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Control Decisions for Flammable Gas Hazards in Double-Contained Receiver Tanks (DCRTs)

L.J.Kripps

H&R Technical Associates

Richland, WA 99352

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Control Decisions for Flammable Gas Hazards in Double-Contained Receiver Tanks (DCRTs)

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

CH2MHILL
Hanford Group, Inc.

Richland, Washington

Contractor for the U.S. Department of Energy
Office of River Protection under Contract DE-AC06-99RL14047

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Date Published
June 2000

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

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LIST OF TERMS

AC	Administrative Control
ALARA	as low as reasonably achievable
D&D	decontamination and decommissioning
DCRT	double-contained receiver tank
DOE	U.S. Department of Energy
DST	double-shell tank
FSAR	Final Safety Analysis Report
GRE	gas release event
HEPA	high-efficiency particulate air (filter)
LCO	limiting condition for operation
LFL	lower flammability limit
O&M	operations and maintenance
ORP	Office of River Protection
PFP	Plutonium Finishing Plant
PNNL	Pacific Northwest National Laboratory
RCRA	<i>Resource Conservation and Recovery Act of 1976</i>
SHMS	Standard Hydrogen Monitoring System
SC	Safety-Class
SSC	structure, system, and component
SST	single-shell tank
TSR	Technical Safety Requirement
TWRS	Tank Waste Remediation System
USQ	Unreviewed Safety Question

CONTROL DECISIONS FOR FLAMMABLE GAS HAZARDS IN DOUBLE-CONTAINED RECEIVER TANKS

This report describes the control decisions for flammable gas hazards in double-contained receiver tanks (DCRTs) made at control decision meetings on November 16, 17, and 18, 1999, on April 19, 2000, and on May 10, 2000, and their basis. These control decisions, and the analyses that support them, will be documented in an amendment to the Final Safety Analysis Report (FSAR) (CHG 2000a) and Technical Safety Requirements (TSR) (CHG 2000b) to close the Flammable Gas Unreviewed Safety Question (USQ) (Bacon 1996 and Wagoner 1996) for DCRTs. Following the contractor Tier I review of the FSAR and TSR amendment, it will be submitted to the U.S. Department of Energy (DOE), Office of River Protection (ORP) for review and approval.

The control decision meetings on November 16, 17, and 18, 1999, to address flammable gas hazards in DCRTs, followed the control decision process and the criteria for control decisions described in Section 3.3.1.5 of the FSAR. The control decision meeting agenda, attendance lists, and the introductory and background presentations on November 16, 1999, are included in Attachments 1 through 4. The control decision discussions on November 17 and 18, 1999, on existing and possible controls for flammable gas hazards in DCRTs and the basis for selecting or not selecting specific controls, are summarized in this report.

The agenda, attendance list, and the purpose, scope, and process for the April 19, 2000 control decision meeting, and the presentations at that meeting related to flammable gas hazards in DCRTs are included in Attachment 5. At this control decision meeting previous control decisions were reviewed and revised based on revisions to the DCRT flammable gas accident analysis presented at the November 16, 17, and 18, 1999 meetings and on new predictions of flammable gas concentrations that incorporated new ammonia solubility data. These control decision discussions are summarized in this report.

Attachment 6 contains the attendance list and the results of flammable gas concentration predictions that were presented to support control decisions at the May 20, 2000 meeting for flammable gas hazards in 244-CR Vault Tank 003. These control decision discussions are summarized in this report.

Section 1.0 describes the DCRTs that are included within the scope of the control decisions documented in this report. The focus of Section 1.0 is the current and future planned use of DCRTs. Sections 2.0 and 3.0 summarize the hazard and accident analyses of flammable gas hazards in DCRTs that supported the control decisions. Existing and possible controls that were considered to prevent or mitigate DCRT flammable gas hazards are identified and discussed in Section 4.0. Section 5.0 summarizes the control decisions and the basis for the selected controls.

1.0 DOUBLE-CONTAINED RECEIVER TANKS DESCRIPTION

DCRTs are interim, short-term (lag) storage facilities and valve pits for waste transfer operations. A DCRT typically consists of an underground concrete structure that contains a vault in which the receiver tank is installed and associated filter pit, pump pit, instrument pit, and/or flush pit (see Figures 1-1 and 1-2). DCRTs include 244-A and 244-BX located in the 200 East Area and 244-S, 244-TX, and 244-U located in the 200 West Area. The 244-CR Vault located in the 200 East Area also contains one tank (Tank 003) that is identified in the FSAR as a DCRT.^a Table 1-1 summarizes information on the location, capacity, configuration, and operation date of these DCRTs.

DCRTs 244-A, 244-BX, 244-S, 244-TX, and 244-U each have a ventilation system with an exhaust fan that provides flow through the DCRT vault and suction to the receiver tank. Except for DCRT 244-U, which has a filtered inlet path to the receiver tank, there is no designed inlet flow path to the DCRT receiver tanks. Because of the DCRT ventilation system design, the ventilation flow through the receiver tanks cannot be measured and is unknown.^b The only assured flow to the DCRT receiver tanks is provided by instrument air injected via three small pipes (known as dip-tubes) as part of the DCRT weight factor and specific gravity liquid-level monitoring system.

Additional design information on the DCRTs, including 244-CR Vault Tank 003, and their ventilation systems is contained in Section 2.4.5 of the FSAR.

Because of its importance to potential flammable gas hazard control decisions, the current and planned future use of each DCRT is described below and summarized in Table 1-2.

1.1 DOUBLE-CONTAINED RECEIVER TANK 244-A

DCRT 244-A is a lift station located at a low point in the 200 East Area waste transfer system. It serves as a catch tank for waste transfers which pass through the 244-A pump pit (i.e., cross-site transfers and transfers from DCRT 244-BX). That is, it receives drainage from transfer line holdup when jumpers are changed and also would receive waste from transfer line leaks. The W-314 project plans include construction of a cross-site transfer line bypass around DCRT 244-A, but the schedule for completion of this bypass is not certain.

^a The 244-CR Vault Tank 003 was not included in the scope of the November 16, 17, and 18, 1999 control decision meetings, but was addressed at the April 19 and May 20, 2000 control decision meetings.

^b HNF-2923, *Headspace Gas Concentration Measurements and Headspace Ventilation Rate Measurements for Double-Contained Receiver Tanks 241-A-244, 241-BX-244, 241-S-244, and 241-TX-244*, Revision 0-B, Lockheed Martin Hanford Corporation, September 1999, reports the results of ventilation rates estimated for DCRTs based on the measured decay rate of tracer gas injected as part of a test. Ventilation rate measurements ranged from 0.45 cfm to 14 cfm.

1.2 DOUBLE-CONTAINED RECEIVER TANK 244-BX

DCRT 244-BX will receive waste from salt well pumping of Tanks 241-BY-105 and 241-BY-106. The salt well pumping of these tanks is scheduled to start in early calendar year 2001 and be completed by mid-calendar year 2003. This schedule meets the consent decree schedule for the completion of single-shell tank (SST) interim stabilization which calls for the pumping of Tanks 241-BY-105 and 241-BY-106 to be initiated by July 15, 2001, with projected pumping completion by June 30, 2003.

1.3 DOUBLE-CONTAINED RECEIVER TANK 244-S

DCRT 244-S receives waste transfers from the 222-S Laboratory, may receive waste from salt well pumping of 241-S and 241-SX Tank Farm tanks (backup route^c), and could receive waste from pumping out catch tanks 241-UX-302A and 241-S-304. DCRT 244-S also serves as a catch tank for DCRT 244-TX transfers which pass through the 244-S pump pit (i.e., receives drainage from DCRT 244-TX transfer line holdup when jumpers are changed and also would receive waste from DCRT 244-TX transfer line leaks).

Waste transfers from the 222-S Laboratory are planned to continue for the next 20 to 30 years, but salt well transfers from 241-S or 241-SX Tank Farm tanks are scheduled to be completed by late calendar year 2003. (Note: The consent decree schedule for SST interim stabilization requires all salt well pumping to be completed by September 30, 2004). The W-314 project plans include an upgrade to the DCRT 244-S ventilation system to meet environmental requirements, but the schedule for completion of this upgrade is not certain. Because of the high estimated costs to meet environmental requirements for continuing long-term use of DCRT 244-S for 222-S Laboratory waste transfers, alternatives that would bypass DCRT 244-S are being considered.

1.4 DOUBLE-CONTAINED RECEIVER TANK 244-TX

Salt well pumping of Tank 241-T-104 and Tank 241-T-110 is complete. Therefore, DCRT 244-TX only receives waste from the Plutonium Finishing Plant (PFP). Because the plans for PFP waste transfers extend beyond the date when DCRT 244-TX transfer lines (incoming and outgoing) would have to be upgraded to meet the *Resource Conservation and Recovery Act of 1976* (RCRA) requirements, alternative methods of transferring PFP waste to tank farm facilities are being considered (e.g., by truck).

1.5 DOUBLE-CONTAINED RECEIVER TANK 244-U

DCRT 244-U may receive waste from salt well pumping of 241-U Tank Farm tanks (backup route^d) and could receive waste from pumping out catch tank 241-U-301B. (Note: DCRT 244-U

^c The planned transfer route for salt well pumping of 241-S and 241-SX Tank Farm tanks bypasses DCRT 244-S. However, DCRT 244-S is considered as a backup route.

^d The planned transfer route for salt well pumping of 241-U Tank Farm tanks bypasses DCRT 244-U. However, DCRT 244-U is considered as a backup route.

has never been placed into service and contains only water.) The salt well pumping of 241-U Tank Farm tanks is ongoing and is scheduled to be completed by mid-calendar year 2003. This schedule meets the consent decree schedule for the completion of all SST interim stabilization by September 30, 2004.

1.6 244-CR VAULT TANK 003

244-CR Vault Tank 003 is identified in the FSAR as a DCRT based on its potential use for short-term storage of salt well waste from the 241-C Tank Farm. Tank 241-C-103 is the only tank remaining in the 241-C Tank Farm requiring interim stabilization (i.e., salt well pumping). Because this tank contains a floating organic layer, it is considered unlikely that DCRT 244-CR-003 would be used for transferring the organic layer or the pumpable liquids from this tank. The only waste transfers to 244-CR Vault Tank 003 expected are transfers of pumpable liquids from other 244-CR Vault tanks and sumps that are planned for interim stabilization of the 244-CR Vault.

Figure 1-1. Typical Double-Contained Receiver Tank
(244-S; 244-A similar but smaller).

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Figure 1-2. Typical Double-Contained Receiver Tank
(244-BX, 244-TX, and 244-U).

Table 1-1. Double-Contained Receiver Tanks Location, Capacity, and Configuration

DCRT	Location	Capacity	Configuration	Operation Date
244-A	200 East Area – West of the 241-AN Tank Farm	61,627 L (16,280 gal)	Vertical receiver tank design similar to but smaller than DCRT 244-S (see Figure 1-1)	1975
244-BX	200 East Area – East of Tank 241-BX-102 in the 241-BX Tank Farm	117,350 L (31,000 gal)	Horizontal receiver tank design similar to DCRTs 244-TX and 244-U (see Figure 1-2)	1981
244-S	200 West Area – South of the 241-SY Tank Farm and east of 13 th Street	76,768 L (20,280 gal)	Vertical receiver tank design similar to but larger than DCRT 244-A (see Figure 1-1)	1978
244-TX	200 West Area – North of 241-TX Tank Farm	117,350 L (31,000 gal)	Horizontal receiver tank design similar to DCRTs 244-BX and 244-U (see Figure 1-2)	1981
244-U	200 West Area – Southeast of Tank 241-U-110 in the 241-U Tank Farm	117,350 L (31,000 gal)	Horizontal receiver tank design similar to DCRTs 244-BX and 244-TX (see Figure 1-2). (Note: DCRT 244-U has the only receiver tank with a filtered inlet.)	a
244-CR Vault Tank 003	200 East Area – South of the 241-C Tank Farm	56,781 L (15,000 gal)	Vertical receiver tank design	1952

^aDCRT 244-U was constructed in 1978, but has never been placed into operation.

DCRT = double-contained receiver tank.

Table 1-2. Current and Planned Future Use of Double-Contained Receiver Tanks.

DCRT	Use
244-A	Serves as a catch tank for waste transfers which pass through the 244-A pump pit (i.e., cross-site transfers and transfers from DCRT 244-BX). That is, receives drainage from transfer line holdup when jumpers are changed and also would receive waste from transfer line leaks.
244-BX	Receives Tank 241-BY-105 and Tank 241-BY-106 salt well waste from the interim stabilization of these tanks.
244-S	<ul style="list-style-type: none"> Receives 222-S Laboratory waste. May receive 241-S and 241-SX Tank Farm tank salt well waste from the interim stabilization of these tanks (backup route). Could receive waste from catch tanks 241-UX-302A and 241-S-304. Serves as a catch tank for DCRT 244-TX transfers which pass through the 244-S pump pit (i.e., receives drainage from DCRT 244-TX transfer line holdup when jumpers are changed and also would receive waste from DCRT 244-TX transfer line leaks).
244-TX	<ul style="list-style-type: none"> Receives Plutonium Finishing Plant waste.
244-U	<ul style="list-style-type: none"> May receive 241-U Tank Farm tank salt well waste from the interim stabilization of these tanks (backup route). Could receive waste from catch tank 241-U-301B.
244-CR Vault Tank 003	<ul style="list-style-type: none"> Previously planned to receive salt well waste from the 241-C Tank Farm. Currently there are no plans to use this tank for any future mission, except for interim stabilization of the 244-CR Vault.

DCRT = double-contained receiver tank.

2.0 POTENTIAL FLAMMABLE GAS HAZARDOUS CONDITIONS

Flammable gases (e.g., hydrogen, ammonia, methane) may enter and accumulate in the headspace of DCRT receiver tanks by one of three processes: (1) transferred in with the waste (e.g., soluble gases, gas bubbles); (2) produced in the tank during waste storage by radiolysis of water and organics, chemical reactions (or thermolysis), and corrosion processes; and (3) produced by chemical adjustments of the waste before transfer to a double-shell tank (DST) (e.g., ammonia release) (PNNL 1998, LMHC 1999a, and CHG 2000). The Authorization Basis hazard analysis data base identifies a number of potential flammable gas hazardous conditions caused by these steady-state (or chronic) flammable gas release mechanisms with significant onsite worker or offsite public consequences (see Table 2-1). No potential flammable gas hazardous conditions are identified with significant facility worker consequences and with an uncontrolled frequency of anticipated (i.e., 10^{-2} to 10^0 per year).

Based on Pacific Northwest National Laboratory (PNNL) analysis of the potential for gas retention in a DCRT nonconvective layer^c (see Section 6.0 of PNNL 1998), there is no significant risk from gas release events (GREs) in DCRTs 244-A, 244-BX, 244-S, 244-TX, and 244-U. The PNNL analysis showed that relatively large, sudden gas releases are theoretically possible only in DCRTs 244-S and 244-U. In these DCRTs, however, even the largest theoretical gas releases would not cause the DCRT receiver tank headspace to exceed the lower flammability limit (LFL), but it could exceed 25% of the LFL.

Due to the remaining sludge heel in 244-CR Vault Tank 003, this tank is conservatively categorized as a Facility Group 3 Tank. That is, there is a potential hazard from releasing flammable gases that may be retained by the waste solids during waste disturbing operations (FSAR Appendix K).

One additional potential flammable gas hazardous condition was identified and considered at the April 19, 2000 control decision meeting. This hazardous condition is the generation and accumulation of flammable gas in a DCRT vault caused by a tank leak or failure.

^c Flammable gas that is generated by radiolysis and chemical reactions can accumulate in a nonconvective solid-liquid matrix that forms as solid particles settle out of or precipitate from a waste slurry. If sufficient gas is retained to make the nonconvective layer buoyant, a buoyant displacement instability may occur that can release a large fraction of the retained gas into the tank's headspace [i.e., a gas release event (GRE)]. Even if the nonconvective layer does not become buoyant, its retained gas can be released if the waste matrix is disrupted.

Table 2-1. Potential Flammable Gas Hazardous Conditions in Double-Contained Receiver Tanks with Significant Consequences to Onsite Workers (S2) and the Offsite Public (S3).^a (4 sheets)

ID	Hazardous Condition	Cause	Prev SSC ^b	Prev TSR ^b	Mit SSC ^b	Mit TSR ^b	Control MEMO	Freq	Cons
CP-MSP-05	Release of radioactive or toxic material to atmosphere from waste tank due to flammable gas deflagration	Human error AND Flammable gas is present in tank AND Mechanical failure of the pipe and probe (ignition source)	SC: SST Vent SC: DCRT Level Dip Tube Flow SC: TK-002 244-AR Level Dip Tube Flow SC: SST Struct	LCO: SST Vent Syss - Active LCO: SST Vent Syss - Passive LCO: DCRT Vent Syss LCO: 244-AR TK-002 Vent System AC: Flam Gas Mon Cntrls AC: Excavation Cntrls	None required	AC: Excavation Cntrls	Controls based on AB Appendix K and accident analysis (Spray Leak from Underground Waste Transfer Lines).	F1	S3
CP-MSP-06	Release of radioactive or toxic material to atmosphere due to flammable gas deflagration caused by puncture and ignition of flammable gas in transfer line which propagates to the waste tank	Human error AND Flammable gas is present in transfer pipe AND Spark from probe tip (ignition source)	SC: SST Vent SC: DCRT Level Dip Tube Flow SC: TK-002 244-AR Level Dip Tube Flow SC: SST Struct	LCO: SST Vent Syss - Active LCO: SST Vent Syss - Passive LCO: DCRT Vent Syss LCO: 244-AR TK-002 Vent System AC: Flam Gas Mon Cntrls AC: Excavation Cntrls	None required	AC: Excavation Cntrls	Controls based on AB Appendix K and accident analysis (Spray Leak from Underground Waste Transfer Lines).	F1	S3
ITK-08	Release of radioactive material from in-tank fire or explosion due to intrusive activity (dome collapse)	Exothermic reaction of incompatible materials in tank	SC: SST Vent Syss SC: DCRT Vent Syss SC: 244-AR TK-002 Vent Sys SC: 244-CR TK-003 Vent Sys SC: SST Struct	LCO: SST Vent Syss - Active LCO: SST Vent Syss - Passive LCO: DCRT Vent Syss LCO: 244-AR TK-002 Vent Sys AC: Flammability Cntrls AC: Ign Cntrls (Flam Gas) AC: Flam Gas Mon Cntrls AC: Trans Cntrls AC: Process Instrument/Measure/Test Equip	None required	AC: HEPA Filter Cntrls (Source Term) AC: Emergency Prep (Fire and Waste Leak)	Controls based on AB Appendix K.	F3	S3

Table 2-1. Potential Flammable Gas Hazardous Conditions in Double-Contained Receiver Tanks with Significant Consequences to Onsite Workers (S2) and the Offsite Public (S3).^a (4 sheets)

ID	Hazardous Condition	Cause	Prev SSC ^b	Prev TSR ^b	Mit SSC ^b	Mit TSR ^b	Control MEMO	Freq	Cons
ITK-09	Release of radioactive material from in-tank fire or explosion due to intrusive activity (dome collapse)	Failure to bond components or incorrect bonding	SC: SST Vent Syss SC: DCRT Vent Syss SC: 244-AR TK-002 Vent Sys SC: 244-CR TK-003 Vent Sys SC: SST Struct	LCO: SST Vent Syss - Active LCO: SST Vent Syss - Passive LCO: DCRT Vent Syss LCO: 244-AR TK-002 Vent Sys AC: Ign Cntrls (Flam Gas) AC: Flam Gas Mon Cntrls AC: Process Instrument/Measure/Test Equip	None required	AC: HEPA Filter Cntrls (Source Term) AC: Emergency Prep (Fire and Waste Leak)	Controls based on AB Appendix K.	F3	S3
ITK-10-a	Release of radioactive material from in-tank fire or explosion due to intrusive activity (dome collapse)	Spark from equipment or tools	SC: SST Vent Syss SC: DCRT Vent Syss SC: 244-AR TK-002 Vent Sys SC: 244-CR TK-003 Vent Sys SC: SST Struct	LCO: SST Vent Syss - Active LCO: SST Vent Syss - Passive LCO: DCRT Vent Syss LCO: 244-AR TK-002 Vent Sys AC: Ign Cntrls (Flam Gas) AC: Flam Gas Mon Cntrls AC: Process Instrument/Measure/Test Equip	None required	AC: HEPA Filter Cntrls (Source Term) AC: Emergency Prep (Fire and Waste Leak)	Controls based on AB Appendix K.	F3	S3
XS-01-FLO W01	Release of radioactive aerosols from 244 TX DCRT due to ignition of flammable gas atmosphere	Pressure drop in transfer line releases flammable gas into DCRT atmosphere and ignition source causes deflagration	SC: DCRT Vent Syss	LCO: DCRT Vent Syss AC: Ign Cntrls (Flam Gas) AC: Flam Gas Mon Cntrls AC: Process Instrument/Measure/Test Equip	None required	AC: HEPA Filter Cntrls (Source Term) AC: Emergency Prep (Fire and Waste Leak)	Controls based on AB Appendix K.	F2	S2

Table 2-1. Potential Flammable Gas Hazardous Conditions in Double-Contained Receiver Tanks with Significant Consequences to Onsite Workers (S2) and the Offsite Public (S3).^a (4 sheets)

ID	Hazardous Condition	Cause	Prev SSC ^b	Prev TSR ^b	Mit SSC ^b	Mit TSR ^b	Control MEMO	Freq	Cons
XS-01-FLO W03	Release of liquids, solids and/or vapors from single shell tank due to dome collapse and DCRT pressurization caused by flammable gas fire/explosion propagating from DCRT to single shell tank	Pipeline connecting single shell tank and DCRT fills with flammable gas; loss of ventilation flow in DCRT so that a flammable gas atmosphere is ignited by the ventilation outlet heater	SC: SST Vent Syss SC: DCRT Vent Syss SC: 244-AR TK-002 Vent Sys SC: 244-CR TK-003 Vent Sys SC: SST Struct	LCO: SST Vent Syss - Active LCO: SST Vent Syss - Passive LCO: DCRT Vent Syss LCO: 244-AR TK-002 Vent Sys AC: Flammability Cntrls AC: Ign Cntrls (Flam Gas) AC: Flam Gas Mon Cntrls AC: Trans Cntrls AC: Process Instrument/Measure/Test Equip	None required	AC: HEPA Filter Cntrls (Source Term) AC: Emergency Prep (Fire and Waste Leak)	Controls based on AB Appendix K.	F2	S3
XS-03-LEV E01 XS-21-LEV E (244-S DCRT)	Release of combustion products from 244 TX DCRT due to flammable gas burn in tank atmosphere	Evaporation of DCRT contents causing decreased ability of waste to retain flammable gases and spark source	SC: DCRT Vent Syss	LCO: DCRT Vent Syss AC: Ign Cntrls (Flam Gas) AC: Flam Gas Mon Cntrls AC: Process Instrument/Measure/Test Equip	None required	AC: HEPA Filter Cntrls (Source Term) AC: Emergency Prep (Fire and Waste Leak)	Controls based on AB Appendix K.	F2	S2
XS-03-PRE S01 XS-21-PRE S (244-S DCRT)	Release of liquid aerosols from 244 TX DCRT due to flammable gas burn in tank atmosphere	Loss of ventilation flow with accumulation of flammable gas and spark source	None required	AC: Ign Cntrls (Flam Gas) AC: Flam Gas Mon Cntrls AC: Process Instrument/Measure/Test Equip	None required	AC: HEPA Filter Cntrls (Source Term) AC: Emergency Prep (Fire and Waste Leak)	Controls based on AB Appendix K.	F2	S2
XS-03-TE MP03 XS-21-TE MP (244-S-DC RT)	Release of liquid aerosols from 244 TX DCRT due to flammable gas burn-fire/explosion in tank atmosphere	Buildup of gases, loss of ventilation, and spark source	None required	AC: Ign Cntrls (Flam Gas) AC: Flam Gas Mon Cntrls AC: Process Instrument/Measure/Test Equip	None required	AC: HEPA Filter Cntrls (Source Term) AC: Emergency Prep (Fire and Waste Leak)	Controls based on AB Appendix K.	F2	S2

Table 2-1. Potential Flammable Gas Hazardous Conditions in Double-Contained Receiver Tanks with Significant Consequences to Onsite Workers (S2) and the Offsite Public (S3).^a (4 sheets)

ID	Hazardous Condition	Cause	Prev SSC ^b	Prev TSR ^b	Mit SSC ^b	Mit TSR ^b	Control MEMO	Freq	Cons
XS-05-TE MP02	Release to atmosphere of materials from DCRT ventilation filters and tank due to filter degradation	Fire in ventilation system due to flammable gas buildup and ignition	Release of radioactive aerosols	SC: DCRT Vent Syss	LCO: DCRT Vent Syss AC: Ign Cntrls (Flam Gas) AC: Flam Gas Mon Cntrls AC: Process Instrument/Measure/Test Equip	None required	AC: HEPA Filter Cntrls (Source Term) AC: Emergency Prep (Fire and Waste Leak)	F3	S2

^aPotential hazardous conditions resulting in flammable gas deflagrations or detonations in DCRTs were identified from a search of the Authorization Basis hazard analysis data base.

^bExisting control allocation.

AB = authorization basis.

AC = Administrative Control.

DCRT = double-contained receiver tank.

HEPA = high-efficiency particulate air (filter).

LCO = limiting condition for operation.

SC = Safety-Class.

SSC = structure, system, and component.

TSR = Technical Safety Requirement.

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3.0 RISK OF POSTULATED FLAMMABLE GAS ACCIDENTS

The postulated accident scenario is the steady state generation of flammable gases in the headspace of a DCRT receiver tank that because of insufficient ventilation accumulates to a concentration above the LFL. An ignition source then causes a deflagration or detonation. The frequency of this postulated accident without controls is conservatively assumed to be anticipated (i.e., 10^{-2} to 10^0 per year) for a deflagration and unlikely (i.e., 10^{-4} to 10^{-2} per year) for a detonation (FFS 2000).

The FSAR includes a consequence analysis of a postulated flammable gas deflagration accident in a DCRT. Consequences are calculated for a flammable gas deflagration that causes receiver tank failure. All of the releases from the pressurized venting of the receiver tank are assumed to be released directly to the environment [18.3 liters of respirable waste composed of 95% SST liquids and 5% SST solids] (WHC 1996). The FSAR DCRT flammable gas accident results are shown in Table 3-1 and indicate that radiological doses and toxicological exposures could exceed offsite and onsite risk evaluation guidelines. See FSAR Section 3.4.2 for additional information.

Additional consequence analysis was performed to support the closure of the Flammable Gas USQ for DCRTs. The original revised analysis in HNF-4526, *Combustion Accident Analysis for Double-Contained Receiver Tanks (DCRTs) 244-S and 244-TX* (FDNW 1999) provided conservatively bounding estimates of releases to the environment from a deflagration and a detonation within a DCRT and then used the established FSAR methodology to estimate the consequences associated with these releases. The accident was analyzed as a sequence of three processes: (1) a rapid combustion process leading to a maximum pressure and temperature for the gas mixture in the receiver tank headspace, (2) the rapid opening of receiver tank depressurization paths, and (3) the subsequent depressurization (or blow-down) of the system and releases to the environment. Conservative and defensible estimates for the pre-combustion inventories, filter inventories, and mass entrained during a deflagration event were established. Also, reasonably conservative estimates for deflagration and detonation entrainment were taken from DOE-HDBK-3010-94, *Airborne Release Fractions/Rates and Respirable Fractions for Nonreactor Nuclear Facilities* (DOE 1994). The HADCRT computer code was used to calculate the mass transport to the environment during the depressurization of the system. The transport mechanisms are well established and validated for simple systems, and included material depletion mechanisms.

Subsequent to the original revised analysis in HNF-4526, a limited review and revision of this conservatively bounding analysis was performed to provide a more reasonably conservative estimate of potential consequences (RPP-6244, *Updated Double-Contained Receiver Tank Combustion Accident Analysis* [FFS 2000]). Improvements in the analysis to remove conservatism focused on the modeling of blowdown entrainment, which was a significant source of material release in HNF-4526, and the application of newly developed radiological source terms, air transport, and plume depletion factors for calculating the consequences from material releases.

The results from the DCRT flammable gas accident analysis in RPP-6244 are shown in Table 3-1. The results show that postulated flammable gas accidents in DCRTs do not challenge offsite risk guidelines, but do exceed onsite risk guidelines. This means that structures, systems, and components (SSCs) selected to prevent or mitigate postulated DCRT flammable gas accidents are classified as safety-significant. RPP-6244 also concluded that based on a comparison of the design of 244-CR Vault Tank 003 to DCRT 244-S, it is expected that a flammable gas accident in the headspace of 244-CR Vault Tank 003 would lead to environmental releases and consequences similar to those calculated for DCRT 244-S.

Table 3-1. Existing and New Double-Contained Receiver Tank Consequence Analyses.

DCRT	Source Term ^a	Radiological (rem)			Toxicological [Sum of Fraction (SOF)]			Accident Frequency
		Onsite		Offsite		Onsite		
		Calculated Dose	Risk Guideline	Calculated Dose	Risk Guideline	Calculated SOF	Risk Guideline	
EXISTING FSAR ANALYSIS								
DCRT	18 L	440	0.5	0.38	0.1	1000	1 (ERPG-1)	1 (PEL-TWA)
	--							
NEW ANALYSIS								
Deflagration								
244-S								
Intact	0.011 L	0.033	0.5	1.7E-05	0.1	2.4	1 (ERPG-1)	2.4E-04
	0.0013 L							1 (PEL-TWA)
Rupture	2.2 L	4.0	0.5	1.7E-03	0.1	340	1 (ERPG-1)	0.025
	0.036 L							1 (PEL-TWA)
244-TX								
Intact	23 L	41	0.5	0.018	0.1	3500	1 (ERPG-1)	0.26
	0.0031 L							1 (PEL-TWA)
Rupture	18 L	33	0.5	0.014	0.1	2800	1 (ERPG-1)	0.20
	0.0021 L							1 (PEL-TWA)
Detonation								
244-S								
Intact	5.8 L	19	5	9.7E-03	0.5	380	1 (ERPG-2)	0.074
	0.82 L							1 (ERPG-1)
Rupture	9.0 L	20	5	9.5E-03	0.5	340	1 (ERPG-2)	0.089
	0.40 L							1 (ERPG-1)
244-TX								
Intact	32 L	69	5	0.032	0.5	1100	1 (ERPG-2)	0.31
	1.2 L							1 (ERPG-1)
Rupture	34 L	68	5	0.031	0.5	1000	1 (ERPG-2)	0.31
	0.72 L							1 (ERPG-1)

*All results are reported to two significant figures.

^aThe source term is the volume of waste released to the environment and it consists of liquid waste releases from the DCRT waste surface and solid waste releases from the tank walls. The liquid waste release volume is shown first and is assumed to be 95% SST liquids and 5% SST solids. The solid waste release volume is the second number and is assumed to be SST solids.

DCRT = double-contained receiver tank.

FSAR = Final Safety Analysis Report.

SOF = sum of fractions.

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4.0 EXISTING AND POSSIBLE FLAMMABLE GAS CONTROLS

This section identifies the existing controls and other possible controls that could prevent or mitigate flammable gas hazards that were considered at the November 16, 17, and 18, 1999, the April 19, 2000, and the May 20, 2000 control decision meetings. For each existing and possible control, thoughts for and against the control are presented. Additional information on the cost, schedule, ALARA concerns, technical feasibility, and operability and maintainability of alternative DCRT ventilation system and/or flammable gas monitoring modifications is contained in RPP-5162, *Evaluation of Flammable Gas Monitoring and Ventilation System Alternatives for Double-Contained Receiver Tanks* (LMHC 1999b).

Existing controls for flammable gas hazards in DCRTs include the following.

- DCRT ventilation system flow rate requirements (TSRs LCO 3.2.4, AC 5.11.2d, and AC 5.12.2.c fourth bullet)
- DCRTs 244-A, 244-BX, 244-S, 244-TX, and 244-U, are in the Flammable Gas Facility Group Non-GRE and 244-CR Vault Tank 003 is in Flammable Gas Facility Group 3 (TSR AC 5.9.2.b, Table 5.9-1)
- For DCRTs 244-A, 244-BX, 244-S, 244-TX, and 244-U, Ignition Source Control Set 2 applies to activity-related equipment and materials until work activity entry monitoring requirements are met. Ignition source controls during entry monitoring are not required in the ex-tank intrusive region. In addition, for 244-CR Vault Tank 003 there are additional ignition and flammable gas monitoring requirements for waste intruding equipment and during waste disturbing activities. (See TSRs AC 5.10, Table 5.10-1; and AC 5.11, Table 5.11-1).

Note: There are no ignition source controls on installed DCRT equipment.

The following tables summarize thoughts for and against the above existing controls and other possible controls considered at the control decision meetings on November 16, 17, and 18, 2000.

DCRT 244-A – See Table 4-1

DCRT 244-BX – See Table 4-2

DCRT 244-S – See Table 4-3

DCRT 244-TX – See Table 4-4

DCRT 244-U – See Table 4-5

Note: Several of the thoughts for or against the different possible control decisions in Tables 4-1 to 4-5 changed subsequent to the November 16, 17, and 18, 1999 control decision meetings. The major change is based on the final predictions of DCRT flammable gas concentrations in RPP-4941, *Methodology for Predicting Flammable Gas*

Mixtures in Double-Contained Receiver Tanks (CHG 2000c). These predictions showed that except for new salt well waste transfers to DCRT 244-S from 241-S and 241-SX tank farms, the DCRT ventilation systems can maintain the flammable gas concentration (hydrogen, ammonia, and methane) below 25% of the LFL during waste storage and waste transfers (see Tables 4-6 and 4-7). Also subsequent to the November 1999 control decision meetings, salt well pumping of Tank 241-T-110 was completed.

At the April 19, 2000 control decision meeting, controls were identified to address flammable gas hazards in a DCRT vault caused by the receiver tank failure. Based on the analysis in RPP-4941, this hazard only exists for DCRT 244-S if new salt well waste is transferred from 241-S or 241-SX tank farms and for 244-CR Vault Tank 003 if material is transferred to the tank (see Table 4-8). At the April 19, 2000 meeting possible controls for DCRT 244-S considered to address this hazard and thoughts for and against the controls are presented below. (Note: Although possible controls for 244-CR Vault Tank 003 were not specifically considered, the possible controls identified below for DCRT 244-S are also applicable to 244-CR Vault Tank 003.)

DCRT vault leak detection system (i.e., vault sump level detection system) – Although this system exists, this control would require its designation as a safety-significant SSC and a new TSR would be required to ensure its operability.

DCRT level detection system – This system is already designated as a safety-significant SSC, but a new TSR would be required to ensure its operability and/or periodically monitor the tank level for unexpected decreases.

DCRT exhaust ventilation continuous air monitor (CAM) – This CAM is already designated as a safety-class SSC, but there are several ongoing activities to eliminate the safety SSC designation. A new or revised TSR would be required to ensure its operability for purposes of vault waste leak detection.

DCRT vault temperature monitoring – This system does not currently exist, but was identified as a possibly more reliable method of detecting waste leaks into the DCRT vault. This possible control would require the design and installation of this safety-significant SSC and a new TSR to ensure its operability and/or periodically monitor the vault temperature for unexpected increases. An engineering basis would also have to be developed to demonstrate the effectiveness and application of this leak detection method, which would be new in the Authorization Basis.

The analysis of flammable gas hazards for 244-CR Vault Tank 003 shows that there is no hazard for the existing waste in the tank. At the April 19, 2000 control decision meeting possible control decisions identified and thoughts for and against the controls are presented below.

Maintain existing controls (i.e., active safety-significant ventilation system and LCO 3.2.4 control to ensure its operability, and existing AC 5.10 and 5.11 flammable gas ignition and monitoring controls) – According to RPP-4941 predictions, operation of the 244-CR Vault ventilation system is not required. Continuation of flammable gas ignition and monitoring controls is prudent.

Maintain existing AC 5.10 and 5.11 flammable gas ignition and monitoring controls, but eliminate the LCO 3.2.4 requirement for operation of the 244-CR Vault ventilation system – RPP-4941 supports this control decision.

Same as above, but add a new TSR requirement for periodic monitoring of 244-CR Vault Tank 003 (e.g., once every 31 days) – The new monitoring requirement would address any questions and uncertainties that may exist with the RPP-4941 analysis.

Table 4-1. Possible Double-Contained Receiver Tank 244-A Control Decisions. (5 sheets)

Possible Control Decision	Thoughts For	Thoughts Against
1. Status Quo – No revisions to existing controls	<ul style="list-style-type: none"> No implementation costs 	<ul style="list-style-type: none"> Existing controls allow supplemental analysis and controls to ensure that flammable gas concentrations are maintained below 25% of the LFL (i.e., the FSAR and TSRs do not completely define the safe operating envelope). DOE does not concur in this unique approach for DCRTs (see TWRs-RT-SER-003, pages 3-72 to 3-74) (DOE-RL 1999) There is no analysis to show that existing controls (i.e., 3 cfm ventilation flow) will maintain flammable gas concentrations below 25% of the LFL There are insufficient monitoring data to conclude that existing controls (i.e., 3 cfm) maintain flammable gas concentrations below 25% of the LFL Unlikely to provide an acceptable basis for resolution and closure of the Flammable Gas USQ for DCRTs (Kinzer 1999)
2. Remove DCRT 244-A from service and D&D it (i.e., remove waste heel) Note: This would require installation of bypasses around DCRT 244-A for active transfer lines that currently pass through the DCRT pump pit (e.g., the cross-site transfer line, transfers from DCRT 244-BX)	<ul style="list-style-type: none"> Flammable gas hazard eliminated 	<ul style="list-style-type: none"> While there are plans for a cross-site transfer line bypass around DCRT 244-A, there are no plans to re-route other transfer lines that pass through the DCRT pump pit Costs for completely bypassing DCRT 244-A are unknown but could be significant
3. Close valve in the ventilation exhaust line from the DCRT vault and revise the controls as follows: <ul style="list-style-type: none"> TSR LCO for DCRT exhaust ventilation system operability DCRT exhaust system is safety-class Notes: <ul style="list-style-type: none"> This control assumes that air leakage past the closed vault exhaust ventilation valve will be small 	<ul style="list-style-type: none"> Ventilation system reconfiguration only requires valve closure 	<ul style="list-style-type: none"> In the absence of an inlet air path to the DCRT receiver tank, the ventilation flow rate through the receiver tank that would result from this reconfiguration of the exhaust ventilation system is unknown Increasing the ventilation flow rate through the receiver tank is a poor control if ammonia is a significant contributor to the % LFL for two reasons: (1) % LFL decreases slowly with increasing ventilation flow rate and (2) the ammonia concentration in the vapor space reaches equilibrium with the ammonia concentration in the liquid waste within hours (i.e., the action completion time on loss of ventilation would be very short). Increased ventilation flow also has minimal effect on the contribution to the % LFL from dissolved hydrogen during waste transfers to DCRTs.

Table 4-1. Possible Double-Contained Receiver Tank 244-A Control Decisions. (5 sheets)

Possible Control Decision	Thoughts For	Thoughts Against
<p>Notes (continued):</p> <ul style="list-style-type: none"> Engineering would need to confirm that the reconfigured DCRT exhaust ventilation system could not to collapse the receiver tank due to high vacuum 		<ul style="list-style-type: none"> Potential ALARA and environmental concerns from eliminating ventilation flow to the DCRT vault Initial and subsequent costs resulting from designating the DCRT exhaust system as safety-class Reliability of the DCRT exhaust system (e.g., single exhaust fan, system age) The motor operated valve in the ventilation exhaust line from the DCRT vault may require maintenance to close
<p>4. Install flow monitor in existing DCRT receiver tank exhaust duct and revise the controls as follows:</p> <ul style="list-style-type: none"> TSR LCO for DCRT exhaust ventilation system operability (including minimum flow rate) DCRT exhaust system is safety-class 	<ul style="list-style-type: none"> Ventilation flow rate through the receiver tank is known and monitored Cost is \$180,000 to install the flow monitor Schedule is 6 months to install flow monitor 	<ul style="list-style-type: none"> In the absence of an inlet air path to the DCRT receiver tank, it is not known what the monitored ventilation flow rate through the receiver tank will be Even if an increased ventilation flow rate through the receiver tank is verified, this is a poor control if ammonia is a significant contributor to the % LFL for two reasons: (1) % LFL decreases slowly with increasing ventilation flow rate and (2) the ammonia concentration in the vapor space reaches equilibrium with the ammonia concentration in the liquid waste within hours (i.e., the action completion time on loss of ventilation would be very short). Increased ventilation flow also has minimal effect on the contribution to the % LFL from dissolved hydrogen during waste transfers to DCRTs. Initial and subsequent costs resulting from designating the DCRT exhaust system as safety-class Reliability of the DCRT exhaust system (e.g., single exhaust fan, system age) Worker radiation exposures during installation and maintenance of flow monitor
<p>5. Install new inlet filter with flow monitor for DCRT receiver tank and revise the controls as follows:</p> <ul style="list-style-type: none"> TSR LCO for DCRT inlet and exhaust ventilation system (including minimum flow rate) DCRT inlet and exhaust system is safety-class SSC 	<ul style="list-style-type: none"> Ventilation flow is increased by providing an inlet flow path to the receiver tank Ventilation flow is monitored Cost is \$260,000 to install the inlet filter Schedule is 7.5 months to install the inlet filter 	<ul style="list-style-type: none"> Increasing the ventilation flow rate through the receiver tank is a poor control if ammonia is a significant contributor to the % LFL for two reasons: (1) % LFL decreases slowly with increasing ventilation flow rate and (2) the ammonia concentration in the vapor space reaches equilibrium with the ammonia concentration in the liquid waste within hours (i.e., the action completion time on loss of ventilation would be very short). Increased ventilation flow also has minimal effect on the contribution to the % LFL from dissolved hydrogen during waste transfers to DCRTs.

Table 4-1. Possible Double-Contained Receiver Tank 244-A Control Decisions. (5 sheets)

Possible Control Decision	Thoughts For	Thoughts Against
<p>Note: Would require re-balancing the ventilation system</p>		<ul style="list-style-type: none"> Initial and subsequent costs resulting from designating the DCRT exhaust system as safety-class Reliability of the DCRT exhaust system (e.g., single exhaust fan, system age)
<p>6A. Install sample probes and connections for periodic vapor space sampling/monitoring and revised the controls as follows:</p> <ul style="list-style-type: none"> TSR requiring flammable gas monitoring of DCRT receiver tank vapor space Delete TSR LCO requiring 3 cfh air inlet flow and DCRT ventilation system safety-class designation <p>Note: This control strategy should be supported by analysis that shows without DCRT ventilation controls the flammable gas concentrations should not exceed 25% of the LFL.</p>	<ul style="list-style-type: none"> Provides monitoring for flammable gas hazards and alerts operators to take actions when flammable gas concentrations exceed 25% of the LFL Periodic monitoring requirements can be defined based on operating modes (e.g., waste transfer, storage) and can be revised based on monitoring experience Cost is \$80,000 to install sample probes and connections (does not include annual O&M costs) Schedule is 4 months to install sample probes and connections Potential cost savings by deletion of existing TSR LCO requiring 3 cfh air inlet flow and DCRT ventilation system safety-class designation 	<ul style="list-style-type: none"> Does not directly control the flammable gas hazard (i.e., without some ventilation flammable gas concentrations in DCRTs can reach 100% of the LFL) Requires determination and justification of periodic monitoring requirements
<p>6B. Install sample probes and connections for periodic vapor space sampling/monitoring and revised the controls as follows:</p> <ul style="list-style-type: none"> TSR requiring flammable gas monitoring of DCRT receiver tank vapor space Retain TSR LCO requiring 3 cfh air inlet flow and DCRT ventilation safety-class designation <p>Note: This control strategy should be supported by analysis that shows with 3 cfh air inlet flow the flammable gas concentrations should not exceed 25% of the LFL.</p>	<ul style="list-style-type: none"> Provides monitoring for flammable gas hazards and alerts operators to take actions when flammable gas concentrations exceed 25% of the LFL Periodic monitoring requirements can be defined based on operating modes (e.g., waste transfer, storage) and can be revised based on monitoring experience Maintains 3 cfh air inlet flow requirements that should adequately control hydrogen generation in the DCRT (i.e., maintains hydrogen concentrations below 25% LFL) Cost is \$80,000 to install sample probes and connections (does not include annual O&M costs) 	<ul style="list-style-type: none"> There are insufficient monitoring data to conclude that 3 cfh maintains flammable gas concentrations (i.e., hydrogen, ammonia, and methane) below 25% of the LFL Requires determination and justification of periodic monitoring requirements

Table 4-1. Possible Double-Contained Receiver Tank 244-A Control Decisions. (5 sheets)

Possible Control Decision	Thoughts For	Thoughts Against
<p>7. Install SHMS for continuous vapor space monitoring and revise the controls as follows:</p> <ul style="list-style-type: none"> TSR LCO on SHMS operation and 25% LFL limit SHMS is safety-class SSC Delete TSR LCO requiring 3 cfm air inlet flow and DCRT ventilation system safety-class designation <p>OR</p> <ul style="list-style-type: none"> TSR AC requiring continuous flammable gas monitoring of DCRT vapor space and actions required if 25% of the LFL is exceeded Delete TSR LCO requiring 3 cfm air inlet flow and DCRT ventilation system safety-class designation <p>Note: This control strategy should be supported by analysis that shows without DCRT ventilation controls the flammable gas concentrations should not exceed 25% of the LFL</p>	<ul style="list-style-type: none"> Schedule is 4 months to install sample probes and connections Provides continuous monitoring for flammable gas hazards and alerts operators to take actions when flammable gas concentrations exceed 25% of the LFL Potential cost savings by deletion of existing TSR LCO requiring 3 cfm air inlet flow and DCRT ventilation system safety-class designation Avoids the need to determine and justify periodic monitoring requirements 	<ul style="list-style-type: none"> Does not directly control the flammable gas hazard (i.e., without some ventilation flammable gas concentrations in DCRTs can reach 100% of the LFL) Cost is \$320,000 to install the SHMS (does not include annual O&M costs) Schedule is 11.5 months to install the SHMS Initial and subsequent cost resulting from designating the SHMS as safety-class. (Note: This could be avoided if the TSR is written as an AC and AC 5.19 is relied on to ensure SHMS operability and accuracy.)
<p>8. Install new portable exhaust and revise the controls as follows:</p> <ul style="list-style-type: none"> TSR LCO for DCRT inlet and portable exhaust operability DCRT inlet and portable exhaust is safety-class SSC 	<ul style="list-style-type: none"> Ventilation flow to the receiver tank in significantly increased (e.g., 10 to 100s of cfm) Ventilation flow is monitored New versus existing exhaust ventilation system avoids questions concerning upgrading the existing SSC classification and the reliability of the existing system 	<ul style="list-style-type: none"> Increasing the ventilation flow rate through the receiver tank is a poor control if ammonia is a significant contributor to the % LFL for two reasons: (1) % LFL decreases slowly with increasing ventilation flow rate and (2) the ammonia concentration in the vapor space reaches equilibrium with the ammonia concentration in the liquid waste within hours (i.e., the action completion time on loss of ventilation would be very short). Increased ventilation flow also has minimal effect on the contribution to the % LFL from dissolved hydrogen during waste transfers to DCRTs.

Table 4-1. Possible Double-Contained Receiver Tank 244-A Control Decisions. (5 sheets)

Possible Control Decision	Thoughts For	Thoughts Against
		<ul style="list-style-type: none"> Cost is \$1,200,000 to install the new portable exhaustor and inlet filter (does not include annual O&M costs) Schedule is 19 months to install the new portable exhaustor and inlet filter
9. Increase air inlet flow via the dip-tubes	<ul style="list-style-type: none"> The costs and schedule to increase air inlet flow requirements (e.g., from 3 to 12 cfh) is expected to be small 	<ul style="list-style-type: none"> Analysis of the increased air inlet flow possible via the existing dip-tubes shows no significant benefit Would likely require the installation of a new DCRT level monitoring system
10. Install an inerting system	<ul style="list-style-type: none"> Prevents flammable gas hazards by reducing oxygen concentrations below the LFL 	<ul style="list-style-type: none"> Cost is \$1,000,000 + to install an inerting system (does not include annual O&M costs) Schedule is 12 months+ to install an inerting system
11. Dilution controls	<ul style="list-style-type: none"> Reduces the concentration of constituents in waste transferred to the DCRT that result in flammable gases that can accumulate in the receiver tank headspace (e.g., ammonia, dissolved hydrogen) 	<ul style="list-style-type: none"> Requires designation of the dilution systems and associated monitoring systems as safety-class Requires development of dilution requirements (i.e., dilution ratios) that are dependent on waste characterization data and the prediction of flammable gas concentrations in DCRT
12. Ignition controls	<ul style="list-style-type: none"> None 	<ul style="list-style-type: none"> Not generally used to control flammable gas hazards that are caused by the steady-state accumulation of flammable gases The cost and schedule of requiring installed equipment in the DCRT to meet Ignition Source Control Set 1 or 2 are unknown

AC = Administrative Control.
 ALARA = as low as reasonably achievable.
 D&D = decontamination and decommissioning.
 DCRT = double-contained receiver tank.
 DOE = U.S. Department of Energy.
 FSAR = Final Safety Analysis Report.
 LCO = limiting condition for operation.
 LFL = lower flammability limit.
 O&M = operations and maintenance.
 SHMS = Standard Hydrogen Monitoring System.
 SSC = structure, system, and component.
 TSR = Technical Safety Requirement.

Table 4-2. Possible DCRT 244-BX Control Decisions. (5 sheets)

Possible Control Decision	Thoughts For	Thoughts Against
1. Status Quo – No revisions to existing controls	<ul style="list-style-type: none"> No implementation costs 	<ul style="list-style-type: none"> Existing controls allow supplemental analysis and controls to ensure flammable gas concentrations are maintained below 25% of the LFL (i.e., the FSAR and TSRs do not completely define the safe operating envelope). DOE does not concur in this unique approach for DCRTs (see TWRS-RT-SER-003, pages 3-72 to 3-74) (DOE-RL 1999) Analysis shows existing controls (i.e., 3 cfm ventilation flow) are marginal for maintaining flammable gas concentrations below 25% of the LFL There are insufficient monitoring data to conclude that existing controls (i.e., 3 cfm) maintain flammable gas concentrations below 25% of the LFL Unlikely to provide an acceptable basis for resolution and closure of the Flammable Gas USQ for DCRTs (Kinzer 1999)
2. Use an alternative route for salt well pumping of Tanks 241-BY-105 and 241-BY-106 and D&D the DCRT (i.e., remove waste heel)	<ul style="list-style-type: none"> Flammable gas hazard eliminated 	<ul style="list-style-type: none"> No alternative route for salt well pumping of Tanks 241-BY-105 and 241-BY-106 have been planned Potential impact on consent decree schedule Costs for an alternative route are unknown but likely to be significant
3. Close valve in the ventilation exhaust line from the DCRT vault and revise the controls as follows: <ul style="list-style-type: none"> TSR LCO for DCRT exhaust ventilation system operability DCRT exhaust system is safety-class Notes: <ul style="list-style-type: none"> This control assumes that air leakage past the closed vault exhaust ventilation valve will be small 	<ul style="list-style-type: none"> Ventilation system reconfiguration only requires valve closure 	<ul style="list-style-type: none"> In the absence of an inlet air path to the DCRT receiver tank, the ventilation flow rate through the receiver tank that would result from this reconfiguration of the exhaust ventilation system is unknown Increasing the ventilation flow rate through the receiver tank is a poor control if ammonia is a significant contributor to the % LFL for two reasons: (1) % LFL decreases slowly with increasing ventilation flow rate and (2) the ammonia concentration in the vapor space reaches equilibrium with the ammonia concentration in the liquid waste within hours (i.e., the action completion time on loss of ventilation would be very short). Increased ventilation flow also has minimal effect on the contribution to the % LFL from dissolved hydrogen during waste transfers to DCRTs.

Table 4-2. Possible DCRT 244-BX Control Decisions. (5 sheets)

Possible Control Decision	Thoughts For	Thoughts Against
<ul style="list-style-type: none"> Engineering would need to confirm that the reconfigured DCRT exhaust ventilation system could not collapse the receiver tank due to high vacuum 		<ul style="list-style-type: none"> Potential ALARA and environmental concerns from eliminating ventilation flow to the DCRT vault Initial and subsequent costs resulting from designating the DCRT exhaust system as safety-class Reliability of the DCRT exhaust system (e.g., single exhaust fan, system age) The motor operated valve in the ventilation exhaust line from the DCRT vault may require maintenance to close
<p>4. Install flow monitor in existing DCRT receiver tank exhaust duct and revise the controls as follows:</p> <ul style="list-style-type: none"> TSR LCO for DCRT exhaust ventilation system operability (including minimum flow rate) DCRT exhaust system is safety-class 	<ul style="list-style-type: none"> Ventilation flow rate through the receiver tank is known and monitored Cost is \$180,000 to install the flow monitor Schedule is 6 months to install flow monitor 	<ul style="list-style-type: none"> In the absence of an inlet air path to the DCRT receiver tank, it is not known what the monitored ventilation flow rate through the receiver tank will be Even if an increased ventilation flow rate through the receiver tank is verified, this is a poor control if ammonia is a significant contributor to the % LFL for two reasons: (1) % LFL decreases slowly with increasing ventilation flow rate and (2) the ammonia concentration in the vapor space reaches equilibrium with the ammonia concentration in the liquid waste within hours (i.e., the action completion time on loss of ventilation would be very short). Increased ventilation flow also has minimal affect on the contribution to the % LFL from dissolved hydrogen during waste transfers to DCRTs. Initial and subsequent costs resulting from designating the DCRT exhaust system as safety-class Reliability of the DCRT exhaust system (e.g., single exhaust fan, system age) Worker radiation exposures during installation and maintenance of flow monitor
<p>5. Install new inlet filter with flow monitor for DCRT receiver tank and revise the controls as follows:</p> <ul style="list-style-type: none"> TSR LCO for DCRT inlet and exhaust ventilation system (including minimum flow rate) DCRT inlet and exhaust system is safety-class SSC 	<ul style="list-style-type: none"> Ventilation flow is increased by providing an inlet flow path to the receiver tank Ventilation flow is monitored Cost is \$160,000 to install the inlet filter Schedule is 4 months to install the inlet filter 	<ul style="list-style-type: none"> Increasing the ventilation flow rate through the receiver tank is a poor control if ammonia is a significant contributor to the % LFL for two reasons: (1) % LFL decreases slowly with increasing ventilation flow rate and (2) the ammonia concentration in the vapor space reaches equilibrium with the ammonia concentration in the liquid waste within hours (i.e., the action completion time on loss of ventilation would be very short). Increased ventilation flow also has minimal effect on the contribution to the % LFL from dissolved hydrogen during waste transfers to DCRTs.

Table 4-2. Possible DCRT 244-BX Control Decisions. (5 sheets)

Possible Control Decision	Thoughts For	Thoughts Against
<p>Notes: Would require re-balancing the ventilation system</p> <p>6A. Install sample probes and connections for periodic vapor space sampling/monitoring and revised the controls as follows:</p> <ul style="list-style-type: none"> • TSR requiring flammable gas monitoring of DCRT receiver tank vapor space • Delete TSR LCO requiring 3 cfm air inlet flow and DCRT ventilation system safety-class designation <p>Note: This control strategy should be supported by analysis that shows without DCRT ventilation controls the flammable gas concentrations should not exceed 25% of the LFL.</p>	<ul style="list-style-type: none"> • Provides monitoring for flammable gas hazards and alerts operators to take actions when flammable gas concentrations exceed 25% of the LFL • Periodic monitoring requirements can be defined based on operating modes (e.g., waste transfer, storage) and can be revised based on monitoring experience • Cost is \$50,000 to install sample probes and connections (does not include annual O&M costs) • Schedule is 2.5 months to install sample probes and connections • Potential cost savings by deletion of existing TSR LCO requiring 3 cfm air inlet flow and DCRT ventilation system safety-class designation 	<ul style="list-style-type: none"> • Initial and subsequent costs resulting from designating the DCRT exhaust system as safety-class • Reliability of the DCRT exhaust system (e.g., single exhaust fan, system age) • Does not directly control the flammable gas hazard (i.e., analyses show that without ventilation flammable gas concentrations in DCRTs can reach 100% of the LFL) • Requires determination and justification of periodic monitoring requirements • There could be significant cost and schedule impacts if waste transfers are stopped and remediation actions implemented whenever flammable gas concentrations exceed 25% of the LFL
<p>6B. Install sample probes and connections for periodic vapor space sampling/monitoring and revised the controls as follows:</p> <ul style="list-style-type: none"> • TSR requiring flammable gas monitoring of DCRT receiver tank vapor space • Retain TSR LCO requiring 3 cfm air inlet flow and DCRT ventilation safety-class designation 	<ul style="list-style-type: none"> • Provides monitoring for flammable gas hazards and alerts operators to take actions when flammable gas concentrations exceed 25% of the LFL • Periodic monitoring requirements can be defined based on operating modes (e.g., waste transfer, storage) and can be revised based on monitoring experience • Maintains 3 cfm air inlet flow requirements that analysis shows adequately controls hydrogen generation in the DCRT (i.e., maintains hydrogen concentrations below 25% LFL) • Cost is \$50,000 to install sample probes and connections (does not include annual O&M costs) 	<ul style="list-style-type: none"> • Analysis shows 3 cfm air inlet flow is marginal for maintaining flammable gas concentrations (i.e., hydrogen, ammonia, and methane) below 25% of the LFL • There are insufficient monitoring data to conclude that 3 cfm maintains flammable gas concentrations (i.e., hydrogen, ammonia, and methane) below 25% of the LFL • Requires determination and justification of periodic monitoring requirements • There could be significant cost and schedule impacts if waste transfers are stopped and remediation actions implemented whenever flammable gas concentrations exceed 25% of the LFL

Table 4-2. Possible DCRT 244-BX Control Decisions. (5 sheets)

Possible Control Decision	Thoughts For	Thoughts Against
<p>Note: This control strategy should be supported by analysis that shows with 3 cfm air inlet flow the flammable gas concentrations should not exceed 25% of the LFL.</p> <p>7. Install SHMS for continuous vapor space monitoring and revise the controls as follows:</p> <ul style="list-style-type: none"> TSR LCO on SHMS operation and 25% LFL limit SHMS is safety-class SSC Delete TSR LCO requiring 3 cfm air inlet flow and DCRT ventilation system safety-class designation <p>OR</p> <ul style="list-style-type: none"> TSR AC requiring continuous flammable gas monitoring of DCRT vapor space and actions required if 25% of the LFL is exceeded Delete TSR LCO requiring 3 cfm air inlet flow and DCRT ventilation system safety-class designation <p>Note: This control strategy should be supported by analysis that shows without DCRT ventilation controls the flammable gas concentrations should not exceed 25% of the LFL</p>	<ul style="list-style-type: none"> Schedule is 2.5 months to install sample probes and connections Provides continuous monitoring for flammable gas hazards and alerts operators to take actions when flammable gas concentrations exceed 25% of the LFL Potential cost savings by deletion of existing TSR LCO requiring 3 cfm air inlet flow and DCRT ventilation system safety-class designation Avoids the need to determine and justify periodic monitoring requirements 	<ul style="list-style-type: none"> Does not directly control the flammable gas hazard (i.e., analyses show that without ventilation flammable gas concentrations in DCRTs can reach 100% of the LFL) Cost is \$220,000 to install the SHMS (does not include annual O&M costs) Schedule is 6.5 months to install the SHMS Initial and subsequent cost resulting from designating the SHMS as safety-class. (Note: This could be avoided if the TSR is written as an AC and AC 5.19 is relied on to ensure SHMS operability and accuracy.) There could be significant cost and schedule impacts if waste transfers are stopped and remediation actions implemented whenever flammable gas concentrations exceed 25% of the LFL There could be cost and schedule impacts if transfers are stopped when the SHMS is inoperable
<p>8. Install new portable exhaustor and new inlet filter and revise the controls as follows:</p> <ul style="list-style-type: none"> TSR LCO for DCRT inlet and portable exhaustor operability 	<ul style="list-style-type: none"> Ventilation flow to the receiver tank in significantly increased (e.g., 10 to 100s of cfm) Ventilation flow is monitored 	<ul style="list-style-type: none"> Increasing the ventilation flow rate through the receiver tank is a poor control if ammonia is a significant contributor to the % LFL for two reasons: (1) % LFL decreases slowly with increasing ventilation flow rate and (2) the ammonia concentration in the vapor space reaches equilibrium with the ammonia concentration in the liquid waste within hours

Table 4-2. Possible DCRT 244-BX Control Decisions. (5 sheets)

Possible Control Decision	Thoughts For	Thoughts Against
<ul style="list-style-type: none"> DCRT inlet and portable exhaust is safety-class SSC 	<ul style="list-style-type: none"> New versus existing exhaust ventilation system avoids questions concerning upgrading the existing SSC classification and the reliability of the existing system 	<p>(i.e., the action completion time on loss of ventilation would be very short). Increased ventilation flow also has minimal affect on the contribution to the % LFL from dissolved hydrogen during waste transfers to DCRTs.</p> <ul style="list-style-type: none"> Cost is \$760,000 to install the new portable exhaust and inlet filter (does not include annual O&M costs) Schedule is 10 months to install the new portable exhaust and inlet filter
9. Increase air inlet flow via the dip-tubes	<ul style="list-style-type: none"> The costs and schedule to increase air inlet flow requirements (e.g., from 3 cfm to 12 cfm) is expected to be small 	<ul style="list-style-type: none"> Analysis of the increased air inlet flow possible via the existing dip-tubes shows no significant benefit Would likely require the installation of a new DCRT level monitoring system
10. Install an inerting system	<ul style="list-style-type: none"> Prevents flammable gas hazards by reducing oxygen concentrations below the LFL The high reliability, availability, and maintainability of an inerting system (versus a mechanical ventilation system or SHMS) could reduce salt well pumping shutdowns due to DCRT flammable gas hazard controls (i.e., cost savings to the interim stabilization program could offset the high costs of an inerting system) 	<ul style="list-style-type: none"> Cost is \$1,000,000 + to install an inerting system (does not include annual O&M costs) Schedule is 12 months+ to install an inerting system Potential impact on consent decree schedule
11. Dilution controls	<ul style="list-style-type: none"> Reduces the concentration of constituents in waste transferred to the DCRT that result in flammable gases that can accumulate in the receiver tank headspace (e.g., ammonia, dissolved hydrogen) 	<ul style="list-style-type: none"> Requires designation of the dilution systems and associated monitoring systems as safety-class Requires development of dilution requirements (i.e., dilution ratios) that are dependent on waste characterization data and the prediction of flammable gas concentrations in DCRT
12. Ignition controls	<ul style="list-style-type: none"> None 	<ul style="list-style-type: none"> Not generally used to control flammable gas hazards that are caused by the steady-state accumulation of flammable gases The cost and schedule of requiring installed equipment in the DCRT to meet Ignition Source Control Set 1 or 2 is unknown

AC = Administrative Control.
 ALARA = as low as reasonably achievable.
 D&D = decontamination and decommissioning.
 DCRT = double-contained receiver tank.
 DOE = U.S. Department of Energy.
 LCO = limiting condition for operation.
 LFL = lower flammability limit.
 O&M = operations and maintenance.
 SHMS = Standard Hydrogen Monitoring System.
 SSC = structure, system, and component.
 TSR = Technical Safety Requirement.
 USQ = Unreviewed Safety Question.

Table 4-3. Possible DCRT 244-S Control Decisions. (6 sheets)

Possible Control Decision	Thoughts For	Thoughts Against
1. Status Quo – No revisions to existing controls	<ul style="list-style-type: none"> No implementation costs 	<ul style="list-style-type: none"> Existing controls allow supplemental analysis and controls to ensure flammable gas concentrations are maintained below 25% of the LFL (i.e., the FSAR and TSRs do not completely define the safe operating envelope). DOE does not concur in this unique approach for DCRTs (see TWRs-RT-SER-003, pages 3-72 to 3-74) (DOE-RL 1999). Analysis shows existing controls (i.e., 3 or 5 cfm ventilation flow) are marginal for maintaining flammable gas concentrations below 25% of the LFL There are insufficient monitoring data to conclude that existing controls (i.e., 3 or 5 cfm) maintain flammable gas concentrations below 25% of the LFL Unlikely to provide an acceptable basis for resolution and closure of the Flammable Gas USQ for DCRTs (Kinzer 1999) None
2. Use an alternative route for salt well pumping of 241-S and 241-SX Tank Farm tanks and for 222-S Laboratory waste transfers; and D&D the DCRT (i.e., remove waste heel) Note: DCRT 244-S is not the primary route for salt well pumping of 241-S and 241-SX Tank Farm tanks, but control decisions were required to establish the Authorization Basis for potential use of DCRT 244-S as a backup route.	<ul style="list-style-type: none"> Flammable gas hazard eliminated Alternative methods for transferring 222-S Laboratory waste (i.e., new transfer line bypassing DCRT 244-S) may be cost effective versus DCRT and waste transfer line upgrades required to meet environmental requirements 	
3. Close valve in the ventilation exhaust line from the DCRT vault and revise the controls as follows: <ul style="list-style-type: none"> TSR LCO for DCRT exhaust ventilation system operability DCRT exhaust system is safety-class 	<ul style="list-style-type: none"> Ventilation system reconfiguration only requires valve closure 	<ul style="list-style-type: none"> In the absence of an inlet air path to the DCRT receiver tank, the ventilation flow rate through the receiver tank that would result from this reconfiguration of the exhaust ventilation system is unknown Increasing the ventilation flow rate through the receiver tank is a poor control if ammonia is a significant contributor to the % LFL for two reasons: (1) % LFL decreases slowly with increasing ventilation flow rate and (2) the ammonia concentration in the vapor space reaches equilibrium with the ammonia concentration in the liquid waste within hours (i.e., the action completion time on loss of ventilation would be very short). Increased ventilation flow also has minimal effect on the contribution to the % LFL from dissolved hydrogen during waste transfers to DCRTs.

Table 4-3. Possible DCRT 244-S Control Decisions. (6 sheets)

Possible Control Decision	Thoughts For	Thoughts Against
<p>Notes:</p> <ul style="list-style-type: none"> This control assumes that air leakage past the closed vault exhaust ventilation valve will be small Engineering would need to confirm that the reconfigured DCRT exhaust ventilation system could not to collapse the receiver tank due to high vacuum 		<ul style="list-style-type: none"> Potential ALARA and environmental concerns from eliminating ventilation flow to the DCRT vault Initial and subsequent costs resulting from designating the DCRT exhaust system as safety-class Reliability of the DCRT exhaust system (e.g., single exhaust fan, system age) The motor operated valve in the ventilation exhaust line from the DCRT vault may require maintenance to close
<p>4. Install flow monitor in existing DCRT receiver tank exhaust duct and revise the controls as follows:</p> <ul style="list-style-type: none"> TSR LCO for DCRT exhaust ventilation system operability (including minimum flow rate) DCRT exhaust system is safety-class 	<ul style="list-style-type: none"> Ventilation flow rate through the receiver tank is known and monitored Cost is \$180,000 to install the flow monitor Schedule is 6 months to install flow monitor 	<ul style="list-style-type: none"> In the absence of an inlet air path to the DCRT receiver tank, it is not known what the monitored ventilation flow rate through the receiver tank will be Even if an increased ventilation flow rate through the receiver tank is verified, this is a poor control if ammonia is a significant contributor to the % LFL for two reasons: (1) % LFL decreases slowly with increasing ventilation flow rate and (2) the ammonia concentration in the vapor space reaches equilibrium with the ammonia concentration in the liquid waste within hours (i.e., the action completion time on loss of ventilation would be very short). Increased ventilation flow also has minimal effect on the contribution to the % LFL from dissolved hydrogen during waste transfers to DCRTs. Initial and subsequent costs resulting from designating the DCRT exhaust system as safety-class Reliability of the DCRT exhaust system (e.g., single exhaust fan, system age) Worker radiation exposures during installation and maintenance of flow monitor
<p>5. Install new inlet filter with flow monitor for DCRT receiver tank and revise the controls as follows:</p> <ul style="list-style-type: none"> TSR LCO for DCRT inlet and exhaust ventilation system (including minimum flow rate) DCRT inlet and exhaust system is safety-class SSC 	<ul style="list-style-type: none"> Ventilation flow is increased by providing an inlet flow path to the receiver tank Ventilation flow is monitored Cost is \$260,000 to install the inlet filter Schedule is 7.5 months to install the inlet filter 	<ul style="list-style-type: none"> Increasing the ventilation flow rate through the receiver tank is a poor control if ammonia is a significant contributor to the % LFL for two reasons: (1) % LFL decreases slowly with increasing ventilation flow rate and (2) the ammonia concentration in the vapor space reaches equilibrium with the ammonia concentration in the liquid waste within hours (i.e., the action completion time on loss of ventilation would be very short). Increased ventilation flow also has minimal effect on the contribution to the % LFL from dissolved hydrogen during waste transfers to DCRTs.

Table 4-3. Possible DCRT 244-S Control Decisions. (6 sheets)

Possible Control Decision	Thoughts For	Thoughts Against
<p>Notes: Would require re-balancing the ventilation system</p> <p>6A. Install sample probes and connections for periodic vapor space sampling/monitoring and revised the controls as follows:</p> <ul style="list-style-type: none"> TSR requiring flammable gas monitoring of DCRT receiver tank vapor space Delete TSR LCO requiring 3 or 5 cfh air inlet flow and DCRT ventilation system safety-class designation <p>Note: This control strategy should be supported by analysis that shows without DCRT ventilation controls the flammable gas concentrations should not exceed 25% of the LFL.</p>	<ul style="list-style-type: none"> Provides monitoring for flammable gas hazards and alerts operators to take actions when flammable gas concentrations exceed 25% of the LFL. Periodic monitoring requirements can be defined based on operating modes (e.g., waste transfer, storage) and can be revised based on monitoring experience Cost is \$80,000 to install sample probes and connections (does not include annual O&M costs) Schedule is 4 months to install sample probes and connections Potential cost savings by deletion of existing TSR LCO requiring 3 or 5 cfh air inlet flow and DCRT ventilation system safety-class designation 	<ul style="list-style-type: none"> Initial and subsequent costs resulting from designating the DCRT exhaust system as safety-class Reliability of the DCRT exhaust system (e.g., single exhaust fan, system age) Does not directly control the flammable gas hazard (i.e., analyses show that without ventilation flammable gas concentrations in DCRTs can reach 100% of the LFL) Requires determination and justification of periodic monitoring requirements There could be significant cost and schedule impacts if waste transfers are stopped and remediation actions implemented whenever flammable gas concentrations exceed 25% of the LFL
<p>6B. Install sample probes and connections for periodic vapor space sampling/monitoring and revised the controls as follows:</p> <ul style="list-style-type: none"> TSR requiring flammable gas monitoring of DCRT receiver tank vapor space Retain TSR LCO requiring 3 or 5cfh air inlet flow and DCRT ventilation safety-class designation 	<ul style="list-style-type: none"> Provides monitoring for flammable gas hazards and alerts operators to take actions when flammable gas concentrations exceed 25% of the LFL Periodic monitoring requirements can be defined based on operating modes (e.g., waste transfer, storage) and can be revised based on monitoring experience Maintains 3 or 5 cfh air inlet flow requirements that analysis shows adequately controls hydrogen generation in the DCRT (i.e., maintains hydrogen concentrations below 25% LFL) 	<ul style="list-style-type: none"> Analysis shows 3 or 5 cfh air inlet flow is marginal for maintaining flammable gas concentrations (i.e., hydrogen, ammonia, and methane) below 25% of the LFL There are insufficient monitoring data to conclude that 3 or 5 cfh maintains flammable gas concentrations (i.e., hydrogen, ammonia, and methane) below 25% of the LFL Requires determination and justification of periodic monitoring requirements There could be significant cost and schedule impacts if waste transfers are stopped and remediation actions implemented whenever flammable gas concentrations exceed 25% of the LFL

Table 4-3. Possible DCRT 244-S Control Decisions. (6 sheets)

Possible Control Decision	Thoughts For	Thoughts Against
<p>Note: This control strategy should be supported by analysis that shows with 3 or 5 cfm air inlet flow the flammable gas concentrations should not exceed 25% of the LFL.</p> <p>7. Install SHMS for continuous vapor space monitoring and revise the controls as follows:</p> <ul style="list-style-type: none"> TSR LCO on SHMS operation and 25% LFL limit SHMS is safety-class SSC Delete TSR LCO requiring 3 or 5 cfm air inlet flow and DCRT ventilation system safety-class designation <p>OR</p> <ul style="list-style-type: none"> TSR AC requiring continuous flammable gas monitoring of DCRT vapor space and actions required if 25% of the LFL is exceeded Delete TSR LCO requiring 3 or 5 cfm air inlet flow and DCRT ventilation system safety-class designation <p>Note: This control strategy should be supported by analysis that shows without DCRT ventilation controls the flammable gas concentrations should not exceed 25% of the LFL</p>	<ul style="list-style-type: none"> Cost is \$80,000 to install sample probes and connections (does not include annual O&M costs) Schedule is 4 months to install sample probes and connections Provides continuous monitoring for flammable gas hazards and alerts operators to take actions when flammable gas concentrations exceed 25% of the LFL Potential cost savings by deletion of existing TSR LCO requiring 3 or 5 cfm air inlet flow and DCRT ventilation system safety-class designation Avoids the need to determine and justify periodic monitoring requirements 	<ul style="list-style-type: none"> Does not directly control the flammable gas hazard (i.e., analyses show that without ventilation flammable gas concentrations in DCRTs can reach 100% of the LFL) Cost is \$320,000 to install the SHMS (does not include annual O&M costs) Schedule is 11.5 months to install the SHMS Initial and subsequent cost resulting from designating the SHMS as safety-class. (Note: This could be avoided if the TSR is written as an AC and AC 5.19 is relied on to ensure SHMS operability and accuracy.) There could be significant cost and schedule impacts if waste transfers are stopped and remediation actions implemented whenever flammable gas concentrations exceed 25% of the LFL There could be cost and schedule impacts if transfers are stopped when the SHMS is inoperable

Table 4-3. Possible DCRT 244-S Control Decisions. (6 sheets)

Possible Control Decision	Thoughts For	Thoughts Against
<p>8. Install new portable exhaustor and revise the controls as follows:</p> <ul style="list-style-type: none"> TSR LCO for DCRT inlet and portable exhaustor operability DCRT inlet and portable exhaustor is safety-class SSC 	<ul style="list-style-type: none"> Ventilation flow to the receiver tank in significantly increased (e.g., 10 to 100s of cfm) Ventilation flow is monitored New versus existing exhaust ventilation system avoids questions concerning upgrading the existing SSC classification and the reliability of the existing system 	<ul style="list-style-type: none"> Increasing the ventilation flow rate through the receiver tank is a poor control if ammonia is a significant contributor to the % LFL for two reasons: (1) % LFL decreases slowly with increasing ventilation flow rate and (2) the ammonia concentration in the vapor space reaches equilibrium with the ammonia concentration in the liquid waste within hours (i.e., the action completion time on loss of ventilation would be very short). Increased ventilation flow also has minimal affect on the contribution to the % LFL from dissolved hydrogen during waste transfers to DCRTs. Cost is \$1,200,000 to install the new portable exhaustor and inlet filter (does not include annual O&M costs) Schedule is 19 months to install the new portable exhaustor and inlet filter
9. Increase air inlet flow via the dip-tubes	<ul style="list-style-type: none"> The costs and schedule to increase air inlet flow requirements (e.g., from 3 or 5 cfm to 12 cfm) is expected to be small 	<ul style="list-style-type: none"> Analysis of the increased air inlet flow possible via the existing dip-tubes shows no significant benefit Would likely require the installation of a new DCRT level monitoring system
10. Install an inerting system	<ul style="list-style-type: none"> Prevents flammable gas hazards by reducing oxygen concentrations below the LFL The high reliability, availability, and maintainability of an inerting system (versus a mechanical ventilation system or SHMS) could reduce salt well pumping shutdowns due to DCRT flammable gas hazard controls (i.e., cost savings to the interim stabilization program could offset the high costs of an inerting system) 	<ul style="list-style-type: none"> Cost is \$1,000,000+ to install an inerting system (does not include annual O&M costs) Schedule is 12 months+ to install an inerting system
11. Dilution controls	<ul style="list-style-type: none"> Reduces the concentration of constituents in waste transferred to the DCRT that result in flammable gases that can accumulate in the receiver tank headspace (e.g., ammonia, dissolved hydrogen) 	<ul style="list-style-type: none"> Requires designation of the dilution systems and associated monitoring systems as safety-class Requires development of dilution requirements (i.e., dilution ratios) that are dependent on waste characterization data and the prediction of flammable gas concentrations in DCRT

Table 4-3. Possible DCRT 244-S Control Decisions. (6 sheets)

Possible Control Decision	Thoughts For	Thoughts Against
12. Ignition controls	<ul style="list-style-type: none"> None 	<ul style="list-style-type: none"> Not generally used to control flammable gas hazards that are caused by the steady-state accumulation of flammable gases The cost and schedule of requiring installed equipment in the DCRT to meet Ignition Source Control Set 1 or 2 is unknown

AC = Administrative Control.
 ALARA = as low as reasonably achievable.
 D&D = decontamination and decommissioning.
 DCRT = double-contained receiver tank.
 DOE = U.S. Department of Energy.
 FSAR = Final Safety Analysis Report
 LCO = limiting condition for operation.
 LFL = lower flammability limit.
 O&M = operations and maintenance.
 SHMS = Standard Hydrogen Monitoring System.
 SSC = structure, system, and component.
 TSR = Technical Safety Requirement.
 USQ = Unreviewed Safety Question.

Table 4-4. Possible DCRT 244-TX Control Decisions. (5 sheets)

Possible Control Decision	Thoughts For	Thoughts Against
1. Status Quo – No revisions to existing controls	<ul style="list-style-type: none"> No implementation costs 	<ul style="list-style-type: none"> Existing controls allow supplemental analysis and controls to ensure flammable gas concentrations are maintained below 25% of the LFL (i.e., the FSAR and TSRs do not completely define the safe operating envelope). DOE does not concur in this unique approach for DCRTs (see TWRs-RT-SER-003, pages 3-72 to 3-74) (DOE-RL 1999). There are insufficient monitoring data to conclude that existing controls (i.e., 3 cfm) maintain flammable gas concentrations below 25% of the LFL Unlikely to provide an acceptable basis for resolution and closure of the Flammable Gas USQ for DCRTs (Kinzer 1999)
2. Use an alternative route for salt well pumping of Tank 241-T-110, if required, and for PFP waste transfers, and D&D the DCRT (i.e., remove waste heel)	<ul style="list-style-type: none"> Flammable gas hazard eliminated Alternative methods for transferring PFP waste (i.e., via truck) may be cost effective versus DCRT and waste transfer line upgrades required to meet environmental requirements 	<ul style="list-style-type: none"> No alternative route for salt well pumping of Tank 241-T-110 has been planned; alternatives methods for transferring PFP wastes are being considered (e.g., via truck), but there has been no decision on an alternative Costs for an alternative route for salt well pumping of Tank 241-T-110 are unknown but likely to be significant
3. Close valve in the ventilation exhaust line from the DCRT vault and revise the controls as follows: <ul style="list-style-type: none"> TSR LCO for DCRT exhaust ventilation system operability DCRT exhaust system is safety-class Notes: <ul style="list-style-type: none"> This control assumes that air leakage past the closed vault exhaust ventilation valve will be small Engineering would need to confirm that the reconfigured DCRT exhaust ventilation system could not to collapse the receiver tank due to high vacuum 	<ul style="list-style-type: none"> Ventilation system reconfiguration only requires valve closure 	<ul style="list-style-type: none"> In the absence of an inlet air path to the DCRT receiver tank, the ventilation flow rate through the receiver tank that would result from this reconfiguration of the exhaust ventilation system is unknown Increasing the ventilation flow rate through the receiver tank is a poor control if ammonia is a significant contributor to the % LFL for two reasons: (1) % LFL decreases slowly with increasing ventilation flow rate and (2) the ammonia concentration in the vapor space reaches equilibrium with the ammonia concentration in the liquid waste within hours (i.e., the action completion time on loss of ventilation would be very short). Increased ventilation flow also has minimal effect on the contribution to the % LFL from dissolved hydrogen during waste transfers to DCRTs. Potential ALARA and environmental concerns from eliminating ventilation flow to the DCRT vault Initial and subsequent costs resulting from designating the DCRT exhaust system as safety-class Reliability of the DCRT exhaust system (e.g., single exhaust fan, system age)

Table 4-4. Possible DCRT 244-TX Control Decisions. (5 sheets)

Possible Control Decision	Thoughts For	Thoughts Against
<p>4. Install flow monitor in existing DCRT receiver tank exhaust duct and revise the controls as follows:</p> <ul style="list-style-type: none"> • TSR LCO for DCRT exhaust ventilation system operability (including minimum flow rate) • DCRT exhaust system is safety-class 	<ul style="list-style-type: none"> • Ventilation flow rate through the receiver tank is known and monitored • Cost is \$180,000 to install the flow monitor • Schedule is 6 months to install flow monitor 	<ul style="list-style-type: none"> • The motor operated valve in the ventilation exhaust line from the DCRT vault may require maintenance to close • In the absence of an inlet air path to the DCRT receiver tank, it is not known what the monitored ventilation flow rate through the receiver tank will be • Even if an increased ventilation flow rate through the receiver tank is verified, this is a poor control if ammonia is a significant contributor to the % LFL for two reasons: (1) % LFL decreases slowly with increasing ventilation flow rate and (2) the ammonia concentration in the vapor space reaches equilibrium with the ammonia concentration in the liquid waste within hours (i.e., the action completion time on loss of ventilation would be very short). Increased ventilation flow also has minimal effect on the contribution to the % LFL from dissolved hydrogen during waste transfers to DCRTs. • Initial and subsequent costs resulting from designating the DCRT exhaust system as safety-class • Reliability of the DCRT exhaust system (e.g., single exhaust fan, system age) • Worker radiation exposures during installation and maintenance of flow monitor
<p>5. Install new inlet filter with flow monitor for DCRT receiver tank and revise the controls as follows:</p> <ul style="list-style-type: none"> • TSR LCO for DCRT inlet and exhaust ventilation system (including minimum flow rate) • DCRT inlet and exhaust system is safety-class SSC <p>Notes: Would require re-balancing the ventilation system</p>	<ul style="list-style-type: none"> • Ventilation flow is increased by providing an inlet flow path to the receiver tank • Ventilation flow is monitored • Cost is \$160,000 to install the inlet filter • Schedule is 4 months to install the inlet filter 	<ul style="list-style-type: none"> • Increasing the ventilation flow rate through the receiver tank is a poor control if ammonia is a significant contributor to the % LFL for two reasons: (1) % LFL decreases slowly with increasing ventilation flow rate and (2) the ammonia concentration in the vapor space reaches equilibrium with the ammonia concentration in the liquid waste within hours (i.e., the action completion time on loss of ventilation would be very short). Increased ventilation flow also has minimal effect on the contribution to the % LFL from dissolved hydrogen during waste transfers to DCRTs. • Initial and subsequent costs resulting from designating the DCRT exhaust system as safety-class • Reliability of the DCRT exhaust system (e.g., single exhaust fan, system age)

Table 4-4. Possible DCRT 244-TX Control Decisions. (5 sheets)

Possible Control Decision	Thoughts For	Thoughts Against
<p>6A. Install sample probes and connections for periodic vapor space sampling/monitoring and revised the controls as follows:</p> <ul style="list-style-type: none"> TSR requiring flammable gas monitoring of DCRT receiver tank vapor space Delete TSR LCO requiring 3 cfm air inlet flow and DCRT ventilation system safety-class designation <p>Note: This control strategy should be supported by analysis that shows without DCRT ventilation controls the flammable gas concentrations should not exceed 25% of the LFL.</p>	<ul style="list-style-type: none"> Provides monitoring for flammable gas hazards and alerts operators to take actions when flammable gas concentrations exceed 25% of the LFL Periodic monitoring requirements can be defined based on operating modes (e.g., waste transfer, storage) and can be revised based on monitoring experience Cost is \$50,000 to install sample probes and connections (does not include annual O&M costs) Schedule is 2.5 months to install sample probes and connections Potential cost savings by deletion of existing TSR LCO requiring 3 cfm air inlet flow and DCRT ventilation system safety-class designation 	<ul style="list-style-type: none"> Does not directly control the flammable gas hazard (i.e., analyses show that without ventilation flammable gas concentrations in DCRTs can reach 100% of the LFL) Requires determination and justification of periodic monitoring requirements There could be significant cost and schedule impacts if waste transfers are stopped and remediation actions implemented whenever flammable gas concentrations exceed 25% of the LFL.
<p>6B. Install sample probes and connections for periodic vapor space sampling/monitoring and revised the controls as follows:</p> <ul style="list-style-type: none"> TSR requiring flammable gas monitoring of DCRT receiver tank vapor space Retain TSR LCO requiring 3 cfm air inlet flow and DCRT ventilation safety-class designation <p>Note: This control strategy should be supported by analysis that shows with 3 cfm air inlet flow the flammable gas concentrations should not exceed 25% of the LFL.</p>	<ul style="list-style-type: none"> Provides monitoring for flammable gas hazards and alerts operators to take actions when flammable gas concentrations exceed 25% of the LFL Periodic monitoring requirements can be defined based on operating modes (e.g., waste transfer, storage) and can be revised based on monitoring experience Maintains 3 cfm air inlet flow requirements that analysis shows adequately controls hydrogen generation in the DCRT (i.e., maintains hydrogen concentrations below 25% LFL Cost is \$50,000 to install sample probes and connections (does not include annual O&M costs) Schedule is 2.5 months to install sample probes and connections 	<ul style="list-style-type: none"> There are insufficient monitoring data to conclude that 3 cfm maintains flammable gas concentrations (i.e., hydrogen, ammonia, and methane) below 25% of the LFL Requires determination and justification of periodic monitoring requirements There could be significant cost and schedule impacts if waste transfers are stopped and remediation actions implemented whenever flammable gas concentrations exceed 25% of the LFL

Table 4-4. Possible DCRT 244-TX Control Decisions. (5 sheets)

Possible Control Decision	Thoughts For	Thoughts Against
<p>7. Install SHMS for continuous vapor space monitoring and revise the controls as follows:</p> <ul style="list-style-type: none"> • TSR LCO on SHMS operation and 25% LFL limit • SHMS is safety-class SSC • Delete TSR LCO requiring 3 cfm air inlet flow and DCRT ventilation system safety-class designation <p style="text-align: center;">OR</p> <ul style="list-style-type: none"> • TSR AC requiring continuous flammable gas monitoring of DCRT vapor space and actions required if 25% of the LFL is exceeded • Delete TSR LCO requiring 3 cfm air inlet flow and DCRT ventilation system safety-class designation <p>Note: This control strategy should be supported by analysis that shows without DCRT ventilation controls the flammable gas concentrations should not exceed 25% of the LFL</p>	<ul style="list-style-type: none"> • Provides continuous monitoring for flammable gas hazards and alerts operators to take actions when flammable gas concentrations exceed 25% of the LFL • Potential cost savings by deletion of existing TSR LCO requiring 3 cfm air inlet flow and DCRT ventilation system safety-class designation • Avoids the need to determine and justify periodic monitoring requirements 	<ul style="list-style-type: none"> • Does not directly control the flammable gas hazard (i.e., analyses show that without ventilation flammable gas concentrations in DCRTs can reach 100% of the LFL) • Cost is \$220,000 to install the SHMS (does not include annual O&M costs) • Schedule is 6.5 months to install the SHMS • Initial and subsequent cost resulting from designating the SHMS as safety-class. (Note: This could be avoided if the TSR is written as an AC and AC 5.19 is relied on to ensure SHMS operability and accuracy.) • There could be significant cost and schedule impacts if waste transfers are stopped and remediation actions implemented whenever flammable gas concentrations exceed 25% of the LFL • There could be cost and schedule impacts if transfers are stopped when the SHMS is inoperable
<p>8. Install new portable exhaustor and new inlet filter and revise the controls as follows:</p> <ul style="list-style-type: none"> • TSR LCO for DCRT inlet and portable exhaustor operability • DCRT inlet and portable exhaustor is safety-class SSC 	<ul style="list-style-type: none"> • Ventilation flow to the receiver tank in significantly increased (e.g., 10s to 100s of cfm) • Ventilation flow is monitored • New versus existing exhaust ventilation system avoids questions concerning upgrading the existing SSC classification and the reliability of the existing system 	<ul style="list-style-type: none"> • Increasing the ventilation flow rate through the receiver tank is a poor control if ammonia is a significant contributor to the % LFL for two reasons: (1) % LFL decreases slowly with increasing ventilation flow rate and (2) the ammonia concentration in the vapor space reaches equilibrium with the ammonia concentration in the liquid waste within hours (i.e., the action completion time on loss of ventilation would be very short). Increased ventilation flow also has minimal effect on the contribution to the % LFL from dissolved hydrogen during waste transfers to DCRTs.

Table 4-4. Possible DCRT 244-TX Control Decisions. (5 sheets)

Possible Control Decision	Thoughts For	Thoughts Against
		<ul style="list-style-type: none"> Cost is \$760,000 to install the new portable exhaustor and inlet filter (does not include annual O&M costs) Schedule is 10 months to install the new portable exhaustor and inlet filter Analysis of the increased air inlet flow possible via the existing dip-tubes shows no significant benefit Would likely require the installation of a new DCRT level monitoring system
9. Increase air inlet flow via the dip-tubes	<ul style="list-style-type: none"> The costs and schedule to increase air inlet flow requirements (e.g., from 3 cfm to 12 cfm) is expected to be small 	
10. Install an inerting system	<ul style="list-style-type: none"> Prevents flammable gas hazards by reducing oxygen concentrations below the LFL The high reliability, availability, and maintainability of an inerting system (versus a mechanical ventilation system or SHMS) could reduce salt well pumping shutdowns due to DCRT flammable gas hazard controls (i.e., cost savings to the interim stabilization program could offset the high costs of an inerting system) 	<ul style="list-style-type: none"> Cost is \$1,000,000+ to install an inerting system (does not include annual O&M costs) Schedule is 12 months+ to install an inerting system Potential impact on consent decree schedule
11. Dilution controls	<ul style="list-style-type: none"> Reduces the concentration of constituents in waste transferred to the DCRT that result in flammable gases that can accumulate in the receiver tank headspace (e.g., ammonia, dissolved hydrogen) 	<ul style="list-style-type: none"> Requires designation of the dilution systems and associated monitoring systems as safety-class Requires development of dilution requirements (i.e., dilution ratios) that are dependent on waste characterization data and the prediction of flammable gas concentrations in DCRT
12. Ignition controls	<ul style="list-style-type: none"> None 	<ul style="list-style-type: none"> Not generally used to control flammable gas hazards that are caused by the steady-state accumulation of flammable gases The cost and schedule of requiring installed equipment in the DCRT to meet Ignition Source Control Set 1 or 2 is unknown

AC = Administrative Control.
 ALARA = as low as reasonably achievable.
 D&D = decontamination and decommissioning.
 DCRT = double-contained receiver tank.
 DOE = U.S. Department of Energy.
 FSAR = Final Safety Analysis Report.
 LCO = limiting condition for operation.
 LFL = lower flammability limit.
 O&M = operations and maintenance.
 PFP = Plutonium Finishing Plant.
 SHMS = Standard Hydrogen Monitoring System.
 SSC = structure, system, and component.
 TSR = Technical Safety Requirement.
 USQ = Unreviewed Safety Question.

Table 4-5. Possible DCRT 244-U Control Decisions. (4 sheets)

Possible Control Decision	Thoughts For	Thoughts Against
1. Status Quo – No revisions to existing controls	<ul style="list-style-type: none"> No implementation costs 	<ul style="list-style-type: none"> Existing controls allow supplemental analysis and controls to ensure flammable gas concentrations are maintained below 25% of the LFL (i.e., the FSAR and TSRs do not completely define the safe operating envelope). DOE does not concur in this unique approach for DCRTs (see TWRs-RT-SER-003, pages 3-72 to 3-74) (DOE-RL 1999). Analysis shows existing controls (i.e., 3 cfm ventilation flow) are marginal for maintaining flammable gas concentrations below 25% of the LFL There are insufficient monitoring data to conclude that existing controls (i.e., 3 cfm) maintain flammable gas concentrations below 25% of the LFL Unlikely to provide an acceptable basis for resolution and closure of the Flammable Gas USQ for DCRTs (Kinzer 1999)
2. Use an alternative route for salt well pumping of 241-U Tank Farm tanks Note: This is the planned control, but control decisions were required to establish the Authorization Basis for potential use of DCRT 244-U as a backup route for the salt well pumping of 241-U Tank Farm tanks.	<ul style="list-style-type: none"> Flammable gas hazard eliminated 	<ul style="list-style-type: none"> None
3. Install a flow monitor on the existing DCRT receiver tank inlet or in the existing DCRT receiver tank exhaust duct and revise the controls as follows: <ul style="list-style-type: none"> TSR LCO for DCRT receiver tank inlet and exhaust ventilation system operability (including minimum flow rate) DCRT inlet and exhaust system is safety-class 	<ul style="list-style-type: none"> Ventilation flow rate through the receiver tank is known and monitored Cost and schedule to install a flow monitor have not been estimated, but should be less than the \$180,000 and 6 months estimated for DCRTs 244-BX and 244-TX There are no ALARA issues since the DCRT has never contained waste 	<ul style="list-style-type: none"> Even if an increased ventilation flow rate through the receiver tank is verified, this is a poor control if ammonia is a significant contributor to the % LFL for two reasons: (1) % LFL decreases slowly with increasing ventilation flow rate and (2) the ammonia concentration in the vapor space reaches equilibrium with the ammonia concentration in the liquid waste within hours (i.e., the action completion time on loss of ventilation would be very short). Increased ventilation flow also has minimal effect on the contribution to the % LFL from dissolved hydrogen during waste transfers to DCRTs.

Table 4-5. Possible DCRT 244-U Control Decisions. (4 sheets)

Possible Control Decision	Thoughts For	Thoughts Against
<p>Note: The ventilation flow rate through the DCRT receiver tank can be adjusted by opening or closing the valve in the ventilation system exhaust line from the DCRT vault.</p> <p>4A. Install sample probes and connections for periodic vapor space sampling/monitoring and revised the controls as follows:</p> <ul style="list-style-type: none"> TSR requiring flammable gas monitoring of DCRT receiver tank vapor space Delete TSR LCO requiring 3 cfm air inlet flow and DCRT ventilation system safety-class designation <p>Note: This control strategy should be supported by analysis that shows without DCRT ventilation controls the flammable gas concentrations should not exceed 25% of the LFL.</p>	<ul style="list-style-type: none"> Provides monitoring for flammable gas hazards and alerts operators to take actions when flammable gas concentrations exceed 25% of the LFL Periodic monitoring requirements can be defined based on operating modes (e.g., waste transfer, storage) and can be revised based on monitoring experience Cost is $\leq \\$50,000$ to install sample probes and connections (does not include annual O&M costs) Schedule is ≤ 2.5 months to install sample probes and connections Potential cost savings by deletion of existing TSR LCO requiring 3 cfm air inlet flow and DCRT ventilation system safety-class designation 	<ul style="list-style-type: none"> Initial and subsequent costs resulting from designating the DCRT exhaust system as safety-class Reliability of the DCRT exhaust system (e.g., single exhaust fan, system age) Does not directly control the flammable gas hazard (i.e., analyses show that without ventilation flammable gas concentrations in DCRTs can reach 100% of the LFL) Requires determination and justification of periodic monitoring requirements There could be significant cost and schedule impacts if waste transfers are stopped and remediation actions implemented whenever flammable gas concentrations exceed 25% of the LFL
<p>4B. Install sample probes and connections for periodic vapor space sampling/monitoring and revised the controls as follows:</p> <ul style="list-style-type: none"> TSR requiring flammable gas monitoring of DCRT receiver tank vapor space Retain TSR LCO requiring 3 cfm air inlet flow and DCRT ventilation safety-class designation <p>Note: This control strategy should be supported by analysis that shows with 3 cfm air inlet flow the flammable gas concentrations should not exceed 25% of the LFL.</p>	<ul style="list-style-type: none"> Provides monitoring for flammable gas hazards and alerts operators to take actions when flammable gas concentrations exceed 25% of the LFL Periodic monitoring requirements can be defined based on operating modes (e.g., waste transfer, storage) and can be revised based on monitoring experience Maintains 3 cfm air inlet flow requirements that analysis shows adequately controls hydrogen generation in the DCRT (i.e., maintains hydrogen concentrations below 25% LFL) Cost is $\leq \\$50,000$ to install sample probes and connections (does not include annual O&M costs) Schedule is ≤ 2.5 months to install sample probes and connections 	<ul style="list-style-type: none"> Analysis shows 3 cfm air inlet flow is marginal for maintaining flammable gas concentrations (i.e., hydrogen, ammonia, and methane) below 25% of the LFL There are insufficient monitoring data to conclude that 3 cfm maintains flammable gas concentrations (i.e., hydrogen, ammonia, and methane) below 25% of the LFL Requires determination and justification of periodic monitoring requirements There could be significant cost and schedule impacts if waste transfers are stopped and remediation actions implemented whenever flammable gas concentrations exceed 25% of the LFL.

Table 4-5. Possible DCRT 244-U Control Decisions. (4 sheets)

Possible Control Decision	Thoughts For	Thoughts Against
<p>5. Install SHMS for continuous vapor space monitoring and revise the controls as follows:</p> <ul style="list-style-type: none"> TSR LCO on SHMS operation and 25% LFL limit SHMS is safety-class SSC Delete TSR LCO requiring 3 cfh air inlet flow and DCRT ventilation system safety-class designation <p>OR</p> <ul style="list-style-type: none"> TSR AC requiring continuous flammable gas monitoring of DCRT vapor space and actions required if 25% of the LFL is exceeded Delete TSR LCO requiring 3 cfh air inlet flow and DCRT ventilation system safety-class designation <p>Note: This control strategy should be supported by analysis that shows without DCRT ventilation controls the flammable gas concentrations should not exceed 25% of the LFL</p>	<ul style="list-style-type: none"> Provides continuous monitoring for flammable gas hazards and alerts operators to take actions when flammable gas concentrations exceed 25% of the LFL Potential cost savings by deletion of existing TSR LCO requiring 3 cfh air inlet flow and DCRT ventilation system safety-class designation Avoids the need to determine and justify periodic monitoring requirements 	<ul style="list-style-type: none"> Does not directly control the flammable gas hazard (i.e., analyses show that without ventilation flammable gas concentrations in DCRTs can reach 100% of the LFL) Cost is ~\$220,000 to install the SHMS (does not include annual O&M costs) Schedule is ~6.5 months to install the SHMS Initial and subsequent cost resulting from designating the SHMS as safety-class. (Note: This could be avoided if the TSR is written as an AC and AC 5.19 is relied on to ensure SHMS operability and accuracy.) There could be significant cost and schedule impacts if waste transfers are stopped and remediation actions implemented whenever flammable gas concentrations exceed 25% of the LFL There could be cost and schedule impacts if transfers are stopped when the SHMS is inoperable
<p>6. Install new portable exhausters and revise the controls as follows:</p> <ul style="list-style-type: none"> TSR LCO for DCRT inlet and portable exhauster operability DCRT inlet and portable exhauster is safety-class SSC 	<ul style="list-style-type: none"> Ventilation flow to the receiver tank in significantly increased (e.g., 10 to 100s of cfm) Ventilation flow is monitored New versus existing exhaust ventilation system avoids questions concerning upgrading the existing SSC classification and the reliability of the existing system 	<ul style="list-style-type: none"> Increasing the ventilation flow rate through the receiver tank is a poor control if ammonia is a significant contributor to the % LFL for two reasons: (1) % LFL decreases slowly with increasing ventilation flow rate and (2) the ammonia concentration in the vapor space reaches equilibrium with the ammonia concentration in the liquid waste within hours (i.e., the action completion time on loss of ventilation would be very short). Increased ventilation flow also has minimal effect on the contribution to the % LFL from dissolved hydrogen during waste transfers to DCRTs.

Table 4-5. Possible DCRT 244-U Control Decisions. (4 sheets)

Possible Control Decision	Thoughts For	Thoughts Against
7. Increase air inlet flow via the dip-tubes	<ul style="list-style-type: none"> The costs and schedule to increase air inlet flow requirements (e.g., from 3 cfm to 12 cfm) is expected to be small 	<ul style="list-style-type: none"> Cost is ~\$760,000 to install the new portable exhauster and inlet filter (does not include annual O&M costs) Schedule is ~10 months to install the new portable exhauster and inlet filter Analysis of the increased air inlet flow possible via the existing dip-tubes shows no significant benefit Would likely require the installation of a new DCRT level monitoring system
8. Install an inerting system	<ul style="list-style-type: none"> Prevents flammable gas hazards by reducing oxygen concentrations below the LFL The high reliability, availability, and maintainability of an inerting system (versus a mechanical ventilation system or SHMS) could reduce salt well pumping shutdowns due to DCRT flammable gas hazard controls (i.e., cost savings to the interim stabilization program could offset the high costs of an inerting system) 	<ul style="list-style-type: none"> Cost is \$1,000,000+ to install an inerting system (does not include annual O&M costs) Schedule is 12 months+ to install an inerting system Potential impact on consent decree schedule
9. Dilution controls	<ul style="list-style-type: none"> Reduces the concentration of constituents in waste transferred to the DCRT that result in flammable gases that can accumulate in the receiver tank headspace (e.g., ammonia, dissolved hydrogen) 	<ul style="list-style-type: none"> Requires designation of the dilution systems and associated monitoring systems as safety-class Requires development of dilution requirements (i.e., dilution ratios) that are dependent on waste characterization data and the prediction of flammable gas concentrations in DCRT
10. Ignition controls	<ul style="list-style-type: none"> None 	<ul style="list-style-type: none"> Not generally used to control flammable gas hazards that are caused by the steady-state accumulation of flammable gases The cost and schedule of requiring installed equipment in the DCRT to meet Ignition Source Control Set 1 or 2 is unknown

AC = Administrative Control.
 ALARA = as low as reasonably achievable.
 DCRT = double-contained receiver tank.
 DOE = U.S. Department of Energy.
 FSAR = Final Safety Analysis Report.
 LCO = limiting condition for operation.

LFL = lower flammability limit.
 O&M = operations and maintenance.
 SHMS = Standard Hydrogen Monitoring System.
 SSC = structure, system, and component.
 TSR = Technical Safety Requirement.
 USQ = Unreviewed Safety Question.

Table 4-6. Summary of DCRT Flammable Gas Calculations Supporting the Revision to TSR LCO 3.2.4
 “DCRT Ventilation Systems.” (2 sheets)

DCRT	Steady State Hydrogen % LFL ^f	Time from 25% to 100% LFL following Loss of Ventilation ^b	Time Allocated to Surveillance Frequency and Action Completion Time ^c	Surveillance Frequency (with 25% Extension) ^d	Action Completion Time ^d
DCRT 244-BX					
Salt well waste ^e	12% LFL	98 days	49 days	14 days (17 days)	7 days
DCRT 244-TX					
Salt well waste ^f	7.1% LFL	248 days	124 days	31 days (38 days)	7 days
PPP waste	7.1% LFL	252 days	126 days	31 days (38 days)	7 days
DCRT 244-S					
Salt well waste ^g	<25% LFL	10 days	5 days (120 hours)	12 hours (15 hours)	72 hours
222-S Laboratory waste	4.9% LFL	226 days	113 days	31 days (38 days)	7 days
Catch tank waste	5.0% LFL	221 days	110 days	31 days (38 days)	7 days
Existing tank waste	5.4% LFL	181 days	90 days	31 days (38 days)	7 days
DCRT 244-A					
Cross-site transfer waste ^h	12% LFL	50 days	25 days	7 days (8 days)	7 days
DCRT 244-U					
Salt well waste ⁱ	12% LFL	106 days	53 days	14 days (17 days)	7 days

Table 4-6. Summary of DCRT Flammable Gas Calculations Supporting the Revision to TSR LCO 3.2.4
 "DCRT Ventilation Systems." (2 sheets)

DCRT	Steady State Hydrogen % LFL ^a	Time from 25% to 100% LFL following Loss of Ventilation ^b	Time Allocated to Surveillance Frequency and Action Completion Time ^c	Surveillance Frequency (with 25% Extension) ^d	Action Completion Time ^d
DCRT 244-TK-CR-003					
Existing tank waste ^e	<100% LFL	--	--	--	--
Interim stabilization waste ^k	<25% LFL	130 hours	65 hours	12 hours (15 hours)	24 hours
Post-interim stabilization waste ^l	<25% LFL	>130 hours	--	--	--

^aThe steady state hydrogen % LFL with the DCRT 80% full and a DCRT ventilation system air inlet flow of 3 cfm for DCRTs 244-A, 244-BX, 244-S, 244-TX, and 244-U except for salt well waste transfers to DCRT 244-S where the air inlet flow is 7 cfm. (Note: The steady state hydrogen concentration is independent of the flow rate of the waste transfer into the DCRT). For DCRT 244-TK-CR-003, see referenced notes. All results are reported to the nearest percent, but the analysis may not be as accurate as this implies.

^bThe time to go from 25% LFL to 100% LFL following the loss of DCRT ventilation system air flow with the DCRT 80% full for DCRTs 244-A, 244-BX, 244-S, 244-TX, and 244-U. For DCRT 244-TK-CR-003, see referenced notes. The only ventilation flow is barometric breathing (i.e., an average air exchange rate of 0.45% of the DCRT headspace volume per day). Ammonia is not considered in the predictions for salt well wastes and, although ammonia is included in the predictions for other wastes, where applicable, it has no significant effect on the predictions. All results are reported to the nearest day or hour, but the analysis may not be as accurate as this implies.

^cThe time allocated to the surveillance frequency and action completion time is one-half (1/2) the time calculated to go from 25% LFL to 100% LFL following the loss of DCRT ventilation system air flow (i.e., third column). This provides a safety factor of two (2) to account for uncertainties in the hydrogen generation rates.

^dThe surveillance frequency and action completion time must satisfy the following requirement

$$[2 \times (\text{Surveillance Frequency} + 25\% \text{ Extension})] + (\text{Action Completion Time}) \leq \text{Column 4}$$

The allocation of time between the surveillance frequency and action completion time is qualitative and determined primarily based on operation considerations.

^eCalculations address salt well waste from Tanks 241-BY-105 and 241-BY-106.

^fCalculations address salt well waste from Tanks 241-T-104 and 241-T-110.

^gCalculations address salt well waste from 241-S and 241-SX Tank Farm tanks. Assumed DCRT ventilation inlet air supply is 7 cfm. For an inlet air supply of 3 cfm the DCRT receiver tank level would have to be limited to <35% to maintain the hydrogen concentration <25% of the LFL.

^hCalculations are for Tank 241-SY-101 waste diluted 1:1 which was determined to be the limiting waste.

ⁱCalculations address salt well waste from 241-U Tank Farm tanks, and encompass waste transfers from catch tank 241-U-301B.

^jCalculations address the existing waste and waste quantity in DCRT 244-TK-CR-003. The only ventilation flow is barometric breathing (i.e., an average air exchange rate of 0.45% of the DCRT headspace volume per day). Ammonia is included in the calculations.

^kCalculations address pumpable liquid waste from all four 244-CR Vault tanks and the existing waste sludge in DCRT 244-TK-CR-003. Assumed DCRT ventilation air flow is 12 cfm and the DCRT is 80% full. Ammonia is included in the calculations.

^lCalculations address post-interim stabilization waste and waste quantity in DCRT 244-TK-CR-003 (i.e., all pumpable liquid waste removed and the existing waste sludge). Assumed DCRT ventilation air flow is 12 cfm. Ammonia is included in the calculations.

Table 4-7. Summary of DCRT Flammable Gas Calculations Supporting the Revision to TSR AC 5.11
 “Flammable Gas Monitoring Controls.” (2 sheets)

DCRT	Post-Fill Flammable Gas %LFL (Hydrogen, Ammonia, and Methane) ^a	Steady State Flammable Gas %LFL (Hydrogen, Ammonia, and Methane) ^a	Time to 100% LFL following Loss of Ventilation ^b	Flammable Gas Monitoring Frequency ^c	Action Time ^c
DCRT 244-BX					
Salt well waste ^d	15% LFL	18% LFL	*	--	--
DCRT 244-TX					
Salt well waste ^e	Not Applicable	7% LFL	*	--	--
PPF waste	<1% LFL	7% LFL	*	--	--
DCRT 244-S					
Salt well waste ^f	72% LFL	71% LFL	4 days ^g	24 hours	72 hours
222-S Laboratory waste	<1% LFL	5% LFL	*	--	--
Catch tank waste	<1% LFL	5% LFL	*	--	--
Existing tank waste	Not Applicable	6% LFL	*	--	--
DCRT 244-A					
Cross-site transfer waste ^b	9% LFL	20% LFL	*	--	--
DCRT 244-U					
Salt well waste ⁱ	12% LFL	17% LFL	*	--	--

Table 4-7. Summary of DCRT Flammable Gas Calculations Supporting the Revision to TSR AC 5.11
 "Flammable Gas Monitoring Controls." (2 sheets)

DCRT	Post-Fill Flammable Gas % LFL (Hydrogen, Ammonia, and Methane) ^a	Steady State Flammable Gas % LFL (Hydrogen, Ammonia, and Methane) ^a	Time to 100% LFL following Loss of Ventilation ^b	Flammable Gas Monitoring Frequency ^c	Action Time ^c
DCRT 244-TK-CR-003					
Existing tank waste ^d	<100% LFL	<100% LFL	*	--	--
Interim stabilization waste ^e	<25% LFL	<25% LFL	*	--	--
Post-interim stabilization waste ^f	<25% LFL	<25% LFL	*	--	--

* Not reported since neither the post-fill or steady state flammable gas concentration exceed 25% LFL. See Table 4-6 for time from 25% to 100% LFL following loss of ventilation.

^aThe post-fill and steady state flammable gas % LFL with the DCRT 80% full and a DCRT ventilation system air inlet flow of 3 cfm for DCRTs 244-A, 244-BX, 244-S, 244-TX, and 244-U except for salt well waste transfers to DCRT 244-S where the air inlet flow is 7 cfm. For DCRT 244-TK-CR-003, see referenced notes. All results are reported to the nearest percent, but the analysis may not be as accurate as this implies.

^bThe time to reach 100% LFL from the higher of the post-fill or steady state flammable gas concentration following the loss of DCRT ventilation system air flow with the DCRT 80% full. The only ventilation flow is barometric breathing (i.e., an average air exchange rate of 0.45% of the DCRT headspace volume per day).

^c The flammable gas monitoring frequency and action time must satisfy the following requirement

Flammable Gas Monitoring Frequency + Action Time ≤ Column 4

The action time is assumed to be the same as the action completion time for LCO 3.2.4.

^dCalculations address salt well waste from Tanks 241-BY-105 and 241-BY-106.

^eCalculations address salt well waste from Tanks 241-T-104 and 241-T-110.

^fCalculations address salt well waste from 241-S and 241-SX Tank Farm tanks. Assumed DCRT ventilation inlet air supply is 7 cfm.

^gThe time is from the post-fill concentration of 72% LFL to 100% of the LFL.

^hCalculations are for Tank 241-SY-101 waste diluted 1:1 which was determined to be the limiting waste.

ⁱCalculations address salt well waste from 241-U Tank Farm tanks, and encompass waste transfers from catch tank 241-U-301B.

^jCalculations address the existing waste and waste quantity in DCRT 244-TK-CR-003. The only ventilation flow is barometric breathing (i.e., an average air exchange rate of 0.45% of the DCRT headspace volume per day).

^kCalculations address pumpable liquid waste from all four 244-CR Vault tanks and the existing waste sludge in DCRT 244-TK-CR-003. Assumed DCRT ventilation air flow is 12 cfm and the DCRT is 80% full.

^lCalculations address post-interim stabilization waste and waste quantity in DCRT 244-TK-CR-003 (i.e., all pumpable liquid waste removed and the existing waste sludge). Assumed DCRT ventilation air flow is 12 cfm.

Table 4-8. Summary of DCRT Vault Flammable Gas Concentrations.

DCRT Vault	Maximum Flammable Gas Concentration ^a
244-A	58% LFL
244-BX	28% LFL
244-S	
If no future salt well waste transfers	44% LFL
If future salt well waste transfers	>100% LFL ^b
244-TX	33% LFL
244-U	26% LFL
244-CR Vault	
Existing tank waste	31% LFL
Existing tank waste plus 1000 gal sump water	31% LFL
Tank 80% full of worst case composite	>100% LFL ^c
Final end state of tank	>100% LFL ^d

Note: The table summarizes the results of predictions of the flammable gas concentration in a DCRT vault following the postulated failure of the DCRT receiver tank. The DCRT is assume to be 80% full of waste that will result in the highest flammable gas concentration. The only ventilation flow is barometric breathing (i.e., an average air exchange rate of 0.45% of the DCRT headspace volume per day).

^aAll results are reported to the nearest percent, but the analysis may not be as accurate as this implies.

^bThe predicted time to reach 100% of the LFL is 31 days.

^cThe predicted time to reach 100% of the LFL is ~52 days.

^dThe predicted time to reach 100% of the LFL is >52 days.

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5.0 CONTROL DECISIONS

Appendix A is the control decision record documenting the controls selected to prevent or mitigate flammable gas hazards in DCRTs at the November 16, 17, and 18, 1999, April 19, 2000, and May 20, 2000 control decision meetings. This section summarizes the discussions at the control decisions meetings and documents the basis why controls were selected or not selected. Sections 5.1 to 5.7 summarize the control decision discussions for DCRTs 244-A, 244-BX, 244-S, 244-TX, and 244-U at the November 16, 17, and 18, 1999 meetings and the review and revision of these control decisions at the April 19, 2000 meeting. Sections 5.8 and 5.9 summarize the control decision discussions at the April 19, 2000 and May 20, 2000 meetings on DCRT vault flammable gas controls and 244-CR Vault Tank 003 flammable gas controls, respectively. Section 5.10 provides a summary of control decision strategy discussions for DCRT 244-S.

5.1 EXISTING CONTROLS (STATUS QUO)

At the November 16, 17, and 18, 1999 control decision meeting, there was consensus that revisions to the existing controls and/or new controls were needed to further address the risk of flammable gas hazards for DCRTs 244-A, 244-BX, 244-S, 244-TX, and 244-U (i.e., the Flammable Gas USQ for DCRTs is unlikely to be resolved and closed without some additional control[s]). Reasons for this conclusion included the following.

- Existing controls allow supplemental analysis and controls to ensure flammable gas concentrations are maintained below 25% of the LFL (i.e., the FSAR and TSRs do not completely define the safe operating envelope). DOE in TWRS-RT-SER-003, *Safety Evaluation Report for the Tank Waste Remediation System (TWRS) Final Safety Analysis Report (FSAR) [HNF-SD-WM-067, Revision H, September 1998] and Technical Safety Requirements [HNF-SD-WM-006, Revision F2, August 1997]* (DOE-RL 1999) stated that the Tier II Review Team does not concur with this unique approach for DCRTs.
- Analysis shows the existing DCRT ventilation system air inlet supply requirement of 3 or 5 cfh is marginal for maintaining the flammable gas concentrations below 25% of the LFL for some salt well transfers (LMHC 1997). The analysis also only covers salt well transfers, and there is no analysis for DCRT 244-A.
- There are technical issues that DOE has identified with the analysis that remain unresolved (e.g., questions on ammonia concentrations in the transferred waste) (Kinzer 1998, Umek 1998a, Sohn 1998, and Umek 1998b). For this reason, DOE has suggested continuous flammable gas monitoring in DCRTs at all times or bypassing the DCRTs for all future transfers (Kinzer 1999).
- There are insufficient monitoring data to conclude that existing controls (i.e., DCRT ventilation air inlet supply requirements of 3 or 5 cfh) maintain flammable gas concentrations below 25% of the LFL.

The concerns with the existing controls were on the DCRT ventilation system requirements (i.e., LCO 3.2.4, AC 5.11.2.d, and AC 5.12.2.c fourth bullet). There were no concerns discussed relating to the assignment of DCRTs to the Flammable Gas Facility Group Non-GRE (TSR AC 5.9.2.b, Table 5.9-1) or to the existing AC 5.10 ignition controls or the AC 5.11 flammable gas monitoring controls that apply to DCRTs.

The RPP-4941 analysis results were available for the April 19, 2000 control decision meeting (see Tables 4-6 and 4-7) and directly addressed the concerns identified in Bullets #2 and #3 above. This had a significant impact on the review and revision of the controls selected at the November 16, 17, and 18, 1999 control decision meetings as discussed in the following sections.

5.2 REMOVE FROM SERVICE AND DECONTAMINATION AND DECOMMISSIONING

This control is to bypass DCRTs 244-A, 244-BX, 244-S, 244-TX, and 244-U for future waste transfers, to ensure that waste could not be inadvertently transferred or drained to DCRTs, and to remove existing waste from the DCRTs. This would eliminate the flammable gas hazard, but would require time and funding to implement. Already DCRTs 244-S and 244-U are identified only as backup routes for salt well pumping, and there are active plans and projects to avoid future use of DCRTs (see Section 1.0). The consensus, however, was that decisions on DCRT flammable gas controls are needed now based on the current and expected possible use of DCRTs. That is, control decisions should not be based on plans or projects whose implementation schedules are uncertain or subject to change, and control decisions are needed to establish the required flammable gas controls for possible use of DCRTs 244-S and 244-U as backup routes for salt well pumping.

5.3 VENTILATION CONTROLS

There were a number of possible ventilation controls considered for DCRTs 244-A, 244-BX, 244-S, 244-TX, and 244-U ranging from simply monitoring the existing DCRT exhaust ventilation flow to various means of increasing the flow through the DCRT receiver tank headspace (see Tables 4-1 through 4-5). Possible controls where operation of the existing DCRT exhaust ventilation system is needed would have required the designation of this system as a safety-significant SSC. Because of their age and design (i.e., single exhaust fan), this was identified as having potentially significant cost and other impacts. Because any new ventilation control would have design and/or operations impacts, the benefits from increased ventilation through the DCRT receiver tank as a control were carefully explored. Based on review of the existing analysis in HNF-SD-WM-118, *Calculation of Flammable Gas Mixtures in Double-Contained Receiver Tanks* (LMHC 1997), and new analysis performed using the model described in RPP-4941, the following understandings were reached.

1. Hydrogen generated in the waste present in the DCRT receiver tank can be maintained below 25% of the LFL by the existing DCRT ventilation system inlet air supply. In addition, following a loss of the inlet air supply the time to reach the LFL is weeks to months. See Table 4-6.

2. With respect to the ammonia:

- A. The analysis model is conservative for low ventilation rates (<1 cfm). The model assumes that the ammonia concentration in the vapor space is always in equilibrium with the concentration in the liquid waste phase. That is, the ammonia concentration is independent of the ventilation rate at low flows.
- B. For higher ventilation rates (>1 cfm), the ammonia concentration in the vapor space is calculated with a dynamic model using mass transfer limiting equations. The effect of increased ventilation on the ammonia concentration is illustrated below.

Case 1 (ammonia concentration is 2346 µg/ml) (Hedengren 1999).

Ventilation Rate	Post-fill Ammonia % LFL
3 cfh (0.05 cfm)	36.84
30 cfm	17.55
100 cfm	7.87

Case 2 (ammonia concentration is 1030 µg/ml):^f

Ventilation Rate	Post-fill % LFL*
3 cfh (0.05 cfm)	19.4
10 cfh (0.2 cfm)	18.5
5 cfm	13.6

*Includes ammonia and hydrogen.

- C. On loss of ventilation, the ammonia concentration in the vapor space will return to an equilibrium with the ammonia concentration in the liquid waste phase within hours.
- D. There are uncertainties in the ammonia concentration in the liquid waste because ammonia concentration data are not available for all SST wastes and because of technical questions on whether ammonia sampling and analysis methods result in accurate determinations of the ammonia concentration in the waste.
- E. Based on the conservative analysis model for ammonia and all available ammonia characterization data, the ammonia concentration in the waste can not cause flammable gas concentrations near the LFL (see Table 4-7).

^f Case 2 is based on analysis performed at the November 17, 1999 control decision meeting.

3. The analysis model assumes that all dissolved hydrogen in the waste is immediately released to the DCRT receiver tank headspace. Based on an analysis assuming a waste with a maximum dissolved hydrogen concentration, dissolved hydrogen could cause a DCRT receiver tank headspace concentration >25% of the LFL, but less than the LFL, during the transfer.
4. Methane and other flammable gases are not significant contributors to the flammable gas hazard in DCRTs.

Based on the above, the consensus on ventilation controls for DCRTs 244-A, 244-BX, 244-S, 244-TX, and 244-U was to keep the DCRT ventilation system inlet air supply controls (safety-significant SSC, TSR LCO 3.2.4) with their safety function defined as preventing the accumulation of flammable gases due to steady-state releases of hydrogen. In addition, it was agreed that additional ventilation controls should not be used to control ammonia concentration or hydrogen concentration due to dissolved hydrogen. The control decision for ammonia and dissolved hydrogen was flammable gas monitoring, if necessary (see below), since there is extensive empirical data and experience that neither of these would actually result in flammable gas concentrations above the LFL. See also the discussion of dilution controls (Section 5.6), which would be viable controls for reducing the concentration of ammonia or hydrogen from dissolved hydrogen if either of these posed a significant risk of exceeding the LFL.

The DCRT exhaust ventilation system was selected as a defense-in-depth controls since it functions to provide additional ventilation to prevent the accumulation of flammable gases due to steady-state releases and is normally running to satisfy other requirements.

5.4 FLAMMABLE GAS MONITORING CONTROLS

There was consensus at the November 16, 17, and 18, 1999 control decision meetings that flammable gas monitoring of the DCRT receiver tank headspace be selected as a new control for DCRTs 244-A, 244-BX, 244-S, 244-TX, and 244-U. Continuous monitoring was selected during salt well pumping to a DCRT receiver tank to ensure the flammable gas concentration remains below 25% of the LFL. Continuous or periodic monitoring requirements for other waste transfers to DCRTs (i.e., 222-S Laboratory, PFP) and at all other times were to be established and the basis documented in the TSRs. Flammable gas monitoring must include both hydrogen and ammonia that may be present in the DCRT receiver tank headspace. This new control addressed all questions concerning uncertainties and unknowns with the concentrations of ammonia and dissolved hydrogen in the waste and with the analysis models. It also made the DCRT flammable gas controls independent of specific salt well pumping operations (e.g., flowrate, dilution ratios). The new control also eliminated the TSR requirements in AC 5.11.2.d and AC 5.12.2.c, fourth bullet, for supplemental analysis and controls to ensure that flammable gas concentrations are maintained below 25% of the LFL.

Subsequent to the November 16, 17, and 18, 1999 control decision meetings the analysis documented in RPP-4941 was developed. The results of this analysis (see Tables 4-7) show, with one exception, that the DCRT ventilation controls for steady-state releases of hydrogen also maintain the flammable gas concentration, including hydrogen and ammonia, to below 25% of the LFL. The one exception is DCRT 244-S if new salt well waste from 241-S or 241-SX tank

farms is transferred to the tank. Based on this, there was consensus that the only new TSR flammable gas monitoring control required is periodic monitoring of DCRT 244-S if it were to receive new salt well waste.

5.5 INERTING CONTROL

A system to inert the DCRT receiver tank headspace (e.g., a nitrogen inerting system) was discussed as a possible control to prevent a flammable gas deflagration or detonation by reducing the oxygen concentration below the LFL. The potential high reliability and availability of an inerting system that would minimize shutdowns of salt well pumping due to flammable gas hazard controls, could offset the high cost of this control. There was consensus, however, that further consideration of this control was not warranted based on its cost, schedule to implement, and the limited time that DCRTs are expected to be required for salt well pumping (see Section 1.0).

5.6 DILUTION CONTROLS

If high ammonia or dissolved hydrogen concentrations in waste transferred to a DCRT resulted in flammable gas concentrations in the receiver tank headspace that exceeded the LFL, dilution of the waste would be selected as the control versus a ventilation control (see above). Dilution reduces the concentration of the ammonia or dissolved hydrogen and, therefore, the associated flammable gas concentration in the DCRT receiver tank headspace. Implementation of any dilution control would involve designation of the dilution systems and associated monitoring systems as safety-class and development of TSRs that establish dilution requirements (i.e., dilution ratios) that are dependent on waste characterization data and predictions of flammable gas concentrations in DCRTs. The consensus was that flammable gas monitoring, if necessary, was the preferred control, especially since neither ammonia nor dissolved hydrogen is expected to result in a flammable environment. However, since salt well pumping operations include inline dilution to protect against plugging of the waste transfer lines, dilution was identified as a defense-in-depth control.

5.7 IGNITION CONTROLS

Ignition controls beyond the existing controls in TSR AC 5.10 were considered only in the general discussion of flammable gas control strategies (e.g., require installed equipment in the DCRTs to meet Ignition Source Control Set 1 or 2). There was agreement that ignition controls should not be the primary control for DCRT flammable gas hazards that are caused by the steady-state accumulation of flammable gases. No revisions to the existing ignition controls for DCRTs were proposed.

5.8 DCRT VAULT FLAMMABLE GAS CONTROLS

There was consensus at the April 19, 2000 control decision meeting that periodic monitoring of tank level in a DCRT for unexpected decreases is a new control required where the analysis shows the potential for a flammable gas hazard (i.e., flammable gas concentration could exceed

the LFL) in the DCRT vault due to a tank leak. As shown in Table 4-8 this hazard is predicted as possible only in 244-CR Vault Tank 003 if any material is transferred to the tank (i.e., transfers from other 244-CR Vault tanks or sumps, line flushes, water additions, chemical additions, or pressure testing of transfer systems with water) and in DCRT 244-S if new salt well waste transfers to the DCRT from 241-S or 241-SX tank farms are made.

5.9 244-CR-VAULT TANK 003

At the April 19, 2000 control decision meeting, there was consensus that operation of the 244-CR Vault ventilation system as currently required by TSR LCO 3.2.4 is not required for the existing waste in 244-CR Vault Tank 003. Because of the planned use of 244-CR Vault Tank 003 for interim stabilization of the 244-CR Vault, consensus was reached at the May 20, 2000 on the following controls beginning when any material is transferred to the tank (i.e., transfers from other 244-CR Vault tanks or sumps, line flushes, water additions, chemical additions, or pressure testing of transfer systems with water).

Safety-significant 244-CR Vault ventilation system that is demonstrated to provide >12 cfm flow through the tank headspace with the associated LCO 3.2.4 control to ensure its operability. Note: Because of the short time required to restore the ventilation system should it fail, there was consensus that an alternate backup system could also be used to provide an inlet air supply of >12 cfm. For this backup system the flow indicator would have to meet the requirements of AC 5.19, "Process Instrumentation and Measuring and Test Equipment."

Periodic monitoring of tank level for unexpected decreases (see Section 5.8 above).

Prohibition of waste transfers to 244-CR Vault Tank 003 except for transfers of pumpable liquids from other 244-CR Vault tanks and sumps.

Based on analysis in RPP-4941 these control would be required to be maintained even after interim stabilization of the 244-CR Vault was completed (i.e., even after all pumpable liquids were removed for 244-CR Vault Tank 003). It is expected, however, that the 244-CR Vault interim stabilization project would develop a basis and develop an Authorization Basis amendment to relax or remove all controls following completion of interim stabilization activities.

5.10 DCRT 244-S CONTROL STRATEGY

Based on the control decisions discussed in the previous sections and summarized in Attachment 1, the controls for DCRT 244-S are highly dependent on whether there will be future transfers of salt well waste to this DCRT from the 241-S or 241-SX tank farms. Because the required control to prevent flammable gas hazards are significantly more restrictive if future salt well pumping to DCRT 244-S occurs, and because salt well pumping to DCRT 244-S is not expected, there was consensus to develop two sets of controls. The first set based on prohibiting

salt well transfers would be implemented upon its review and approval. The second set assuming salt well transfer occurs would be developed, but would not be implemented until needed. With this strategy, the added implementation and operating costs required with the second set of controls would be delayed and likely avoided entirely.

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APPENDIX A

**CONTROL DECISION RECORD FOR FLAMMABLE GAS HAZARDS
IN DOUBLE-CONTAINED RECEIVER TANKS**

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A1.0 CONTROL DECISION RECORD**A1.1 HAZARD/ACCIDENT TITLE:**

Flammable gas hazards (i.e., deflagrations or detonations) in DCRTs (i.e., 244-A, 244-BX, 244-S, 244-TX, 244-U, and 244-CR Vault Tank 003).

A1.1.1 Structures, Systems, and Components (SSCs)

Note: Revisions to existing controls and new controls are in *bold italics*

Structures, Systems, and Components	Classification		Safety Function	Comments
	SC ^a	SS ^b		
Double-contained receiver tank ventilation systems	--	X	The safety function of the DCRT ventilation systems are to prevent the accumulation of flammable gases due to steady-state releases, thus decreasing the frequency of the Flammable Gas Deflagrations accident.	--

^aSC = safety class.

^bSS = safety significant.

A1.1.2 Technical Safety Requirements (TSRs)

Note: Revisions to existing controls and new controls are in ***bold italics***.

Control	Safety Function	Comments
DCRT ventilation systems (LCO 3.2.4)	Ensures a minimum ventilation flow to prevent the accumulation of flammable gases due to steady-state releases.	--
Flammability controls <ul style="list-style-type: none"> • Flammable Gas Facility Groups defined in (FSAR) Appendix K (i.e., DCRTs 244-A, 244-BX, 244-S, 244-TX, and 244-U are "Non-GRE" and 244-CR Vault Tank 003 is Facility Group 3) (AC 5.9.2.b, Table 5.9-1)	Controls ensure that flammable gas hazards are managed.	--
<i>Waste Transfer Prohibitions (i.e., prohibition of specific waste transfers to DCRTs)</i> <i>(Revision to AC 5.9)</i>	<i>Prevents waste transfers that may result in flammable gas hazards that are not addressed by existing analyses and/or controls.</i>	<i>Waste transfers to 244-CR Vault Tank 003 are prohibited, except for waste transfers from other 244-CR vault tanks or sumps.</i> <i>Waste transfers to DCRT 244-S from 241-S or 241-SX tank farms are prohibited unless additional controls are implemented.</i>
<i>DCRT Vault Leak Detection (i.e., periodic monitoring of tank level for unexpected decreases)</i> <i>(Revision to AC 5.9)</i>	<i>Ensures a leak into the vault is detected so that actions to prevent accumulation of flammable gas in the vault can be taken.</i>	<i>Only applies to 244-CR Vault Tank 003 if any material is transferred to the tank (i.e., transfers from other 244-CR Vault tanks or sumps, line flushes, water additions, chemical additions, or pressure testing of transfer systems with water) and to DCRT 244-S if new salt well waste transfers to the DCRT from 241-S or 241-SX tank farms are made.</i>
Ignition Controls detailed in (FSAR) Appendix K (i.e., existing DCRT flammable gas ignition source control set requirements) (AC 5.10, Table 5.10-1)	Reduces frequency of a flammable gas deflagration	--

Control	Safety Function	Comments
Flammable Gas Monitoring Controls detailed in (FSAR) Appendix K (i.e., existing DCRT flammable gas monitoring requirements) (AC 5.11, Table 5.11-1)	Reduces frequency of a flammable gas deflagration	--
<i>DCRT Flammable Gas Monitoring Controls</i> <i>(Revision to AC 5.11)</i>	<i>Reduces frequency of a flammable gas deflagration</i>	<i>Periodic monitoring of the flammable gas concentration in DCRT 244-S if new salt well waste transfers to the DCRT from 241-S or 241-SX tank farms are made.</i>
<i>Flammable Gas Monitoring Controls</i> <i>See Comments</i>	--	<i>The existing flammable gas monitoring requirements in AC 5.11.2.d, "DCRT Ventilation Requirements," are deleted.</i>
<i>Transfer Controls</i> <i>See Comments</i>	--	<i>The existing transfer waste compatibility requirement in AC 5.12.2.c fourth bullet, "DCRT Time to LFL Determination," is deleted.</i>
Emergency Preparedness (AC 5.14)	Mitigate the consequences of a flammable gas deflagration.	--
HEPA Filter Controls (source term) (AC 5.18)	Reduces the consequences from a possible HEPA filter failure by limiting the inventory available	Applies to all HEPA filters, prefilters, and inlet filters in the ventilation system. Also protects accident analysis assumptions regarding HEPA filter release amounts.
Process Instrumentation and Measuring and Test Equipment (AC 5.19)	Ensures instrumentation used to monitor the concentration of flammable gases is maintained.	--

A1.1.3 Defense-in Depth Controls

Note: Revisions to existing controls and new controls are in ***bold italics***.

Control	Safety Function	Comments
<i>DCRT exhaust ventilation system</i>	<i>Provides additional ventilation to prevent the accumulation of flammable gases due to steady-state releases</i>	<i>Credit for the DCRT ventilation exhaust system is not include in the flammable gas analysis because there is no inlet air path to the DCRTs (except for 244-U) and ventilation flow rate can not be measured.</i>
<i>Dilution of salt well waste transferred to the DCRT from SSTs.</i>	<i>Reduces the concentration of ammonia and constituents that affect the generation of hydrogen in the DCRT.</i>	<i>Dilution is required to prevent plugging of the waste transfer line.</i>

ATTACHMENT 1

**AGENDA FOR CONTROL DECISION MEETINGS ON
NOVEMBER 16, 17, AND 18, 1999 TO ADDRESS
DOUBLE-CONTAINED RECEIVER TANKS
FLAMMABLE GAS HAZARDS**

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**AGENDA FOR CONTROL DECISION MEETINGS ON
NOVEMBER 16, 17, AND 18, 1999 TO ADDRESS
DOUBLE-CONTAINED RECEIVER TANKS
FLAMMABLE GAS HAZARDS**

November 16, 1999 (Tuesday)

Note: All times are estimates and may vary.

8:30-9:00 Introduction

- A. Purpose
- B. Scope
- C. Process

9:00-9:15 Background

- A. Flammable gas USQ
- B. Potential DCRT flammable gas hazards
- C. Basis of existing controls (i.e., JCO)

9:15-10:00 Description/Planned Use of DCRTs (244-A, 244-BX, 244-S, 244-TX, 244-U)

10:00-10:15 Break

10:15-10:30 DCRT vapor sampling and ventilation flow measurements (RP-2923, Rev. 0-B)

10:30-10:45 Existing and New DCRT Consequence Analyses (HNF-4526)

10:45-11:00 Predictions of DCRT flammable gas concentrations [CN-118/RPP-4941 (draft)]

11:00-11:30 Evaluation of Flammable Gas Monitoring and Ventilation System Alternatives for DCRTs (RPP-5162)

11:30-12:30 General Flammable Gas Control Strategies

- A. Existing DCRT flammable gas controls
- B. Alternative DCRT flammable gas control strategies

November 17, 1999 (Wednesday)

Note: All times are estimates and may vary.

8:30-10:15 DCRT 244-BX Control Decision

- A. Existing Controls
- B. Possible Controls
An initial list of possible new or revised controls with observations for and against will be presented to initiate the control decision discussion
- C. Selected Controls

10:15-10:30 Break

10:30-11:30 DCRT 244-TX Control Decision

- A. Existing Controls
- B. Possible Controls
An initial list of possible new or revised controls with observations for and against will be presented to initiate the control decision discussion
- C. Selected Controls

11:30-12:30 DCRT 244-S Control Decision

- A. Existing Controls
- B. Possible Controls
An initial list of possible new or revised controls with observations for and against will be presented to initiate the control decision discussion
- C. Selected Controls

November 18, 1999 (Thursday)

8:30-9:15 DCRT 244-U

- A. Existing Controls
- B. Possible Controls
An initial list of possible new or revised controls with observations for and against will be presented to initiate the control decision discussion
- C. Selected Controls

9:15-10:15 DCRT 244-A Control Decision

- A. Existing Controls
- B. Possible Controls
An initial list of possible new or revised controls with observations for and against will be presented to initiate the control decision discussion
- C. Selected Controls

10:15-10:30 Break

10:30-12:30 Summary and Path Forward

ATTACHMENT 2

**ATTENDANCE LISTS FOR CONTROL DECISION MEETINGS
NOVEMBER 16, 17, AND 18, 1999 TO ADDRESS
DOUBLE-CONTAINED RECEIVER TANKS
FLAMMABLE GAS HAZARDS**

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Attendance List for November 16, 1999.

Attendance List for Control Division Meeting November 16, 1999 To Address
DCRT Flammable Gas Hazards

Name	Organization	Telephone #
LARRY KRIPS	NS&L	376-1061
MIKE GRIGSBY	NS&L	372-1907
RON TUCKER	TFFU	372-0910
Bob Nicholson	Eng	373-2986
DAN BAIDE	DST ENG.	376-3274
Tom Goetz	NS&L	373-4818
BOB GUSTAVSON	EQUIP. ENG.	373-5090
David Hedengren	Proc. Eng.	373-5094
Raymond Pugh	INDUS.	376-3766
Pete Sedwington	Retr. Eng'r.	373-3227
Jerry Johnson	NS&L	373-1224
Lim Shun Shuen	ORP-TSD	373-7655
Tom Dineff	Environmental	373-1060
Yusuf Nassari	Doe-ORP/TSD	372-2018
Dave Bratzel	NS&L	373-3579
Rich Larson	SST Eng'ng.	373-9100

Attendance List for November 17, 1999.

Attendance List for Control Room Meeting, November 17, 1999 to address DCRT Plan and Gas
 Literacy

Name	Organization	Phone
LARRY KRIPPS	NSCL	376-1061
TOM GOETZ	NSCL	373-4818
BOB GUSTAVSON	EQUIPMENT ENGR.	373-5090
Rich Larson	SST Eng'ng	373-9100
PAUL KISON	SST Eng'ng	373-1938
RON TUCKER	TFFO	372-6910
Chan-Shun Shum	ORP - TSD	373-7655
Greg Johnson	NSCL	373-1724
Dave Bratzel	NSCL	373-3579
Jim Billetdeaux	NSCL	373-2588
Mike Greigby	NSCL	372-1907

Attendance List for November 18, 1999.

Attendance List for Central Drivers Meeting November 18, 1999 to 1800h NERT FG (head)

Name	Organization	Phone
LARRY KRIMM	NSRL	376-1061
Terry Hising	Saltworks	572-0677
Tom Goetz	NS&L	373-4818
DAN BAIDE	DST ENG.	376-3274
Bob Nicholson	DST ENG.	373-2986
RON TUCKER	TFFU	372-0910
Mike Grigsby	NS&L	372-1907
Jim Billetdeaux	NS&L	373-2588
Dave Hedengren	Pro. Eng.	373-5094
PAUL KISON	SST Eng	373-1938

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ATTACHMENT 3

**PURPOSE, SCOPE, AND PROCESS FOR CONTROL DECISION MEETINGS TO
ADDRESS DOUBLE-CONTAINED RECEIVER TANKS
FLAMMABLE GAS HAZARDS**

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CONTROL DECISION MEETINGS TO ADDRESS DOUBLE-CONTAINED RECEIVER TANKS FLAMMABLE GAS HAZARDS

Note: Controls include safety-class and safety-significant structures, systems, and components (SSCs); technical safety requirements (TSRs); and other controls that provided defense-in-depth or environmental protection.

Purpose:

The purpose of the control decision meetings is to review existing controls and potentially select new or revised controls to prevent or mitigate flammable gas hazards in DCRTs. The control decisions and their basis support the resolution and closure of the Flammable Gas Unreviewed Safety Question (USQ) for DCRTs.

Scope:

The scope of the control decision meetings covers potential flammable gas hazards in five DCRTs. DCRTs are interim, short-term (lag) storage facilities and valve pits for waste transfer operations. DCRTs are 244-A and 244-BX located in the 200 East Area and 244-S, 244-TX, and 244-U located in the 200 West Area. These DCRTs are described in the River Protection Project (RPP) Final Safety Analysis Report (FSAR) (HNF-SD-WM-SAR-067, Revision 1). The 244-CR Vault located in the 200 East Area also contains one tank (244-CR-003) that is identified in the FSAR as a DCRT based on its potential use for short-term storage of salt well waste from the 241-C Tank Farm. However, because of the uncertainty associated with its future use as a DCRT, Tank 244-CR-003 is not included in the scope of these control decision meetings.

Process:

The control decision process and the criteria for control decisions are described in the FSAR along with the methodology for the hazard and accident analyses whose results are used to identify controls. Control decision criteria are summarized in Exhibit I.

Control decisions will be based on the best available information from the hazard and accident analyses and on the technical expertise and experience of the meeting participants. Decisions will be made by consensus.

Required participants in the DCRT flammable gas hazard control decision meetings are representatives from operations, engineering (including Design Authority and cognizant engineers), process engineering, and nuclear safety and licensing. Control decision meeting participants may also include representatives from safety services, emergency management, nuclear regulatory compliance, quality assurance, radiological control, environmental, interim stabilization operations and engineering, and retrieval engineering. Personnel responsible for developing the information or performing the analysis supporting DCRT control decisions will be present at the control decision meetings. U.S. Department of Energy (DOE) Office of River Protection (ORP) staff have been invited to observe the control decision meetings.

The control decision meeting discussions will be documented, including the control decisions (see Exhibit II). The control decisions and their basis will be incorporated into the FSAR and TSRs through an Authorization Basis amendment to resolve and close the Flammable Gas USQ for DCRTs. Contractor (i.e., Tier I) and DOE review and approval of the Authorization Basis amendment will be required.

SUMMARY OF CONTROL DECISION CRITERIA

Note: FSAR Section 3.3.1.5, "Controls Identification," contains a complete discussion of control decision criteria.

Control decision criteria are based on the following documents.

DOE 5480.23, Nuclear Safety Analysis

DOE 5480.22, Technical Safety Requirements

DOE-STD-3009-94, Preparation Guide for U.S. Department of Energy Nonreactor Nuclear Facility Safety Analysis Reports

WHC-CM-4-46, Nonreactor Facility Safety Analysis Manual, Section 6, "Technical Safety Requirements," Rev. 1, and Section 9, "Safety Classification of Structures, Systems, and Components," Rev. 2.

Risk Evaluation Guidelines:

Radiological Risk Guidelines

Frequency category	Frequency range (yr-1)	Effective dose equivalent (rem)	
		Onsite	Offsite
Anticipated	$>10^{-2}$ to $\leq 10^0$	0.5	0.1
Unlikely	$>10^{-4}$ to $\leq 10^{-2}$	5	0.5
Extremely unlikely	$>10^{-6}$ to $\leq 10^{-4}$	10	4

Toxicological Risk Guidelines

Frequency category	Frequency range (yr-1)	Primary concentration guidelines	
		Onsite	Offsite
Anticipated	$>10^{-2}$ to $\leq 10^0$	$\leq$ ERPG-1	$\leq$ PEL-TWA
Unlikely	$>10^{-4}$ to $\leq 10^{-2}$	$\leq$ ERPG-2	$\leq$ ERPG-1
Extremely unlikely	$>10^{-6}$ to $\leq 10^{-4}$	$\leq$ ERPG-3	$\leq$ ERPG-2

ERPG = Emergency Response Planning Guideline

PEL-TWA = permissible exposure limit – time-weighted average

Additional criteria to guide control decisions are the following:

- Control preferences are as follows:
 - Controls that prevent the accident versus those that mitigate its consequences
 - Passive engineered versus active engineered controls
 - Engineered controls versus administrative controls.
- Controls providing significant defense-in-depth are classified as safety SSCs or are elevated to a TSR control
- TSR controls are not developed for postulated accidents resulting in only environmental consequences
- SSCs are not classified safety-class or safety-significant solely for preventing or mitigating postulated accidents resulting in environmental consequences.

Other criteria that are important considerations in control decisions are listed below:

- Control reliability, availability, and maintainability
- Control effects on facility workers (i.e., increased radiation doses or toxicological exposures – ALARA issues)
- Control optimization and integration
- Control cost/benefit
- Control human factors impacts
- Control impacts on TWRS mission

CONTROL DECISION RECORD**HAZARD/ACCIDENT TITLE:****Structures, Systems, and Components (SSCs)**

Structures, Systems, and Components	Classification		Safety Function	Comments
	SC*	SS*		

*SC is safety class
SS is safety significant

Technical Safety Requirements (TSRs)

Control	Safety Function	Comments

Defense-in Depth Controls

Control	Safety Function	Comments

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ATTACHMENT 4

**NOVEMBER 16, 1999 CONTROL DECISION
MEETING PRESENTATIONS**

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Background

Background

- There is an open USQ concerning flammable gas hazards in DCRTs (TF-96-0433, Wagoner 1996)
- The FY00 MYWP includes submittal by 1/18/00 of an AB amendment to resolve and close the Flammable Gas USQ for DCRTs
- This AB submittal will also satisfy a LMHC commitment to ORP (i.e., response to 99-TSD-056)

Background

DCRT Flammable Gas Hazards

- Flammable gas hazards in DCRTs are caused by steady state (or chronic) gas release
- There is no significant risk from GREs in DCRTs (PNNL-11836, Rev. 1)

Background

DCRT Flammable Gas Hazards (continued)

- Flammable gas (e.g., hydrogen, ammonia, methane) may be transferred in with the waste; produced in the tank by radiolysis, organic decomposition, or corrosion; or released as a result of chemical adjustment

ID	Hazardous Condition	Cause	Preventive SSCs	Preventive TSRs	Mitigative SSCs	Mitigative TSRs	Memo	Cons
X3-01-FLOW03	Release of liquids, solids and/or vapors from single shell tank due to dome collapse and DCRT pressurization caused by flammable gas fire/explosion propagating from DCRT to single shell tank	Pipeline connecting single shell tank and DCRT fills with flammable gas; loss of ventilation flow in DCRT so that a flammable gas atmosphere is ignited by the ventilation outlet heater	SC: SST Ventilation SC: DCRT Level Dip Tube Flow	LCO: SST Ventilation Sys LCO: DCRT Ventilation Sys AC: Flammability Cntrl's AC: Ign Cntrl's AC: Flammable Gas Mon Cntrl's	None required	None required	Controls based on 910 Appendix E.	S3
CP-WSP-05	Release of radioactive or toxic material to atmosphere from waste tank due to flammable gas deflagration	Human error AND Flammable gas is present in tank AND Mechanical failure of the pipe and probe (ignition source)	SC: SST Ventilation SC: DCRT Level Dip Tube Flow SC: TK-002 244-AR Level Dip Tube Flow	LCO: SST Ventilation Sys - Active LCO: SST Ventilation Sys - Passive LCO: DCRT Ventilation Sys LCO: 244-AR TK-002 Ventilation Sys AC: Flammable Gas Mon Cntrl's AC: Excavation Cntrl's	None required	None required	Controls based on 910 Appendix E and accident analysis (Spray Leak from Underground Waste Transfer Line).	S3
CP-WSP-06	Release of radioactive or toxic material to atmosphere due to flammable gas deflagration caused by puncture and ignition of flammable gas in transfer line which propagates to the waste tank	Human error AND Flammable gas is present in transfer pipe AND Spark from probe tip (ignition source)	SC: SST Ventilation SC: DCRT Level Dip Tube Flow SC: TK-002 244-AR Level Dip Tube Flow	LCO: SST Ventilation Sys - Active LCO: SST Ventilation Sys - Passive LCO: DCRT Ventilation Sys LCO: 244-AR TK-002 Ventilation Sys AC: Flammable Gas Mon Cntrl's AC: Excavation Cntrl's	None required	None required	Controls based on 910 Appendix E and accident analysis (Spray Leak from Underground Waste Transfer Line).	S3

ID	Hazardous Condition	Cause	Preventive SSCs	Preventive ISRs	Mitigative SSCs	Mitigative ISRs	Hemo	Cons
ITK-08	Release of radioactive material from in-tank fire or explosion due to intrusive activity (dome collapse)	Exothermic reaction of incompatible materials in tank	SC: SST Ventilation SC: DCRT Level Dip SC: Tube Flow SC: 244-AR TK-002 Level (Ventilation)	LCO: SST Ventilation Sys LCO: DCRT Ventilation Sys AC: Ign Cntrls AC: Flammable Gas Mon Cntrls LCO: 204-AR TK-002 Ventilation Sys	None required	None required	Controls based on B10 Appendix E. Auto-ign temperature of H2 at LFL is 400 C.	S3
ITK-09	Release of radioactive material from in-tank fire or explosion due to intrusive activity (dome collapse)	Failure to bond components or incorrect bonding	SC: SST Ventilation SC: DCRT Level Dip SC: Tube Flow SC: 244-AR TK-002 Level (Ventilation)	LCO: SST Ventilation Sys LCO: DCRT Ventilation Sys LCO: 244-AR TK-002 Ventl Sys AC: Ign Cntrls AC: Flammable Gas Mon Cntrls	None required	None required	Controls based on B10 Appendix E.	S3
ITK-10-a	Release of radioactive material from in-tank fire or explosion due to intrusive activity (dome collapse)	Spark from equipment or tools	SC: SST Ventilation SC: DCRT Level Dip SC: Tube Flow SC: 244-AR TK-002 Level (Ventilation)	LCO: SST Ventilation Sys LCO: DCRT Ventilation Sys LCO: 244-AR TK-002 Ventl Sys AC: Ign Cntrls AC: Flammable Gas Mon Cntrls	None required	None required	Controls based on B10 Appendix E.	S3
XS-01-FLOW01	Release of radioactive aerosols from 244 TX DCRT due to ignition of flammable gas atmosphere	Pressure drop in transfer line releases flammable gas into DCRT atmosphere and ignition source causes deflagration	SC: DCRT Level Dip SC: Tube Flow	LCO: DCRT Ventilation Sys AC: Ign Cntrls AC: Flammable Gas Mon Cntrls	None required	None required	Controls based on B10 Appendix E for DCRTs.	S2

ID	Hazardous Condition	Cause	Preventive SSCs	Preventive TSRs	Mitigative SSCs	Mitigative TSRs	Memo	Cons
XS-03-LEVED1 XS-21-LEVE (244-S DCRT)	Release of combustion products from 244 TX DCRT due to flammable gas burn in tank atmosphere	Evaporation of DCRT contents causing decreased ability of waste to retain flammable gases and spark source	SC: DCRT Level Dip Tube Flow	LCD: DCRT Ventilation Sys AC: Ign Entrls AC: Flammable Gas Non Entrls	None required	None required	Controls based on B10 Appendix E.	S2
XS-03-PRES01 XS-21-PRES (244-S DCRT)	Release of liquid aerosols from 244 TX-DCRT due to flammable gas burn in tank atmosphere	Loss of ventilation flow with accumulation of flammable gas and spark source	SC: DCRT Level Dip Tube Flow	LCD: DCRT Ventilation Sys AC: Ign Entrls AC: Flammable Gas Non Entrls	None required	None required	Controls based on B10 Appendix E.	S2
XS-03-TEMP03 XS-21-TEMP (244-S- DCRT)	Release of liquid aerosols from 244 TX DCRT due to flammable gas burn-fire/explosion in tank atmosphere	Buildup of gases, loss of ventilation, and spark source	SC: DCRT Level Dip Tube Flow	LCD: DCRT Ventilation Sys AC: Ign Entrls AC: Flammable Gas Non Entrls	None required	None required	Controls based on B10 Appendix E.	S2

Background

- Existing DCRT flammable gas controls are based on the qualitative evaluation and practical interim controls described in FSAR Appendix K (i.e., JCO)

Description/Planned Use of DCRTs

Description

DCRT	Location	Capacity	Configuration
244-A	200 East Area – West of the 241- AN Tank Farm	16,280 gal	Vertical receiver tank
244-BX	200 East Area – East of Tank 241- BX-102 in the 241- BX Tank Farm	31,000 gal	Horizontal receiver tank
244-S	200 East Area – South of the 241- SY Tank Farm and east of 13 th Street	20,280 gal	Vertical receiver tank
244-TX	200 West Area – North of 241-TX Tank Farm	31,000 gal	Horizontal receiver tank
244-U	200 West Area – Southeast of Tank 241-U-110 in the 241-U Tank Farm	31,000 gal	Horizontal receiver tank

TYPICAL DOUBLE-CONTAINED RECEIVER TANK
(244-S; 244-A similar but smaller)

SP98020119.3

TYPICAL DOUBLE-CONTAINED RECEIVER TANK
(244-BX, 244-TX, and 244-U)

Tank
Diameter: 12 ft (3.7 m)
Centerline Length: 48 ft (14.6 m)
Material: Carbon Steel
SP-900000119.9

Description

- DCRTs contain a liquid waste heel, except for 244-U which only contains water
- DCRT 244-BX has a sludge heel of less than 24 inches

Description

- The DCRT ventilation system provides flow through the vault and suction to the receiver tank, but the ventilation flow through the receiver tank is unknown
- The receiver tank in DCRT 244-U has a filtered inlet; the other DCRT receiver tanks have no designed inlet air path
- Dip-tubes provide the only assured flow to the DCRT receiver tanks

Schematic of DCRT Ventilation System

Planned Use

DCRT 244-A

- There are no planned waste transfers to DCRT 244-A
- Catch tank for waste transfers through pump pit (e.g., cross-site transfers)

Notes:

W-314 project plans include cross-site transfer line bypass around 244-A

Planned Use

DCRT 244-BX

- Salt well pumping of Tanks 241-BY-105 and 241-BY-106

Planned Use

DCRT 244-S

- Waste transfers from 222-S Laboratory (via 219-S)
- Potential waste transfers from catch tanks (i.e., 241-UX-302A and 241-S-304)
- Catch tank for waste transfers through pump pit (e.g., salt well and PFP transfers from DCRT 244-TX)

Planned Use

DCRT 244-S (continued)

Notes:

- Salt well pumping of the 241-S and 241-SX Tank Farm tanks will bypass 244-S
- Environmental issues will require 244-S upgrades for continued use
- W-314 project plans include 244-S ventilation system upgrade
- Retrieval engineering investigating bypass of 244-S for 222-S Laboratory waste transfers

Planned Use

DCRT 244-TX

- Waste transfers from PFP

Notes:

- Salt well pumping of Tanks 241-T-104 and 241-T-110 is complete
- DCRT 244-TX will not received waste transfers from T-Plant

Planned Use

DCRT 244-U

- None (salt well pumping of 241-U Tank Farm tanks will bypass DCRT 244-U)

Notes:

DCRT 244-U has never been placed into service, and there are no plans to place it in service.

DCRT Vapor Sampling and Ventilation Flow Measurements

DCRT Vapor Sampling and Ventilation Flow Measurements^a

DCRT	Waste Volume/ Tank Capacity	Vapor Sample Concentration		Ventilation Rate Measurement ^b
		Hydrogen	Ammonia	
244-A	7,521/17,803 gal	28 ppmv (maximum)	<5 ppmv ^c	> 7.6 cfm
244-BX	22,780/31,000 gal	<10 ppmv ^c	<5 ppmv	0.7 cfm
244-S	2,203/22,840 gal	<10 ppmv	<5 ppmv	>14 cfm
244-TX	11,831/31,000 gal	<10 ppmv	<5 ppmv	>0.45 cfm ^d

a. Source: HNF-2923, *Headspace Gas Concentration Measurements and Headspace Ventilation Rate Measurements for Double-Contained Receiver Tanks 241-A-244, 241-BX-244, 241-S-244, and 241-TX-244*, Rev 0-B.

b. 3.0 cfm = 0.05 cfm

c. Detection limit of measurement instrument.

d. Lower bound.

Existing and New DCRT Consequence Analyses

Existing and New DCRT Consequence Analyses

DCRT	Source Term*	Radiological (rem)				Toxicological (Sum of Fraction (SOF))				Frequency
		Onsite		Offsite		Onsite		Offsite		
		Calculated Dose	Risk Guideline	Calculated Dose	Risk Guideline	Calculated SOF	Risk Guideline	Calculated SOF	Risk Guideline	
EXISTING FSAR										
DCRT	18 L	440	0.5	0.38	0.1	1000	1	1.1	1	Anticipated
HNP-4526, COMBUSTION ACCIDENT ANALYSIS FOR DOUBLE-CONTAINED RECEIVER TANKS (DCRTS) 244-S AND 244-TX										
Deflagration										
244-S										
Intact	3.1 L	73	0.5	0.052	0.1	5200	1	0.081	1	Anticipated
Rupture	8.4 L	200	0.5	0.14	0.1	16,000	0.26	0.26	1	Anticipated
244-TX										
Intact	13 L	300	0.5	0.21	0.1	20,000	1	0.31	1	Anticipated
Rupture	18 L	410	0.5	0.29	0.1	28,000	1	0.49	1	Anticipated
Detonation										
244-S										
Intact	8.5 L	200	0.5	0.14	0.1	17,000	1	0.27	1	Anticipated
Rupture	20 L	470	0.5	0.33	0.1	45,000	1	0.79	1	Anticipated
244-TX										
Intact	24 L	580	0.5	0.41	0.1	44,000	1	0.81	1	Anticipated
Rupture	33 L	780	0.5	0.56	0.1	62,000	1	1.2	1	Anticipated

a. 95% SST liquids, 5% SST solids

Predictions of DCRT Flammable Gas Concentrations

Att 4-27

Evaluation of Flammable Gas Monitoring and Ventilation System Alternatives for DCRTs

FIGURE # 5
ALTERNATIVE # 5, INSTALL NEW INLET FILTER AND SHMS
FOR PRIMARY TANK

CUTLER FIGURES
33

Evaluation of Flammable Gas Monitoring and Ventilation System Alternatives

	Description	Average Cost per DCRT		Average Schedule per DCRT (months)		Relative Ranking (1 to 7 are from lowest to highest)				Overall Ranking (1 is highest, 7 is lowest)
		244-BX/ 244-TX	244-A/ 244-S	244-BX/ 244-TX	244-A/ 244-S	ALARA (Installation)*	ALARA (Operation)	Technical Feasibility	Operability and Maintainability	
1	Install sample probes and connections for periodic vapor space sampling/monitoring	\$50K	\$80K	2.5	4	7	7	7	7	1
2	Install SHMS for continuous vapor space monitoring	\$220K	\$320K	6.5	11.5	6	5	4	5	3
3	Provide flow monitor in existing receiver tank exhaust duct	\$180K	\$180K	6	6	1	1	5	3	4
4	Install new inlet filter for receiver tank	\$160K	\$260K	4	7.5	5	6	6	6	2
5	Install new inlet filter and SHMS	\$380K	\$580K	8.5	16.5	4	4	3	4	5
6	Install new portable exhaust with new inlet filter	\$760K	\$960K	10	18	3	3	2	2	6
7	Install new portable exhaust with new inlet filter and SHMS	\$980K	\$1,200K	11	19	2	2	1	1	7

- a. For all alternatives except #1 and #3, DCRTs 244-A and 244-S would require installation of jumpers to nozzle tank penetrations in pump pits and excavation around contaminated transfer lines external to the vault walls and would result in greater personnel radiation exposures than DCRTs 244-BX and 244-TX.

General Flammable Gas Control Strategies

Control Strategies

- The standard control for flammable gas hazards caused by steady-state (or chronic) gas release is ventilation (i.e., ensure the ventilation rate exceeds the flammable gas generation rate to maintain the gas concentration below the LFL)

Control Strategies

- Ignition controls are used to prevent flammable gas deflagrations/detonations when gas concentration exceeding the LFL are expected or can not be prevented
- Monitoring controls identify the presence or absence of a flammable gas environment as either a permissive for operations or as verification of ventilation controls.

Existing DCRT Controls

- DCRT ventilation system flowrate (TSRs LCO 3.2.4, AC 5.11.2d, and AC 5.12.2c fourth bullet)
- DCRTs are in the Flammable Gas Facility Group Non-GRE (TSR AC 5.9.2b, Table 5.9-1)

Existing DCRT Controls

- Ignition Source Control Set #2 applies to activity-related equipment and materials until work activity entry monitoring requirements are met. Ignition source controls are not required in the ex-tank intrusive region (TSRs AC 5.10, Table 5.10-1; and AC 5.11, Table 5.11-1).
- There are no ignition source controls on installed DCRT equipment

Evaluation of DCRT Controls

- DCRT flammable gas controls are intended to provide ventilation to prevent flammable gas concentrations >25% of the LFL
- Safety-Class ventilation systems (i.e., instrument air supplied via the DCRT weight factor and specific gravity liquid-level monitoring systems) and TSRs provide 3 cfh.

Evaluation of DCRT Controls

- Existing controls require supplemental analysis and controls to ensure flammable gas concentrations are maintained below 25% of the LFL (i.e., the FSAR and TSRs do not completely define the safe operating envelope)
- Existing controls (i.e., 3 cfh ventilation flow) may not envelop uncertainties in the analysis of flammable gas sources

Evaluation of DCRT Controls

- There is insufficient monitoring data to conclude that DCRT ventilation flow maintains flammable gas concentrations below 25% of the LFL (i.e., adequacy of controls are based on analysis)

ATTACHMENT 5

**CONTROL DECISION MEETING ON APRIL 19, 2000 TO ADDRESS FLAMMABLE
GAS HAZARDS IN DCRTS AND WASTE TRANSFER SYSTEMS**

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ATTACHMENT 5 – PART 1

**AGENDA FOR CONTROL DECISION MEETING ON APRIL 19, 2000 TO ADDRESS
FLAMMABLE GAS HAZARDS IN DCRTS AND WASTE TRANSFER SYSTEMS**

**Agenda for Control Decision Meeting on April 19, 2000 To Address
Flammable Gas Hazards in DCRTs and Waste Transfer Systems**

April 19, 2000 (Wednesday)

Note: All times are estimates and may vary.

1:00- 1:15 Introduction

- A. Purpose
- B. Scope
- C. Process

1:15-1:45 New and Revised Accident Analyses

- A. Revised frequencies and consequences of flammable gas deflagrations and detonations in DCRTs and the effect on the classification of safety SSCs (i.e., DCRT ventilation systems)
- B. Estimated consequences of flammable gas deflagrations in RCSTS diversion box 6241-A and vent station 6241-V and the effect on the classification of safety SSCs (e.g., leak detection systems)

1:45-2:15 New and Revised Predictions of Flammable Gas Concentrations

- A. Revised predictions for DCRTs 244-A, 244-BX, 244-S, 244-TX and 244-U
- B. New predictions for 244-CR Vault Tank 003 to support interim stabilization of the vault and the need for controls
- C. New predictions for waste leaks into the DCRT vaults and the need for controls

2:15-2:30 Break

2:30-3:00 Draft LCO 3.2.4, DCRT Ventilation Systems (i.e., air supply flow rate, required actions and completion times, surveillance frequencies)

3:00-3:15 Draft AC 5.9

- A. Waste transfer-associated structure ventilation control
- B. Waste transfer prohibitions

3:15-4:00 Draft AC 5.11.2d, DCRT (Flammable Gas Monitoring) Controls

- A. Continuous monitoring during salt well pumping
- B. Periodic monitoring

4:00-4:30 Summary

ATTACHMENT 5 – PART 2

**ATTENDANCE RECORD OF CONTROL DECISION MEETING
FOR FLAMMABLE GAS HAZARDS IN DCRTS AND
WASTE TRANSFER SYSTEMS ON APRIL 19, 2000**

**Attendance Record of Control Decision Meeting for Flammable Gas Hazards in
DCRTs and Waste Transfer Systems on April 19, 2000**

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ATTACHMENT 5 – PART 3

**PURPOSE, SCOPE, AND PROCESS FOR CONTROL DECISION MEETING
TO ADDRESS DCRT AND WASTE TRANSFER SYSTEM
FLAMMABLE GAS HAZARDS**

CONTROL DECISION MEETING TO ADDRESS DCRT AND WASTE TRANSFER SYSTEM FLAMMABLE GAS HAZARDS

Note: Controls include safety-class and safety-significant structures, systems, and components (SSCs); technical safety requirements (TSRs); and other controls that provided defense-in-depth or environmental protection.

Purpose:

The purpose of the control decision meeting is to review and revise previously selected controls for the prevention or mitigation of flammable gas hazards in double-contained receiver tanks (DCRTs) and waste transfer systems. The control decision meeting is needed to consider new and revised analyses since the November 16, 17, and 18, 1999 control decision meetings for DCRTs and the November 30, 1999 control decision meeting for waste transfer systems. The control decisions and their basis support the closure of the Flammable Gas Unreviewed Safety Question (USQ) for DCRTs and waste transfer systems.

Scope:

The scope of the control decision meeting covers potential flammable gas hazards in DCRTs (i.e., 244-A, 244-BX, 244-S, 244-TX, 244-U, and 244-CR Vault Tank 003) and in waste transfer systems (i.e., waste transfer piping and waste transfer-associated structures).

Process:

The control decision process and the criteria for control decisions are described in the FSAR (HNF-SD-WM-SAR-067) along with the methodology for the hazard and accident analyses whose results are used to identify controls. Control decision criteria are summarized in Attachment I.

Control decisions will be based on the best available information from the hazard and accident analyses and on the technical expertise and experience of the meeting participants. Decisions will be made by consensus.

Required participants in the DCRT and waste transfer system flammable gas hazard control decision meeting are representatives from operations, engineering (including SST and DST Design Authority and cognizant engineers), interim stabilization, process engineering, and nuclear safety and licensing. Control decision meeting participants may also include representatives from waste retrieval, nuclear regulatory compliance support, radiological control, safety and emergency preparedness, environmental, and quality assurance. Personnel responsible for developing the information or performing the analysis supporting control decisions will be present at the control decision meeting. U.S. Department of Energy (DOE) Office of River Protection (ORP) staff have been invited to observe the control decision meeting.

The control decision meeting discussions will be documented, including the control decisions (see Attachment II). This documentation will be included or referenced in an amendment to the Authorization Basis (i.e., FSAR and TSRs) containing the proposed basis and control revisions to close the Flammable Gas USQ for DCRTs and waste transfer systems. DOE review and approval of the Authorization Basis amendment will be required.

SUMMARY OF CONTROL DECISION CRITERIA

Note: FSAR Section 3.3.1.5, "Controls Identification," contains a complete discussion of control decision criteria.

Control decision criteria are based on the following documents

DOE 5480.23, *Nuclear Safety Analysis*

DOE 5480.22, *Technical Safety Requirements*

DOE-STD-3009-94, *Preparation Guide for U.S. Department of Energy Nonreactor Nuclear Facility Safety Analysis Reports*

WHC-CM-46, *Nonreactor Facility Safety Analysis Manual*, Section 6, "Technical Safety Requirements," Rev. 1, and Section 9, "Safety Classification of Structures, Systems, and Components, Rev. 2.

Risk Evaluation Guidelines:

Radiological Risk Guidelines

Frequency category	Frequency range (yr-l)	Effective dose equivalent (rem)	
		Onsite	Offsite
Anticipated	$>10^{-2}$ to $\leq 10^0$	0.5	0.1
Unlikely	$>10^{-4}$ to $\leq 10^{-2}$	5	0.5
Extremely unlikely	$>10^{-6}$ to $\leq 10^{-4}$	10	4

Toxicological Risk Guidelines

Frequency category	Frequency range (yr-l)	Primary concentration guidelines	
		Onsite	Offsite
Anticipated	$>10^{-2}$ to $\leq 10^0$	$\leq$ ERPG-1	$\leq$ PEL-TWA
Unlikely	$>10^{-4}$ to $\leq 10^{-2}$	$\leq$ ERPG-2	$\leq$ ERPG-1
Extremely unlikely	$>10^{-6}$ to $\leq 10^{-4}$	$\leq$ ERPG-3	$\leq$ ERPG-2

ERPG = Emergency Response Planning Guideline

PEL-TWA = permissible exposure limit - time-weighted average

Additional criteria to guide control decisions are the following

- Control preferences are as follows:
 1. Controls that prevent the accident versus those that mitigate its consequences
 2. Passive engineered versus active engineered controls
 3. Engineered controls versus administrative controls
- Controls providing significant defense-in-depth are classified as safety SSCs or are elevated to a TSR control
- TSR controls are not developed for postulated accidents resulting in only environmental consequences
- SSCs are not classified safety-class or safety-significant solely for preventing or mitigating postulated accidents resulting in environmental consequences

Other criteria that are important considerations in control decisions are listed below

- Control reliability, availability, and maintainability
- Control effects on facility workers (i.e., increased radiation doses or toxicological exposures - ALARA issues)
- Control optimization and integration
- Control cost/benefit
- Control human factors impacts
- Control impacts on TWRS mission

CONTROL DECISION RECORD**HAZARD/ACCIDENT TITLE:****Structures, Systems, and Components (SSCs)**

Structures, Systems, and Components	Classification		Safety Function	Comments
	SC*	SS*		

* SC is safety class
SS is safety significant

Technical Safety Requirements (TSRs)

Control	Comments	Safety Function

Defense-in Depth Controls

Control	Comments	Safety Function

ATTACHMENT 5 – PART 4

**PRESENTATIONS AT THE CONTROL DECISION MEETING ON
APRIL 19, 2000 TO ADDRESS FLAMMABLE
GAS HAZARDS IN DCRTS**

DCRT Accident Analysis

The accident analysis for DCRTs (HNF-4526) has been revised as follows.

- Estimated frequency of detonation revised to extremely unlikely (10^{-6} to 10^{-4} per year)
- Source term revised (waste entrainment during blowdown)
- New radiological ULDs and plume depletion

Existing and New DCRT Consequence Analyses

DCRT	Source Term*	Radiological (rem)			Toxicological [Sum of Fraction (SOF)]			Accident Frequency
		Onsite		Offsite	Onsite		Offsite	
		Calculated Dose	Risk Guideline	Calculated Dose	Calculated SOF	Risk Guideline	Calculated SOF	Risk Guideline
EXISTING FSAR ANALYSIS								
DCRT	18 L	440	0.5	0.38	0.1	1000	1.1	1 (PEL-TWA)
NEW ANALYSIS								
Deflagration								
244-S								
Intact	0.0064 L	0.041	0.5	2.1E-05	0.1	2.6	3.2E-04	1 (PEL-TWA)
Rupture	0.0029 L	2.5	0.5	9.9E-04	0.1	220	0.016	1 (PEL-TWA)
244-TX								
Intact	21.6 L	39	0.5	0.015	0.1	3300	0.24	1 (PEL-TWA)
Rupture	0.0028 L	33	0.5	0.013	0.1	2900	0.21	1 (PEL-TWA)
Detonation								
244-S								
Intact	5.5 L	18	10	0.0086	4	30	0.020	1 (ERP-2)
Rupture	0.826 L	18	10	0.0080	4	31	0.018	1 (ERP-2)
244-TX								
Intact	29.9 L	66	10	0.028	4	120	0.058	1 (ERP-2)
Rupture	1.18 L	69	10	0.028	4	120	0.056	1 (ERP-2)

a. The source term is a combination of 95/5 liquid waste and solids. The liquid volume is shown first, then the solid volume.

DCRT Accident Analysis

Conclusions

- Postulated flammable gas accidents in DCRTs do not challenge offsite REGs, but exceed onsite REGs
- SSCs selected to prevent postulated DCRT flammable gas accidents are, therefore, classified as safety-significant

Predictions of Flammable Gas Concentrations

Revised predictions were performed to
include:

- New ammonia solubility data from 222-S
Laboratory tests
- Molar versus molal units correction

Predictions of Flammable Gas Concentrations

New predictions were performed to include:

- Salt well transfers to DCRT 244-S from tanks in the 241-S and 241-SX Tank Farms
- 244-CR Vault Tank 003 and planned interim stabilization activities involving Tank 003
- DCRT receiver tank failure and flammable gas buildup in the vault

Summary of DCRT Flammable Gas Calculations Supporting the Revision to TSR LCO 3.2.4 "DCRT Ventilation Systems"

DCRT	Steady State Hydrogen % LFL ¹	Time from 25% to 100% LFL following Loss of Ventilation ²	Time Allocated to Surveillance Frequency and Action Completion Time ³	Surveillance Frequency (with 25% Extension) ⁴	Action Completion Time ⁵
DCRT 244-BX					
Salt well waste ⁶	12.2% LFL	98 days	49 days	14 days (17 days)	7 days
DCRT 244-TX					
Salt well waste ⁶	7.1% LFL	248 days	124 days	31 days (38 days)	7 days
PEP waste	7.1% LFL	251 days	125 days	31 days (38 days)	7 days
DCRT 244-S					
Salt well waste ⁶	<25% LFL	10 days	5 days	12 hours (15 hours)	72 hours
222-S Laboratory waste	4.9% LFL	226 days	113 days	31 days (38 days)	7 days
Catch tank waste	5.0% LFL	220 days	110 days	31 days (38 days)	7 days
Existing tank waste	5.4% LFL	181 days	90 days	31 days (38 days)	7 days
DCRT 244-A					
Cross-site transfer waste ⁷	11.8% LFL	51 days	25 days	7 days (8 days)	7 days
DCRT 244-U					
Salt well waste ⁶	11.5% LFL	106 days	53 days	14 days (17 days)	7 days

- * The steady state hydrogen % LFL with the DCRT 80% full and a DCRT ventilation system air inlet flow of 3 cfm for DCRTs 244-A, 244-BX, 244-S, 244-TX, and 244-U except for salt transfers to DCRT 244-S where the air inlet flow is 7 cfm. (Note: The steady state hydrogen concentration does not include ammonia and is independent of the flow rate of the waste transfer to DCRT).
- b The time to go from 25% LFL to 100% LFL following the loss of DCRT ventilation system air flow with the DCRT 80% full. The only ventilation flow is barometric breathing (i.e., an exchange rate of 0.45% of the DCRT headspace volume per day). Ammonia is not considered in the prediction for salt well wastes and, although ammonia is included in the predictions wastes, where applicable, it has no significant effect on the predictions.
- c The time allocated to the surveillance requirement frequency and action completion time is one-half (1/2) the time calculated to go from 25% LFL to 100% LFL following the loss of DC ventilation system air flow (i.e., third column). This provides a safety factor of two (2) to account for uncertainties in the hydrogen generation rates.
- d The surveillance requirement frequency and action completion time must satisfy the following requirement

$$[2 \times (\text{Surveillance Frequency} + 25\% \text{ Extension})] + (\text{Action Completion Time}) \leq \text{Column 4}$$
- e The allocation of time between the surveillance requirement frequency and action completion time is a qualitative determined primarily based on operation considerations.
- f Calculations address salt well waste from Tanks 241-BY-105 and 241-BY-106.
- g Calculations address salt well waste from Tanks 241-T-104 and 241-T-110.
- h Calculations address salt well waste from 241-S and 241-SX Tank Farm tanks. Assumed DCRT ventilation inlet air supply is 7 cfm. For an inlet air supply of 3 cfm the DCRT receiver is would have to be limited to <5% to maintain the hydrogen concentration <25% of the LFL.
- i Calculations are for Tank 241-SY-101 waste diluted 1:1 which was determined to be the limiting waste.
- j Calculations address salt well waste from 241-U Tank Farm tanks, and encompass waste transfers from catch tank 241-U-301B.

Summary of DCRT Flammable Gas Calculations Supporting the Revision to TSR AC 5.11.2d "DCRT (Flammable Gas Monitoring) Controls"

DCRT	Post-Fill Flammable Gas %LFL (Hydrogen, Ammonia, and Methane)	Steady State Flammable Gas %LFL (Hydrogen, Ammonia, and Methane)	Time from 25% to 100% LFL following Loss of Ventilation ¹	Flammable Gas Monitoring Frequency	Action Time ²
DCRT 244-BX					
Salt well waste ³	15.0% LFL	17.9% LFL	94 days	31 days	7 days
DCRT 244-TX					
Salt well waste ⁴	Not Applicable	7.1% LFL	248 days	31 days	7 days
PPF waste	0.1% LFL	7.1% LFL	251 days	31 days	7 days
DCRT 244-S					
Salt well waste ⁵	71.8% LFL	71.3% LFL	4 days ¹	24 hours	72 hours
222-S Laboratory waste	0.5% LFL	5.4% LFL	226 days	31 days	7 days
Catch tank waste	0.02% LFL	5.0% LFL	220 days	31 days	7 days
Existing tank waste	Not Applicable	5.6% LFL	181 days	31 days	7 days
DCRT 244-A					
Cross-site transfer waste ⁶	8.9% LFL	20.4% LFL	50 days	31 days	7 days
DCRT 244-U					
Salt well waste ⁷	12.1% LFL	17.2% LFL	102 days	31 days	7 days

- a The time to go from 25% to 100% LFL following the loss of DCRT ventilation system air flow with the DCRT 80% full. The only ventilation flow is barometric breathing (i.e., an average exchange rate of 0.45% of the DCRT headspace volume per day).
- b The flammable gas monitoring frequency and action time must satisfy the following requirement
 - Flammable Gas Monitoring Frequency + Action Time $\leq$ Column 4
 - The action time is assumed to be the same as the action completion time for LOO 3.2.4.
 - c Calculations address salt well waste from Tanks 241-BY-103 and 241-BY-106.
 - d Calculations address salt well waste from Tanks 241-T-104 and 241-T-110.
 - e Calculations address salt well waste from 241-S and 241-SX Tank Farm tanks.
 - f The time is from the post-fill concentration of 71.8% LFL to 100% of the LFL.
 - g Calculations are for Tank 241-SY-101 waste diluted 1:1 which was determined to be the limiting waste.
 - h Calculations address salt well waste from 241-U Tank Farm tanks, and encompass waste transfers from catch tank 241-U-301B.

Summary of 244-CR Vault Tank 003 Flammable Gas Calculations Supporting TSR Control Revisions

Scenario^a	Maximum Flammable Gas %LFL	Time to 100% LFL	Flammable Gas Monitoring Frequency^b	Action Time^b
Existing tank waste	43% LFL	-	-	-
Waste transfers from other 244-CR Vault tanks and sumps for interim stabilization of the vault (i.e., tank 80% full of worst case composite waste)	>>100% LFL	143 hours	-	-
Final end state of Tank 003 (i.e., all pumpable liquids removed following interim stabilization of the vault)	>>100% LFL	-	-	-

^a The only ventilation flow assumed in all scenarios is barometric breathing (i.e., an average air exchange rate of 0.45% of the DCRT headspace volume per day).

^b The flammable gas monitoring frequency and action time must satisfy the following requirement

$$\text{Flammable Gas Monitoring Frequency} + \text{Action Time} \leq 0.75 \cdot \text{Column 3}$$

The factor of 0.75 assumes a linear increase in the flammable gas concentration from 0% to 100% of the LFL and is included to estimate the time from 25% to 100% of the LFL.

Summary of DCRT Vault Maximum Flammable Gas Concentrations

The table below summarizes the results of predictions of the maximum flammable gas concentration in a DCRT vault following the postulated failure of the DCRT receiver tank. The DCRT is assumed to be 80% full of waste that will result in the highest flammable gas concentration. The only ventilation flow is barometric breathing (i.e., an average air exchange rate of 0.46% of the DCRT headspace volume per day).

DCRT Vault	Maximum Flammable Gas Concentration
244-A	57.5% LFL
244-BX	27.7% LFL
244-S	
If no future salt well waste transfers	43.9% LFL
If future salt well waste transfers	217.4% LFL ⁱ
244-TX	32.5% LFL
244-U	26.2% LFL
244-CR Vault	>100% LFL

ⁱ The predicted time to reach 100% of the LFL is 31 days.

Predictions of Flammable Gas Concentrations

Review/revision of control decisions on

- LCO 3.2.4 inlet air flow rates, action completion times, surveillance frequencies
- AC 5.9 waste transfer prohibitions
- AC 5.11.2d flammable gas monitoring requirements
- Active ventilation system for 244-CR Vault Tank 003 requirement

Predictions of Flammable Gas Concentrations

New controls decisions required to address

- Flammable gas hazards in the DCRT 244-S vault caused by receiver tank failure if future salt well transfers are made to this tank
- Flammable gas hazards in 244-CR Vault Tank 003 during interim stabilization of the vault

Control Decisions

Possible control decisions for existing flammable gas hazards in 244-CR Vault

Tank 003

- Maintain all existing controls
 - Active ventilation system for 244-CR Vault is safety-significant and LCO 3.2.4 requirements
 - Flammable gas ignition and monitoring controls (AC 5.10 and 5.11)

Control Decisions

Possible controls (continued)

- Maintain existing flammable gas ignition and monitoring controls, but eliminate the safety-significant designation and LCO 3.2.4 requirements for the 244-CR Vault active ventilation system

Control Decisions

Possible controls (continued)

- Same as above, but with a new requirement for periodic flammable gas monitoring of 244-CR Vault Tank 003 (e.g., at least once every 31 days)
- Other?

Control Decisions

Possible controls to address flammable gas hazards in the DCRT 244-S vault caused by receiver tank failure if future salt well transfers are made to this tank

Control Decisions

Possible controls (continued)

- Vault leak detection system (i.e., vault sump level detection system)
 - New safety-significant SSC
 - New LCO for system operability and new surveillance requirements or new AC for periodic monitoring of sump level

Control Decisions

Possible controls (continued)

- DCRT level detection system
 - No new safety SSC since it is already a safety-significant SSC for other hazards
 - New TSR LCO for system operability and new surveillance requirements or new AC for periodic monitoring of DCRT level

Control Decisions

Possible controls (continued)

- Other

Control Decisions

Based on predictions of flammable gas concentrations in 244-CR Vault Tank 003 during and following planned interim stabilization activities, additional controls are potentially required to address potential flammable gas hazards. Existing predictions of flammable gas concentrations in the vault following postulated tank failure during interim stabilization activities also indicate that additional controls may be required.

Control Decisions

Control decisions to address flammable gas hazards in 244-CR Vault Tank 003 during interim stabilization of the vault will be considered at a separate control decision meeting. In the absence of these control decisions, transfers to Tank 003, including waste and water, would be prohibited.

ATTACHMENT 6

**CONTROL DECISION MEETING ON MAY 10, 2000 TO ADDRESS FLAMMABLE
GAS HAZARDS IN 244-CR VAULT TANK 003**

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244-CR FLAMMABLE GAS**CONTROL DECISION MEETING****Wednesday, May 10, 2000****1300-1500****2750HV B225**

The purpose of the meeting is to follow-up on the control decision meeting held April 19, 2000. That meeting addressed several flammable gas issues. However, because there was still more analyses being done on 244-CR and the interim stabilization project team had not had an opportunity to consider options, it was decided to defer the control decision concerning Tank 003 of 244-CR.

The attachment demonstrates that the head space of the tank will reach flammable gas concentrations during the transfer relatively quickly without controls. Further it points out that the concentrations will reach flammable concentrations even after the pumpable liquids are removed assuming only barometric breathing.

This meeting will determine what types of controls are required before the pumping is started, during the transfer operations, and after the pumpable liquid is removed. This will address both the tank and the cell. A conceptual layout of the ventilation system with verification of flows will be considered.

ATTENDANCE

<i>NAME (Initials)</i>	<i>ORGANIZATION</i>	<i>PHONE NUMBER</i>
Larry Kripps <i>LK</i>	Nuclear Safety and Licensing	376-1061
Jim Zach <i>JZ</i>	Nuclear Safety and Licensing	373-0670
Dave Hedengren <i>DH</i>	Process Engineering	373-5094
Dave Parkman <i>DP</i>	Cognizant Engineer	373-3462
Steve Henry <i>SH</i>	244-CR Interim Stabilization Project	373-5241
Jennifer Stewart <i>JS</i>	Nuclear Safety and Licensing	376-5633

Summary of 244-CR Vault Tank 003 Flammable Gas Calculations Supporting Control Revisions

Scenario ^a	Maximum Flammable Gas %LFL	Time to 100% LFL	Surveillance Frequency (with 25% Extension) ^b	Action Time ^b
Existing tank waste	43% LFL	-	-	-
Waste transfers from other 244-CR Vault tanks and sumps for interim stabilization of the vault (i.e., tank 80% full of worst case composite waste)				
- Barometric breathing	>>100% LFL	143 hours	-	-
- Ventilation ≥ 11 cfh	<25% LFL	4.5 days	12 hours (15 hours)	24 hours
Final end state of Tank 003 (i.e., all pumpable liquids removed following interim stabilization of the vault)				
- Barometric breathing	>>100% LFL	-	-	-
- Ventilation ≥ 3 cfh	<25% LFL	80 days		

^a The only ventilation flow assumed in all scenarios is barometric breathing (i.e., an average air exchange rate of 0.45% of the DCRT headspace volume per day).

^b The surveillance requirement frequency and action completion time must satisfy the following requirement

$$[2 \times (\text{Surveillance Frequency} + 25\% \text{ Extension})] + (\text{Action Completion Time}) \leq \text{One half of Column 3}$$

The allocation of time between the surveillance requirement frequency and action completion time is a qualitative determined primarily based on operation considerations.

Summary of DCRT Vault Maximum Flammable Gas Concentrations

The table below summarizes the results of predictions of the maximum flammable gas concentration in a DCRT vault following the postulated failure of the DCRT receiver tank. The DCRT is assume to be 80% full of waste that will result in the highest flammable gas concentration. The only ventilation flow is barometric breathing (i.e., an average air exchange rate of 0.46% of the DCRT headspace volume per day).

DCRT Vault	Maximum Flammable Gas Concentration
244-A	57.5% LFL
244-BX	27.7% LFL
244-S	
If no future salt well waste transfers	43.9% LFL
If future salt well waste transfers	217.4% LFL ⁱ
244-TX	32.5% LFL
244-U	26.2% LFL
244-CR Vault	
Tank 80% full of worst case composite	>100% LFL ⁱⁱ
Existing tank waste	22% LFL
Existing tank waste plus 1000 gal sump water	22% LFL
Final end state of tank	>100% LFL ⁱⁱⁱ

ⁱ The predicted time to reach 100% of the LFL is 31 days.

ⁱⁱ The predicted time to reach 100% of the LFL is 45 days.

ⁱⁱⁱ The predicted time to reach 100% of the LFL is 504 days.

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