tanks.

- The personnel working near the open riser, open sample port, or any other opening in the tank and those personnel elsewhere in the tank farm (i.e., the upwind staging area) shall wear respiratory protection as determined by the field representative of Industrial Health, Safety, and Fire Protection. The level of protection for those personnel will be based on the field measurements and the requirements in the *Tank Farm Health and Safety Plan* (Erickson 1994).

- The gas monitoring for respiratory protection shall be performed in accordance with standard work practices contained in the *Tank Farm Health and Safety Plan* (Erickson 1994).

4.2.1.5 Time of Intrusion.

- Work shall be done after a review group has looked at recent tank behavior and decided that the tank is behaving in a manner consistent with its historical norm. This review group will have members from Waste Tank Safety Assurance, Operations (200 East or 200 West Area, as appropriate), Waste Tank Process Engineering (200 East or 200 West Area, as appropriate), Waste Tank Process Control, Tank Waste Remediation System Safety Analysis and Engineering, Waste Tank Plant Engineering (200 East or 200 West Area, as appropriate), and Flammable Gas Tank Safety Program Office. If conditions exist outside of the normal behavior of the tank, a formal presentation will be made to the Plant Review Committee. This last measurement is not required for activities that do not intrude into the tank vapor space. For this analysis, this includes the ventilation and balance activities; instrument testing, calibration, repair, or replacement; and level-indicating transmitter flushing, repair, or replacement.

- During the activity, tank conditions shall be monitored for the entire time that the activity is being performed. This monitoring will include the tank waste level and the hydrogen concentration in the tank (measured using either a hand-held combustible-gas meter or the standard hydrogen monitoring system). The operator shall look for indications that a gas release might occur, e.g., a sudden decrease in waste surface level and/or an increase in the hydrogen concentration. If any measurements indicate that a gas release is imminent, the tank shall be placed in safe shutdown mode (Van Vleet 1994) and the tank farm shall be evacuated. If the activity being performed is repair or replacement of the level-indicating transmitter device, the intent of this control would be met if a measurement were taken just before the work is initiated and immediately after the work is completed.

4.2.1.6 Dome Loading. Applicable Operational Specification Requirements for dome loading (both uniform and point loads) shall be satisfied for the tank on which the activity is occurring. An analysis will need to account for loads placed on the tank: new equipment, new concrete pads, new soil cover, etc., along with equipment needed to perform the activity such as cranes and trucks.

4.2.2 Activity-Specific Controls

The following controls are activity specific, i.e., the nature of the activity invokes their inclusion into the control section. The controls listed below for each activity are those controls required in addition to <u>all</u> the generic controls listed in Section 4.2.1.

4.2.2.1 Standard Hydrogen Monitoring System and Gas Probe Assembly

- All components in the standard hydrogen monitoring system shall be inspected to ensure that they are installed properly and according to design requirements before operation of the system.

- The system shall be leak tested before initial startup and when components of the system that contain or contact sample gases are replaced.

- All standard hydrogen monitoring system drawings shall identify intrinsic safety features that must be maintained. No modifications will be made to any of these drawings without appropriate approvals.

- The crane and rigging that are used in the activity shall be load tested with loads that equal or exceed the weight of the heaviest assembly. The actual lift shall be treated as a critical lift.

- During installation and removal of the gas probe assembly, precautions shall be taken to prevent the equipment from being dropped into the tank. An example would be an impact-limiting device installed to absorb the energy of a potential drop to protect the riser and/or liner integrity.

- If the high-efficiency particulate air filter (breather filter) is removed, standard grounding and bonding techniques (see Section 6.1.2) shall be followed. Installation of the spool piece shall be considered a critical lift. In addition, the high-efficiency particulate air filter (breather filter) shall be operational again for the time limits specified in Section 4.2.1.1.

- During insertion or removal of tall objects greater than 3 m (10 ft), the objects shall be grounded to protect against lightning strikes. Grounding of a tall object provides a more favorable path for the lightning thus preventing electrical discharges within the tank.

- During insertion or removal of tall objects greater than 3 m (10 ft), a weather watch shall be maintained. If lightning is present in an 80.5-km (50-mile) radius around the tank farm where the activity is being performed, the tank will be placed in a safe shutdown condition.

- Installation of the gas probe assembly shall proceed slowly and deliberately. The gas probe assembly should lower freely into the tank with no resistance. If resistance is encountered, installation shall be halted and the riser inspected for interferences according to procedure.

- All tools and equipment used around the open riser that are small enough to fall through the riser shall be equipped with lanyards.

4.2.2.2 Vapor-Space Sampling.

- The crane and rigging that are used in the activity shall be load tested with loads that equal or exceed the weight of the heaviest assembly. The actual lift shall be treated as a critical lift.

- During installation and removal of the vapor-space sampling probe assembly, precautions shall be taken to prevent the equipment from dropping into the tank. An example would be an impact-limiting device installed to absorb the energy of a potential drop to protect the riser and/or liner integrity.

- During insertion or removal of tall objects greater than 3 m (10 ft), the objects shall be grounded to protect against lightning strikes. Grounding of a tall object provides a more favorable path for the lightning thus preventing electrical discharges within the tank.

- During insertion or removal of tall objects greater than 3 m (10 ft), a weather watch shall be maintained. If lightning is present in an 80.5-km (50-mile) radius around the tank farm where the activity is being performed, the tank will be placed in a safe shutdown condition.

- Installation of the vapor-space sampling probe assembly shall proceed slowly and deliberately. The assembly should lower freely into the tank with no resistance. If resistance is encountered, installation shall be halted and the riser inspected for interferences according to procedure.

- Before the sample tubes are inserted into the riser, the waste level shall be determined and the sample tube lengths adjusted to reduce the possibility of removing samples from the waste surface (liquid or solids).

- All tools and equipment used around the open riser that are small enough to fall through the riser shall be equipped with lanyards.

4.2.2.3 Still Photography.

- Contamination control shall be provided around the open pump pit or open riser. The means of contamination control shall be specified in the applicable work package.

- Photographic equipment used, to include lighting and/or flash, shall conform to either the National Electric Code, Article 501 for use in Class 1, Division 1, Group B (flammable hydrogen environment) or shall be purged with inerting gas in accordance with National Fire Protection Association, Inc., Article 496, Type X purging to conform with the requirements of the National Electric Code, Article 501 for a flammable hydrogen environment. The purge gas system, if used, shall have dual safety instrumentation to alarm and automatically shut off all electrical power to the electrical components served by the purge gas system if a loss of gas pressure occurs.

- Photographic hardware shall be of spark-resistant materials, such as stainless steel.

- A stainless steel insert with a plastic liner shall be used to protect the tank riser and to keep the photographic equipment from becoming contaminated.

- The photographic equipment shall have a device similar to the existing "top hat" used in the still photography in non-watch list tanks to provide for tank containment.

- The crane and rigging that are used in the activity shall be load tested with loads that equal or exceed the weight of the heaviest assembly. The actual lift shall be treated as a critical lift.

- During installation and removal of the photographic equipment, precautions shall be taken to prevent the equipment from dropping into the tank. An example would be an impact-limiting device installed to absorb the energy of a potential drop to protect the riser and/or liner integrity.

- During insertion or removal of tall objects greater than 3 m (10 ft), the objects shall be grounded to protect against lightning strikes. Grounding of a tall object provides a more favorable path for the lightning thus preventing electrical discharges within the tank.

- During insertion or removal of tall objects greater than 3 m (10 ft), a weather watch shall be maintained. If lightning is present in an 80.5-km (50-mile) radius around the tank farm where the activity is being performed, the tank will be placed in a safe shutdown condition.

- Photographic equipment installation and removal shall proceed slowly and deliberately. The assembly shall be lowered into or removed from the tank with no resistance. If resistance is encountered, installation/removal shall be halted, and the riser inspected for interference.

- All tools and equipment used around the open riser that are small enough to fall through the riser shall be equipped with lanyards.

4.2.2.4 Instrument Tree.

- The crane and rigging that are used in the activity shall be load tested with loads that equal or exceed the weight of the heaviest assembly. The actual lift shall be treated as a critical lift.

- The riser shall be inspected for obstructions before installation of the instrument tree. A high-intensity light source and a mirror or leaded glass could be used. Another method would involve using a non-sparking riser gauge plug.

- During installation and removal of the instrument tree, precautions shall be taken to prevent the equipment from dropping into the tank. An example would be an impact-limiting device installed to absorb the energy of a potential drop to protect the riser and/or liner integrity.

- During insertion or removal of tall objects greater than 3 m (10 ft), the objects shall be grounded to protect against lightning strikes. Grounding of a tall object provides a more favorable path for the lightning thus preventing electrical discharges within the tank.

- During insertion or removal of tall objects greater than 3 m (10 ft), a weather watch shall be maintained. If lightning is present in an 80.5-km (50-mile) radius around the tank farm where the activity is being performed, the tank will be placed in a safe shutdown condition.

- If the installation of the instrument tree is done using the ultra-high-pressure nozzle, the water pressure shall be reduced to 34.5 MPa (5,000 psi) when the instrument tree flange is 30.5 cm (1 ft) above the riser flange. In addition, the instrument tree shall be rotated during the entire time water is supplied to the sluicing nozzle.

- Installation of the instrument tree shall proceed slowly and deliberately. The instrument tree should lower freely into the tank with no resistance. If resistance is encountered, installation shall be halted and the riser inspected for interferences according to procedure.

- A maximum of 950 L (250 gal) of water can be used for insertion of the instrument tree. If it is necessary to exceed this amount, permission must be obtained from Tank Farm Operations and Nuclear Safety.

4.2.2.5 Installation of LOW, Salt Well Screen, and/or Jet Pump.

- The crane and rigging that are used in the activity shall be load tested with loads that equal or exceed the weight of the heaviest assembly. The actual lift shall be treated as a critical lift.

- The riser shall be inspected for obstructions before installation of the Liquid Observation Well (LOW), salt well screen, and/or jet pump. A high-intensity light source and a mirror or leaded glass could be used. Another method would involve use of a non-sparking riser gauge plug.

- During installation of the liquid observation well, salt well screen, and/or jet pump, precautions shall be taken to prevent the equipment from dropping into the tank. An example would be an impact-limiting device installed to absorb the energy of a potential drop to protect the riser and/or liner integrity.

- To minimize changes in tank waste characterization, no more than 1,892 L (500 gal) of water shall be added to the tank for the pit decontamination and lancing operation. Tank Farms Operations and Industrial Safety will be required to authorize the use of additional water, if needed. The temperature of the water shall be less than 100 °C (212 °F). In addition, a flow totalizer shall be used to measure the amount of water added to the tank.

- During insertion or removal of tall objects greater than 3 m (10 ft), the objects shall be grounded to protect against lightning strikes. Grounding of a tall object provides a more favorable path for the lightning thus preventing electrical discharges within the tank.

- During insertion or removal of tall objects greater than 3 m (10 ft), a weather watch shall be maintained. If lightning is present in an 80.5-km (50-mile) radius around the tank farm where the activity is being performed, the tank will be placed in a safe shutdown condition.

- Salt well screen and/or jet pump installation and removal shall proceed slowly and deliberately. The assembly shall be lowered into or removed from the tank with no resistance. If resistance is encountered, installation/removal shall be halted, and the riser inspected for interference.

- All tools and equipment used around the open riser that are small enough to fall through the riser shall be equipped with lanyards.

4.2.2.6 Auger Sampling.

- During manual installation, one lifting bar shall be in place at all times.
- The crane and rigging that are used in the activity shall be load tested with loads that equal or exceed the weight of the heaviest assembly. The actual lift shall be treated as a critical lift.
- The riser shall be inspected for obstructions before installation of the auger assembly. A high-intensity light source and a mirror or leaded glass could be used. Another method would involve use of a non-sparking riser gauge plug.
- During insertion or removal of tall objects greater than 3 m (10 ft), the objects shall be electrically bonded to the ground and the tank via a riser to protect against lightning strikes. Grounding of a tall object provides a more favorable path for the lightning thus preventing electrical discharges within the tank.
- During insertion or removal of tall objects greater than 3 m (10 ft), a weather watch shall be maintained. If lightning is present in an 80.5-km (50-mile) radius around the tank farm where the activity is being performed, the tank will be placed in a safe shutdown condition.
- Installation of the auger/guide tube assembly shall proceed slowly and deliberately. The assemblies should lower freely into the tank with no resistance. If resistance is encountered, installation shall be halted and the riser inspected for interferences according to procedure.
- All tools and equipment used around the open riser that are small enough to fall through the riser shall be equipped with lanyards.

4.2.2.7 Push-Mode Sampling.

- A maximum of 950 L (250 gal) of water can be used during push-mode sampling for each complete core. If it is necessary to exceed this amount, permission must be obtained from Tank Farm Operations and Nuclear Safety.
- During core sampling, the core drill truck shall be electrically grounded to protect against lightning strikes.
- During core sampling, a weather watch shall be maintained. If lightning is present in an 80.5-km (50-mile) radius around the tank farm where the activity is being performed, the tank will be placed in a safe shutdown condition.

- The hydraulic safety interlock that prevents penetration through the bottom of the tank shall be tested to ensure that it is functioning before the tank is sampled. The hydraulic safety interlock shall be engaged immediately before the last (determined by calculations) core segment is taken.
- The core drill truck shall not be modified to allow more pressure, i.e., 1.7 MPa (250 lbf/in^2), or more downward force than the currently allowed 23.7 kN (5,300 lbf) for push-mode core sampling.
- The old push-mode core sampling truck shall disengage rotary-mode capability using established lock and tagout procedures.

4.2.2.8 Routine Maintenance and Surveillance.

- Removal of pump pit cover blocks or cover plates shall require a critical lift procedure.
- The crane and rigging that are used to remove the pump pit cover blocks or cover plates shall be load tested with loads that equal or exceed the weight of the heaviest assembly.
- All tools and equipment used around the open riser that are small enough to fall through the riser shall be equipped with lanyards.

4.2.2.9 Flushing the Jet Pump, Jet Pump Foot Valve, DOV, and Dip Tubes.

- To minimize changes in tank waste characterization, the water addition to the SSTs shall not exceed 190 L (50 gal) for each tank. The temperature of the water shall be less than 100 °C (212 °F). In addition, a flow totalizer shall be used to accurately indicate how much water was added to each tank.

4.2.2.10 Jet Pump Operation and Testing.

- Before jet pump testing is initiated, the vapor sampling of the SST dome space shall be performed and have acceptable results.
- Before cover plate or cover block removal, the pump pit shall have been sampled using a combustible gas meter via the access ports or cracks in the coverplates. If the meter reading (calibrated to methane or pentane) is < 25% the lower flammability limit, work may proceed. [Note: Industry standard for LFL is 25% and is the requirement for this analysis. Tank Farm Operations are using 20% LFL for their workplans, which is a more conservative approach.] If the meter reading is ≥ 25% the lower flammability limit, a grab sample shall be taken for laboratory analysis. No further work is permitted until the sample results are completed and the appropriate Safety and Tank Farm Project Management approvals are received.
- During jet pump testing and operation, the coverplates will be installed. The lifting of the cover plates or cover blocks shall follow the guidelines in the Hanford Hoisting and Rigging manual.

- During specified activities, a Health Physics Technician(s) shall be present to enforce the requirements of the Hanford Site Radiation Control Manual (HSRCM-1).

- A technician from Industrial, Health, Safety, and Fire Protection (IHSFP) organization shall be present whenever tank vapor space confinement, including pump pits, is breached. They shall enforce the requirements of the IHSFP, as covered in WHC-SD-WM-HSP-002 (Erickson 1994). This includes the level of respiratory protection, and the type and frequency of workspace environmental monitoring.

4.3 FERROCYANIDE TANKS

The controls applicable to Ferrocyanide Watch List Tanks as identified in OSD-T-151-00030 (WHC 1994b), are to be followed. The limits, restrictions, and controls applicable for interim stabilization of Ferrocyanide Watch List Tanks as identified in WHC-SD-WM-SAD-018 (Kummerer 1993) exist in applicable Interim Operational Safety Requirements with one exception. The one exception, relative to maintaining a minimum interstitial liquid level following pumping, has been subsequently determined by analysis and simulant testing to be unnecessary. Therefore, there are no additional controls imposed for interim stabilization of Ferrocyanide Watch List Tanks.

4.4 ORGANIC TANKS

In addition to the controls applicable to Organic Watch List Tanks identified in OSD-T-151-00030 (WHC 1994b), the following limits, restrictions, and controls are applicable for emergency pumping of Organic Watch List Tanks as identified in WHC-SD-WM-TI-579 (Postma and Kummerer 1993):

4.4.1 Controls Applicable to Headspace Flammability

Existing information indicates that for non-episodic gas release mechanisms, combustion gas concentrations will peak out at levels well below the Lower Flammability Limit (LFL). To verify this expectation, the headspace atmosphere should be sampled and analyzed to confirm that the total concentration of combustibles remains at below 20% of the LFL. [Note: Industry standard (NFPA 1986) for LFL is 25% and is the requirement for this evaluation. Results of the Accelerated Safety Analysis (WHC 1994a) also indicate that for flammable gas Watch List Tanks, the tank headspace must remain below 25% of the LFL. Tank Farm Operations are using the 20% LFL for their workplans and this value is reflected in this evaluation.]

For high-organic tanks that are on the Flammable Gas Watch List, follow-on studies will be required to quantify the hazard posed by episodic releases from these tanks. In addition to the LFL control noted above, it may be necessary to choose a "safe window" and employ operating procedures applicable to flammable atmospheres.

4.4.2 Controls Applicable to Pool Fires

For tanks that potentially contain an organic phase at the air-waste interface, it shall be assumed that wicks are present and additional precautions shall be taken to preclude ignition sources. Ignition sources that must be controlled include: (1) energetic sparks, (2) open flames, and (3) hot debris from grinding.

4.4.3 Controls Applicable to Solid Waste Reactions

Pump installation, operation, and removal should be done in a manner that will avoid the heating of the solid waste to reaction onset temperatures. The specific pump installation and operation procedure should be reviewed to ensure that normal operation and credible accidents would not lead to the heating of solid waste to reaction onset temperatures.

4.4.4 Controls to Prevent Mixing of Separable Organic Liquid Phase

Interim stabilization of 241-C-103 has not been adequately evaluated. However, should emergency pumping of C-103 be directed, it is recommended that pumping techniques preclude intermingling of the organic liquid with the solid waste. This would prevent the possible creation of a new hazard, the potential for a pool fire that could initiate an organic-nitrate/nitrite reaction (Postma and Kummerer 1993).

Additional analyses are underway to consider interim stabilization of tank 241-C-103 without previous removal of the liquid organic layer. Until results are available, this activity is not presently supported by existing safety analyses.

4.4.5 Monitoring of Pumped Tanks

Controls and monitoring required to ensure that the drained waste does not become unstable are identified in WHC-SD-WM-TI-579 (Postma and Kummerer 1993). Key hazards of focus are as follows: (1) a deflagration in headspace air and (2) a runaway or propagation reaction in solid waste.

4.4.5.1 Headspace Gas Flammability. Combustible gases are not expected to build to flammable levels and are expected to be less of a threat after pumping. To confirm that deflagrations are not a problem, headspace air should be analyzed for combustible gas concentrations on a regular schedule. The schedule should require testing at high frequencies during and immediately after pumping. If combustible concentrations remain below 20% LFL as anticipated, the duration between tests could be lengthened as time passes.

Detailed analysis of trace level gases is not needed. Rather, the sum of combustibles, measured by a calibrated and proven flammability, is what is needed. If combustibles were to exceed 20% LFL level, the gas phase should be purged with atmosphere air to lower the concentration to less than 20% LFL.

Flammable Gas Watch List Tanks are a special case because of the potential for episodic releases. For the tanks on both the Flammable Gas Watch List and the Organic Watch List, controls applicable to Flammable Gas

Watch List Tanks would need to be applied in addition to the controls for Organic Watch List Tanks.

4.4.5.2 Monitoring Related to Solid Waste Runaway Reactions. The following monitoring efforts are prescribed to detect the early stages of unexpected waste heatup.

Temperature in Waste. Temperatures in waste, as measured by installed thermocouples, should be monitored for unexpected temperature increases.

Moisture Content of Waste. In situ moisture levels should be measured using neutron scans or other available methodology.

Moisture Loss Rate by Air Outleakage. The rate of moisture loss from the tank in-ventilation-air needs to be quantified by paper analyses and/or experimental measurements that define both the gas flow rate and the moisture content of outgoing air. If tanks are passively ventilated, then natural convention through leaks that bypass High-Efficiency Particulate Air (HEPA) filters can dominate. If is suggested that tracer techniques be used to measure headspace ventilation rates if paper analyses indicate that significant drying of waste could occur.

4.4.6 Response to Unanticipated Changes Following Pumpout

Organic Watch List Tanks that have been pumped will be monitored to detect unanticipated changes in storage conditions. Key parameters will include the following:

- Combustible gas concentrations in headspace air
- Temperatures in solid waste and headspace air
- Moisture loss from waste.

Potential responses to unexpected changes in these parameters are discussed within WHC-SD-WM-TI-579 (Postma and Kummerer 1993) and should be referred to in case monitoring results indicate unexpected conditions.

4.5 AUTHORIZATION BASES FOR INTERIM STABILIZATION OF WATCH LIST TANKS

The *Hanford Site Tank Farm Facilities Interim Safety Basis* (ISB) (Leach and Stahl 1993) was approved as the Tank Farms' "authorization basis" in accordance with Department of Energy (DOE) Order 5480.21 via DOE letter from J. D. Wagoner to the President of WHC dated November 18, 1993. Specifically, Chapter 6 of the ISB and the associated safety bases documentation referenced therein were accepted for the purposes of Unreviewed Safety Question (USQ) determinations, resolving USQ program issues, and authorizing new emerging activities.

Incorporated as part of the ISB is Safety Analysis Report SD-WM-SAR-034, *Stabilization of Single-Shell Waste Storage Tanks by Saltwell Jet Pumping* (Hanson and LaRiviere 1989). This document provided the initial safety basis for conduct of interim stabilization activities as part of normal operations of Hanford Site Tank Farms. Several analyses supporting the interim stabilization safety basis have been updated since initial issuance of

SD-WM-SAR-034, as referenced within the Tank Farms' ISB. The results of these analyses, and corresponding limitations, controls, and restrictions provide assurance that interim stabilization of the SSTs can continue to be conducted safely, in conformance with the authorization bases. New safety issues, or potential discoveries, associated with interim stabilization activities are screened and/or evaluated as potential Unreviewed Safety Questions against documentation referenced within the Tank Farms' ISB. If it is determined that the issue is not adequately addressed within the existing safety documentation and authorization bases, a USQ is declared and DOE is informed.

On November 5, 1990, the U.S. Congress passed Public Law 101-510. Section 3137, "Safety Measures for Waste Tanks at Hanford Nuclear Reservation," is a portion of that law that addresses safety issues concerning the handling of high-level nuclear waste in storage tanks at the Hanford Site.

Section 3137 specifically addresses the issues concerning Hanford Site tanks by directing that the Secretary of Energy take the following actions:

- Identify those tanks that "...may have a serious potential for release of high-level waste due to uncontrolled increases in temperature or pressure..."

- Ensure that "...continuous monitoring to detect a release or excessive temperature or pressure..." is being carried out

- "...develop action plans to respond to excessive temperature or pressure or a release from any tank identified..."

- Restrict additions of high-level nuclear wastes to the identified tanks unless no safer alternative exists or the serious potential for a release of high-level nuclear waste is no longer a threat.

An effort was undertaken at the Hanford site to identify those tanks that may have a serious potential for release of high-level waste due to uncontrolled increases in temperature or pressure. Tanks identified as having "issues and/or situations that contain <u>most</u> of the necessary conditions that could lead to worker (onsite) or offsite radiation exposure through an uncontrolled release of radioactive waste, e.g., tank 241-SY-101" (Wilson and Reep 1991) were identified as WHC Priority 1 Safety Issues, and included on a Hanford Site Watch List.

Although Section 3137 does not specifically exclude interim stabilization activities, including the removal of pumpable liquid from the SST Watch List Tanks, WHC has imposed restrictions on transfers of wastes from the Watch List Tanks via OSD-T-151-00030, *Operating Specifications for Watch List Tanks* (WHC 1994b). As noted within this document, Hydrogen/Flammable Gas Tanks, Ferrocyanide Tanks, and Organic Tanks have a specification limit that requires written approval from DOE for transfers of waste out of these tanks.

The restrictions on interim stabilization imposed via OSD-T-151-00030 were intended to remain in place until such time that the associated safety issues were better understood. WHC has conducted numerous analyses that provide technical bases for safe conduct of interim stabilization on several categories of Watch List Tanks. The results of these analyses have been provided to the DOE. Safety issues that were determined to not have an adequate technical bases for conduct of operations under the existing authorization bases, were declared USQs. USQs were declared on the topics of Ferrocyanide Watch List Tanks, Flammable Gas Watch List Tanks, and one Organic Watch List Tank (241-C-103) that contained a floating organic layer. The Ferrocyanide Tank USQ and the Organic Tank USQ have since been approved for closure by DOE. The Flammable Gas USQ remains open.

Although the USQs for Ferrocyanide Watch List Tanks and Organic Tank 241-C-103 were approved for closure by DOE, additional restrictions and limitations were imposed upon these tanks. Closure of the ferrocyanide USQ by DOE (Sheridan 1994) included acknowledgement that the closure did not resolve the Ferrocyanide Safety Issue. Likewise, closure of the tank 241-C-103 USQ by DOE (Grumbly 1994) included restrictions on activities not authorized by DOE. Restrictions and limitations imposed by DOE relative to Watch List Tanks are discussed below.

4.5.1 Ferrocyanide Watch List Tanks

The Ferrocyanide USQ was declared closed via letter (Sheridan 1994) dated March 4, 1994. The closure of the Ferrocyanide USQ included a statement that resolution will require characterization of the ferrocyanide tank waste to confirm that the criteria outlined in WHC-EP-0691 (Postma et al. 1994b), *Ferrocyanide Safety Program: Safety Criteria for Ferrocyanide Watch List Tanks*, are met. Also, the necessary monitoring, controls, and procedures must be in place to ensure that operations are conducted within the criteria prior to resolution of the Ferrocyanide Safety Issue. As a result of ferrocyanide waste simulant testing programs and waste characterization conducted as noted within this report, WHC has concluded that interim stabilization of the Ferrocyanide Watch List Tanks can be performed safely, and the safety criteria will be met following interim stabilization. WHC has since revised the Tank Farms' ISB to note that interim stabilization of the Ferrocyanide Watch List Tanks is considered to be part of the authorization bases for permitted activities. Therefore, no additional DOE approval for interim stabilization of the Ferrocyanide Watch List tanks is deemed necessary.

4.5.2 Organic Watch List Tanks

The Organic Watch List Tank 241-C-103 USQ was declared closed via letter (Grumbly 1994) dated May 19, 1994. The letter noted that several activities planned for future mitigation and remediation of Tank 241-C-103 had not been evaluated in the Safety Analysis. Those activities (listed below) are not authorized by the DOE approval to close the USQ.

ACTIVITIES NOT AUTHORIZED BY USQ CLOSURE ON TANK 241-C-103

A) Installation or removal of a liquid observation well

B) Installation or removal of a thermocouple tree

C) Installation or removal of a transfer pump

D) Installation or removal of a saltwell screen

E) Removal of the floating organic layer.

Before initiating any work on or in tank 241-C-103 that is not authorized by DOE approval, required safety evaluations are to be performed by WHC as well as applicable USQ Screenings/Evaluations to ensure that the activities are covered by the current Authorization Basis (ISB).

Another DOE Letter (Gerton 1993) dated September 13, 1993 also provided information relative to the authorization status for interim stabilization of Organic Watch List Tanks. This letter noted that the organic tanks which have not been interim stabilized can be divided into three groups:

1. Tanks containing organic materials, but which do not have a floating organic layer, and do not also have combustible gas concerns. This category includes tanks 241-U-106, -107, and -111. There are no USQs associated with the organic content of these tanks. [Note that tank 241-U-107 has since been added to the Flammable Gas Watch List.]

2. Tanks containing organic materials that do not have a floating organic layer, but do have combustible gas generation concerns, and therefore are also on the flammable gas Watch List. These include tanks 241-S-102 and 241-SX-106. The flammable gas issue has been declared a USQ.

3. Tanks containing a floating organic layer. Only tank 241-C-103, is in this group. The floating organic layer was previously declared a USQ.

The letter notes that the analysis to conclude that interim stabilization of tanks 241-U-106, -107, and -108 will not result in unacceptable risks was not complete. Once the analysis was complete, results were to be used along with existing safety analyses to perform a USQ Evaluation of interim stabilization of the tanks. Unless the USQ evaluation concluded that interim stabilization is a USQ, authorization to interim stabilize the three tanks was not required from DOE.

Analyses to address Organic Watch List Tanks was documented in WHC-EP-0681 (Babad and Turner 1993), *Interim Criteria for Organic Watch List Tanks at the Hanford Site* and WHC-SD-WM-TI-579 (Postma and Kummerer 1993), *Technical Basis and Guidelines for Pumping of High-Organic Waste Tanks That Develop Leaks*. Both of these reports have been submitted to DOE. To date, no documentation of DOE approval of these reports has been received by WHC.

Therefore, information contained therein cannot be considered to be part of the "authorization basis." However, results presented within these two documents are being used by WHC in conjunction with existing safety analyses consistent with the DOE Letter, to determine if a USQ exists relative to interim stabilization of Organic Watch List Tanks.

Results of these USQ Evaluations have been documented to justify interim stabilization of tank 241-T-111 and tank 241-C-102. The USQ Evaluations determined that the tanks contained organic materials, but they did not have a floating organic layer, nor combustible gas concerns, nor any other previously unanalyzed hazards not addressed in the authorization basis. WHC concluded that these tanks met the criteria of the Group 1 Organic Tanks and hence no additional authorization from DOE was necessary to interim stabilize these tanks.

WHC will continue to perform USQ Screenings/Evaluations for Organic Watch List Tanks scheduled for interim stabilization. If the results of the screenings and evaluations indicate that no USQ exists relative to the DOE approved "authorization basis" (ISB), then no additional DOE approval for interim stabilization is deemed necessary. However, in those cases where potential safety issues which are not addressed within the "authorization basis" remain unresolved (e.g., tank 241-C-103 floating organic layer) interim stabilization will not be commenced unless WHC concludes that it can be performed safely, and prior DOE approval is obtained.

4.5.3 Flammable Gas Watch List Tanks

The Flammable Gas USQ has not yet been closed. Therefore, there is no existing authorization basis for interim stabilization of the Flammable Gas Watch List Tanks.

WHC has issued WHC-SD-WM-SARR-004 (Van Vleet 1994), *Safety Basis for Activities in Single-Shell Flammable Gas Watch List Tanks* for DOE review and approval. Once DOE approval is obtained, this document will become part of the "authorization basis" against which USQ determinations regarding interim stabilization of Flammable Gas Watch List Tanks could be based.

As noted in Section 3.1, certain safety issues associated with Flammable Gas Watch List Tanks remain unresolved. As with the other Watch List Tanks, WHC will perform USQ Screenings/Evaluations of Flammable Gas Watch List Tanks prior to interim stabilization to determine if the activities are considered safe and addressed within the scope of the "authorization basis." In those cases where interim stabilization is considered safe but not addressed within the "authorization basis," DOE approval will be obtained prior to initiation of interim stabilization.

5.0 STABILIZATION PLANS

The Tri-Party Agreement SST Stabilization Schedule is identified in WHC-EP-0182-78 (Hanlon 1994), *Tank Farm Surveillance and Waste Status Summary Report*, Latest Revision. The following table provides the present interim stabilization schedule for Watch List SSTs. Tank C-106, a High-Heat Watch List Tank, is not included on this schedule as there are no present plans for interim stabilization of this tank. Non-Watch List Tanks are also not identified on this table, although it is planned that they are to be interim stabilized.

Table 5.0-1
TPA SST STABILIZATION SCHEDULE FOR WATCH LIST TANKS

TANKS	START DATE	END DATE	TPA MILESTONE
T-111	5/94	3/95	M-41-16A
C-102	9/94	12/94	M-41-01-T1
A-101, AX-101	4/96	12/98	M-41-10
U-103, -105, -108, -109	4/96	5/97	M-41-11
BX-106, BY-103, -105, -106	4/97	9/98	M-41-12
U-106, -107[1], -111	7/95	12/96	M-41-13
S-111, -112, SX-101, -102, -103, -104, -105	6/97	11/99	M-41-14
S-102, SX-106	6/97	3/99	M-41-15
T-107	4/98	5/98	M-41-17
T-110	4/98	7/98	M-41-18
C-103	9/98	3/99	M-41-19

(1) Tank 241-U-107 has been added to the Flammable Gas Watch List since issuance of this schedule. The schedule will need to be revised to reflect this.

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APPENDIX A

APPLICABLE SAFETY ANALYSES

The following listing identifies safety analyses that address hazards associated with interim stabilization of Watch List SSTs. Included with the document identification is a summation abstract, and in some cases, summary conclusions stated within the documents.

GENERAL:

Bajwa, J., and W. Farley, 1994, *Construction/Maintenance Activities and Operations Analysis Summaries*, WHC-SD-WM-SARR-009, Revision 0, Westinghouse Hanford Company, Richland, Washington.

Abstract: The document covers minor modifications to the Tank Farm facilities, routine Tank Farm maintenance activities, and installation/operation/removal of Tank Farm instrumentation. It lists the accidents and consequences, summarized the analysis related to these activities, and references the controls to minimize the safety risks to Tank Farm workers and offsite personnel.

Leach, C. E., and S. M. Stahl, 1993, *Hanford Site Tank Farm Facilities Interim Safety Basis*, WHC-SD-WM-ISB-001, Revision 0B, Westinghouse Hanford Company, Richland, Washington.

Abstract: The Tank Farms Interim Safety Basis document provides a ready reference to the tank farms safety envelope. The safety envelope constitutes the technical basis for safe operation and maintenance of tank farm facilities, equipment, and processes. The ISB is intended to facilitate understanding of the safety envelope and its corresponding justification, until formalized Safety Analysis Report upgrades can be completed in accordance with recently issued DOE requirements. This information is intended to be utilized for consideration of proposed changes, tests, or experiments to determine any potential adverse effects on the existing safety envelope.

Stahl, S. M., 1992, *Safety Study of Interim Stabilization of Nonwatchlist Single-Shell Tanks*, WHC-SD-WM-RPT-048, Revision 0, Westinghouse Hanford Company, Richland, Washington.

Abstract: Document provides the results of a study conducted to evaluate the safety of interim stabilization by saltwell jet pumping of the nonwatchlist single-shell tanks (241-S-101, -103, -106, -107, -108, -109, -110; 241-T-104, -111; 241-U-102, -111). The safety study results provide identification of safety issues that had been previously evaluated for the nonwatchlist tanks, as well as other issues that required further study to support an educated decision on the safety of continuing interim stabilization activities.

APPENDIX A

ORGANICS:

Babad, H., and D. A. Turner, 1993, *Interim Criteria for Organic Watch List Tanks at the Hanford Site*, WHC-EP-0681, Revision 0, Westinghouse Hanford Company, Richland, Washington.

Abstract: The document establishes interim criteria for identifying single-shell radioactive waste storage tanks at the Hanford site that contain organic chemicals mixed with nitrate/nitrite salts in potentially hazardous concentrations. The criteria are not intended to be used, in their present state of development, for resolution of the organic tanks safety issue. Additional laboratory testing, waste characterization data, and technical analyses are required to support safety issue resolution in a satisfactory manner.

Guthrie, R. L., 1993, *Hazard and Accident Initiator Evaluation for Interim Stabilization of Organic Watch List Tanks*, WHC-SD-WM-SAD-023, Revision 0, Westinghouse Hanford Company, Richland, Washington.

Abstract: Document identified potential hazards associated with Interim Stabilization of Single Shell Tanks on the Organic Watch List.

Kummerer, M., and A. K. Postma, 1993, *Technical Basis and Guidelines for Pumping of High Organic Waste Tanks that Develop Leaks*, WHC-SD-WM-TI-579, Revision 0, Westinghouse Hanford Company, Richland, Washington.

Abstract: The document presents the technical basis and guidelines for pumping high organic Watch List single shell tanks that develop leaks.

Conclusion: While much of the information needed to completely resolve all associated safety issues does not exist, what is known indicates that the solid waste will remain passively cooled and chemically stable after pumpable liquid is removed.

Leach, C. E., and S. M. Stahl, 1993, *Hanford Site Tank Farm Facilities Interim Safety Basis*, WHC-SD-WM-ISB-001, Revision 0B, Section 5,2, "Interim Safety Basis Topical Report, High-Organic Waste Tanks," Westinghouse Hanford Company, Richland, Washington.

Abstract: The objective of the topical report was to describe the key hazards associated with storing high-organic wastes at the Hanford site. Issues addressed included identification of the safety issues, phenomenology of each issue, criteria needed to define conditions for safety storage, and identification of key uncertainties that need to be closed to resolve the safety issue.

Conclusions: Waste temperatures need to be maintained well below reaction threshold temperatures. Water content is a key factor in separating waste compositions between those that will sustain a propagating reaction and those that will not. It is important to prevent the reactivity of organic wastes locally to reaction threshold temperatures. The issue of surface fires in tanks that formally held organic liquids (e.g., should be revisited. The concern is that the upper surface of the waste may contain salt cake saturated with organic

liquid, an admixture that may be easier to ignite than a liquid pool without wicks.

Postma, A. K., and D. B. Bechtold, G. L. Borsheim, J. M. Grigsby, R. L. Guthrie, M. Kummerer, M. G. Plys, D. A. Turner, 1994, *Safety Analysis of Exothermic Reaction Hazards Associated With the Organic Liquid Layer in Tank 241-C-103*, WHC-SD-WM-SARR-001, Revision 0, Westinghouse Hanford Company, Richland, Washington.

Abstract: Safety hazards associated with the interim stabilization of a potentially flammable organic liquid in waste tank C-103 are identified and evaluated. The technical basis for closing the unreviewed safety question (USQ) associated with the floating liquid organic layer in this tank is presented.

Conclusions: Because the methods to be used to remove the liquid are not yet well defined, hazards involved in the removal operation are not considered within the document.

Sawtelle, G. R., *Transmittal of Unreviewed Safety Question Safety Evaluation TF-94-0189, "Jet Pump Installation and Operation for Pumping Tank 241-T-111," Revision 3*, Internal Memo 8D114-GRS-94047, Westinghouse Hanford Company, Richland, Washington.

Abstract: The document evaluates whether the proposed jet pumping activity is covered by the existing safety envelope for organic tanks. The evaluation includes a review of the equipment and methodology developed for the activity, a correlation to other safety documentation and application of the questions used to determine if an unreviewed safety question exists. It includes consideration of installation and operation of the jet pump assembly and the activation of the pump pit leak detector elements.

Conclusion: Based on the sludge moisture content, the propensity for the waste to contain interstitial water, and the potential for moisture loss during pumping, long-term evaporation, and hypothetical tank leakage, pumping Tank 241-T-111 is not a hazard, and will remain safe after interim stabilization. The high moisture content will provide for safety storage of the tank. Based upon the safety evaluation, it is concluded that the hazards associated with the installation and operation of the jet pump have been analyzed and the activity is bounded by the existing safety envelope and may be accomplished safety by utilizing the controls already established in existing safety analysis documentation.

Stahl, S. M., 1994, *Transmittal of USQ Evaluation for Interim Stabilization of Tank 241-C-102 (USQ No. TF-94-0280)*, Internal Letter 8D112-SMS-94042 dated August 11, 1994, Westinghouse Hanford Company, Richland, Washington.

Abstract: The USQ evaluation was intended to determine if interim stabilization of 241-C-102 is enveloped by existing safety analysis and within the limits of the Hanford Site Tank Farms existing "authorization basis." Tank 241-C-102 is currently being treated as a Watch List Tank,

relative to tank intrusive activities. A safety concern exists, related to the potential for a fire on the "dry" surface of the waste in this tank, due to the presence of absorbed (interstitially bound) organic liquid.

Conclusion: Tank 241-C-102 has been identified as an Organic Watch List Tank because it previously contained an organic liquid layer which was subsequently removed. Waste within tank 241-C-102 relative to waste organic content, moisture retention capacity, and waste temperature identify the tank status as "Safe" relative to Interim Criteria for Organic Watch List Tanks. The possibility that the sludge waste surface of C-102 may have been saturated with organic liquid, making it more prone to ignition and subsequent burning was considered. The more volatile organics which may have remained following removal of the organic liquid layer in tank C-102 would be expected to have evaporated. Interim stabilization of C-102 would have little effect on the waste surface of C-102 since the liquid level of the waste to be pumped is well below the waste surface level. Interim stabilization processes are not expected to introduce any new ignition sources into tank C-102 that could ignite the waste surface. There were no additional controls imposed as a result of this USQ evaluation.

FERROCYANIDE:

Kummerer, M., 1993, *Safety Assessment for Interim Stabilization of Ferrocyanide Tanks*, WHC-SD-WM-SAD-018, Revision 2, Westinghouse Hanford Company, Richland, Washington.

Abstract: The document presents a safety assessment which examines the existing safety analysis of interim stabilization of single shell tanks, and discusses the additional potential hazards arising from the reactive nature of the waste components in ferrocyanide tanks.

Milliken, N. J., 1992, *Transmittal of Revised USQ Screening/Safety Evaluation for Emergency Pumping Tank 241-T-101 Using a Submersible Pump with Installation of Saltwell Screen*, 29120-NJM-92002, Westinghouse Hanford Company, Richland, Washington.

Abstract: The document evaluates whether the installation of pumping equipment (including the addition of a saltwell screen) and the proposed substitution of a submersible pump for a jet pump are covered by the existing safety analysis documentation for ferrocyanide tanks. The evaluation includes: a review of the equipment and methodology developed for the activity, a correlation to other safety documentation, and application of the questions used to determine if an unreviewed safety question exists relative to the installation of the pumping equipment and the submersible pumping of Tank 101-T.

Postma, A. K., 1994, *Ferrocyanide Safety Program: Safety Criteria for Ferrocyanide Watch List Tanks*, WHC-EP-0691, Revision 0, Westinghouse Hanford Company, Richland, Washington.

APPENDIX A

Abstract: Document provides safety criteria to ensure interim safe storage of ferrocyanide waste and the technical basis for closure of the Ferrocyanide Unreviewed Safety Question.

FLAMMABLE GASES:

Cowley, W. L., 1993, *Hazard and Accident Initiator Evaluation for Interim Stabilization of Hydrogen Watch List Tanks*, WHC-SD-WM-SAD-022, Revision 0, Westinghouse Hanford Company, Richland, Washington.

Abstract: The document identifies potential hazards associated with Interim Stabilization of Single Shell Tanks on the Hydrogen Watch List.

Guthrie, R. L., 1994, *Interim Stabilization Pumping Guidelines for Single Shell Tank Watch List Tanks Containing Flammable Gas*, WHC-SD-WM-TI-637, Revision 0, Westinghouse Hanford Company, Richland, Washington.

Abstract: The document provides the pumping guidelines for interim stabilizing Flammable Gas Watch List Single Shell Tanks. All activities required to interim stabilize or support stabilization of a Flammable Gas Watch List Single-Shell Tank (SST) are listed. These activities are either approved, not approved, or have not been analyzed for Flammable Gas Watch List SSTs and are listed as such.

Los Alamos National Laboratory, *Safety Assessment for Proposed Pump Operation to Mitigate Episodic Gas Releases in Tank 241-SY-101*, LAUR-92-3196, Revision 8, Los Alamos, New Mexico.

Abstract: The document is applicable to Double-Shell Tank 241-SY-101, which is not included in the interim stabilization effort scope. However, certain of the safety assessment results can also be applied to flammable gas generation safety issues within single-shell tanks. The safety assessment addresses each of the elements required to install, operate, and remove a mixing pump in 101-SY. The objective of the safety assessment was to (1) systematically identify each of the potential hazards, (2) analyze each of the resultant accident sequences, (3) assess the consequences of the accident sequences, and (4) identify the controls and procedures necessary to eliminate or reduce the potential hazards.

Van Vleet, R. J., 1994, *Safety Basis for Activities in Single-Shell Flammable Gas Watch List Tanks*, WHC-SD-WM-SARR-004, Revision 0, Westinghouse Hanford Company, Richland, Washington.

Abstract: The document provides the basis for certain activities that will be performed in single-shell flammable gas watch list tanks, The document covers the standard hydrogen monitoring systems; vapor space sampling; still photography; instrument tree installation; saltwell screen installation; liquid observation well installation; jet pump installation, repair and removal; auger and push-mode sampling. Hazards are identified and evaluated, consequences are calculated and controls to mitigate or prevent the accidents are developed.