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Chemical Reaction in a DCRT

T. B. Powers

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Abstract: This document supports the development and presentation of the following accident scenario in the TWRS Final Safety Analysis Report:

Mixing of Incompatible Materials - Tank Pressurization.

The calculations needed to quantify the risk associated with this accident scenario are included within.

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Calculation Cover Sheet

Project Hanford TWRS FSAR		Calculation No. M-CLC-G-00237		Project Number N/A	
Title Chemical Reaction in a DCRT		Functional Classification N/A		Sheet 1 of 52	
		Discipline: Mechanical			
☐ Preliminary		☐ Committed		☒ Confirmed	
Computer Program: n/a				Version Release No.:	
Purpose and Objective The purpose of this calc note is to determine the consequences; both radiological and toxic from a mistransfer of acidic waste to a waste tank containing basic waste for the Hanford Tank Waste Remediation System (TWRS). This accident involves this mistransfer of acid or acidic waste into a Double Container Receiver Tank(DCRT) which leads to an exothermic chemical reaction and the release of radionuclides and toxic material. Revision 3 contains new calculations to incorporate new information on the limited amount of nitric acid available in the processing facilities for mistransfer. This revision also removes the temperature limit of 150°F used in previous revisions.					
Summary of Conclusions The offsite consequence values for this accident are well within the risk evaluation. Therefore, no DCRT structures, systems, or components have been designated safety class. In order to reduce the onsite consequences to within the evaluation guidelines, the HEPA filters will be designated safety significant. Additional controls which provide defense in depth are the use of formal controls and procedures between sending facilities and the DST tank farm system to ensure that all incoming wastes are neutralized prior to acceptance into a DCRT. Also, the continuation of the Compatible Waste Program to ensure that incoming wastes are compatible with DCRT and DST contents with respect to criticality, chemical reactivity, organics, and other safety and operational considerations.					
Revision					
Rev. No.	Revision Description				
0	Original issue				
1	Incorporate revised toxic chemical Sum-of-Fraction Risk Guidelines				
2	Incorporate FSAR write-up text in appendix per Hanford instructions.				
3	New input for maximum acid inventory in processing facilities and remove DCRT temperature limit of 150°F.				
Sign Off					
Rev. No.	Originator (Print) Sign/Date	Verification / Checking Method Sign/Date	Verifier/Checker (Print) Sign/Date	Manager (Print) Sign/Date	
3	I. K. Norick <i>[Signature]</i> 9/6/96	Verification by Individual Review (Manual ET, Procedure 2.40) <i>[Signature]</i>	T. F. Burt <i>[Signature]</i> 9/14/96	L.A. Wooten <i>[Signature]</i> 9/9/96	
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CALC-NOTE CHECKLIST

REVIEWER(S):

NAME (PRINT OR TYPE)

SIGNATURE

DATE

T. E. Britt

Thomas E. Britt

9/9/96

CIRCLE ONE

1. Is the Subject and/or Purpose clearly stated? ☒ YES ☐ NO
2. Are the required Input Data and their references and source provided and are they consistent with the Calc-Note purpose? ☒ YES ☐ NO
3. Are the Assumptions clearly identified, valid and consistent with the Calc-Note purpose? ☒ YES ☐ NO
4. Is the Analytical Method or Approach Used clearly identified? ☒ YES ☐ NO
5. Are all the pages consecutively numbered and identified by the Calc-Note number? ☒ YES ☐ NO
6. Is/are the version(s) of the computer program(s) used identified and QA'd adequately? YES ☐ NO ☒ NA
7. Are input listings for all computer programs documented in this Calc-Note, and are they V&V'd and appropriate for the intended use? YES ☐ NO ☒ NA
8. Are the Results and Conclusions clearly stated? ☒ YES ☐ NO
9. Are OUTPUT documents included (or if not part of the calculation, clearly referenced in the Results section?) grammatically, correct, clear, and consistent with the main calc-note text? ☒ YES ☐ NO ☐ NA
10. Are the results, methods, input, and assumptions compatible with the stated purpose? ☒ YES ☐ NO

IF NO TO ANY OF THE ABOVE, LIST SHEET NUMBER(S) WITH JUSTIFICATION AND OBTAIN MANAGER'S SIGNATURE BELOW:

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Manager's Signature

REVIEWER'S NOTES (use additional pages as necessary)

Review method used:

Y__N__

Alternate calculation ☐ Attached?

Approximated Originator steps ☒

_____
_____
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2. INTRODUCTION

The purpose of this calc note is to determine the consequences, both radiological and toxic from a mistransfer of acidic waste to a waste tank containing basic waste for the Hanford Tank Waste Remediation System (TWRS).

This accident involves this mistransfer of acid or acidic waste into a Double Container Receiver Tank (DCRT) which leads to an exothermic chemical reaction and the release of radionuclides and toxic material.

A DCRT is a short-term waste storage facility that consists of an underground concrete structure that contains a filter pit, pump pit, and a vault in which a catch tank is installed. The DCRT is used for interim storage of liquid waste and as a valve pit for waste transfer operations. Components for mixing steam and water for backflushing and decontamination operations are located in a nearby flush pit.

The exhaust fans in the tank ventilation systems keep a negative air pressure inside the primary tank to prevent unfiltered air emissions from escaping from the DCRT/catch

station. The air exhausted from the tank passes through a heater, prefilter, HEPA filters, and is monitored for radiation before being released into the environment.

The hazard analysis performed for incompatible waste issues identified a mistransfer of incompatible waste in a DCRT leading to a chemical reaction release radioactive and toxic aerosols as an accident with potentially significant onsite consequences.

To assess the potential consequences ^{WITH & WITHOUT} ~~in the absence of~~ engineered, mitigative systems, a transfer of 110 ~~1000~~ gallons of 57 weight percent nitric acid into a DCRT was analyzed. A nitric acid transfer was used because:

- Processing facilities contain small amounts of nitric acid, mostly in laboratory scale or 55 gallon drums used for decontamination purposes. A 110 gallon mistransfer of 57 wt % nitric acid would bound the transfer from any single source.
- Processing facilities are required to neutralize acidic wastes prior to transfer. Unneutralized wastes would be much more dilute than nitric acid. The only facility identified which has substantial amounts of acidic waste was 222-S labs which has a 4000 gallon tank which is connected to the tank farm. Waste contained in this tank could have an unneutralized pH of 1 ($[H^+] = .1M$).

This accident has been analyzed as being an anticipated event.

The material at risk to be released is based on the maximum radionuclide content for one-third double shell solids and two thirds double shell liquids. In practice, there is very little DST solids transferred into DCRTs. Therefore, this is a very conservative assumption.

Revision 3 contains new calculations to incorporate new information on the limited amount of nitric acid available in the processing facilities for mistransfer. This revision also removes the temperature limit of 150°F used in previous revisions.

3. OPEN ITEMS

None.

4. INPUT

4.1. Double Contained Receiver Tank Corrosion Protection Limits

For wastes in with $NO_3 < 1.0 M$, the upper limit on $[OH^-]$ is $5.0 M$. For wastes which $NO_3 > 1 M$, the $[OH^-]$ upper limit is $10 M$ [1,2]

4.2. Airborne Release Fraction (ARF) Boiling Liquid

The airborne release fraction for boiling of liquid waste is 2×10^{-3} [3].

4.3. DCRT Volume

DCRT	Volume (gal)
244-S	20,280
244-TX	31,000
~~244-U~~	~~31,000~~
244-A	16,280
~~244-BX~~	~~31,000~~

The volume for DCRT 244-A will be used in this calculation since it is the minimum volume and will thereby lead to a maximum concentration of radionuclides and toxics. *THE VOLUMES OF DCRTs ARE FOUND IN REFERENCE 10, APPENDIX A.*

4.4. DCRT Ventilation System

DCRT	Ventilation Rate (cfm)
244-S	165
244-TX	250
~~244-U~~	~~-~~
244-A	150
~~244-BX~~	~~250~~

The ventilation system in the DCRT draws from the cell and the catch tank. There are not, however, engineered ventilation flow paths from the catch tanks. Any release from the catch tank is from leakage in penetrations. It will be assumed that the entire ventilation flow rate is from the catch tank. This will maximize the source concentration for toxic consequence calculations. *THE DCRT VENTILATION RATES ARE FOUND IN REFERENCE 11.*

The filtration efficiency of a HEPA filter is 99.95% [2].

4.5. Heats of Formation

The heat of formation of the reactants and products of the reaction:

and the resulting heat of reaction for the neutralization reaction is given by:

$$\Delta H_r = \sum_{\text{products}} \Delta H_f^\circ - \sum_{\text{reactants}} \Delta H_f^\circ$$

	ΔH_f° , kcal/g-mole [8]	ΔH_f° , kcal/g-mole[9]
HNO ₃	-49.37	-49.21
NaOH	-112.24	-112.193
H ₂ O	-68.32	-68.317
NaNO ₃	-106.65	-106.88
Heat of Reaction	~~-55.9~~ -13.36	~~-57.75~~ -13.79

The data from Ref. 9, which yield a larger energy release will be used for this calculation.

4.6. Unit Liter Dose-DST [4]

Composite	Inhalation ULD (Sv/L)	Ingestion ULD* (Sv-m ³ /s-L)
Double-shell tank liquids	6.1 E+03	0.068
Double-shell tank solids	5.3 E+05	0.48

4.7. Toxicological Exposure - Sum of Fractions Values.[7]

Radiological risk guidelines are quantified in terms of single dose value which can be determined and summed for all types and energies of radiation. In contrast, toxicological risk guidelines are specific to individual chemicals. To account for exposure to all chemicals contained in a release, sum-of-fractions values were calculated in Ref. 7. The basic steps used to determine sum-of-fractions values for a continuous release of solids or liquids were:

1. Assume that a continuous release of 1 L/sec occurs
2. Assume that each of the chemical constituents of the composite tank inventories are contained within the release.
3. Calculate the peak concentration at the receptor of interest.
4. Divide the peak concentration for each analyte by the risk guideline concentration limit value for that analyte, given the location of the receptor and the frequency of the scenario. This yields a fraction of the limit.

5. Sum individual fractions to give the sum-of-fraction values.

Sum-of-Fractions for Unit Releases of Solids and Liquids.[7]

Tank Waste Type	Maximum Individual	Sum-of-Fractions (s/L) as a function of Accident Frequency (1/yr)		
		1 - 10 ⁻²	10 ⁻² - 10 ⁻³	10 ⁻³ - 10 ⁻⁴
DST solid or liquid continuous release				
DST liquids	Onsite	1.0 E+04	7.5 E+02	2.1 E+02
	Offsite	8.4 E+00	8.4 E+00	6.2 E-01
DST solids	Onsite	1.8 E+004	3.3 E+03	6.3 E+02
	Offsite	1.9 E+02	1.5 E+01	2.8 E+0

4.8. Atmospheric Dispersion Factors [6]

TABLES 4 & 5

Centerline Atmospheric Dispersion Coefficients for a 200-Area Tank Farm Acute, Ground Level Release.

Maximum Individual	Bounding Integrated χ/Q' (s/m ³)
Onsite Sector and distance	3.41 E-02E 100 m
Offsite Sector and distance	2.83 E-5 W 11,100 m

N 8,760 m

4.9. Breathing Rates

For the maximum onsite individual, the light activity breathing rate is used, i.e., 3.3×10^{-4} m³/s. For the maximum offsite individual, the 24-hr average breathing rate is used, i.e., 2.7×10^{-4} m³/s. THESE VALUES ARE FOUND IN REFERENCE 6, SECTION 4.3.

4.10. Dose limits

Receptor/Hazard	Risk Guidelines		
	Anticipated	Unlikely	Extremely Unlikely
Off-Site/ Radiological	0.1 rem	.5 rem	4 rem
On-Site/ Radiological	.5 rem	5 rem	10 rem
Off-Site/ Toxicological	1	1	1
On-Site/ Toxicological	1	1	1

5. ASSUMPTIONS

SEE REFERENCE 12.

5.1. Acidic Waste

The acidic waste is assumed to be 57 wt % nitric acid (12 M). The waste which is shipped to the TWRS tanks will be much more dilute, therefore, this is a bounding value. Response to an Information Validation Form (see Appendix) on nitric acid inventories in processing facilities connected to TWRS indicates very limited quantities of nitric acid and

acidic waste. The maximum acidic waste transfer is assumed to be 110 gallons. This is the maximum allowed in any of the processing facilities connected to the TWRS [B-Plant].

Also, a transfer of 4000 gallons of unneutralized acidic waste ($\text{pH}=1$, $[\text{H}^+]=.1\text{M}$) will be analyzed.

5.2. Basic Waste

The accident scenario assumes that the DCRT contains waste which is sufficiently basic to completely neutralize the incoming acid transfer

$$V_{\text{waste}} = \frac{[\text{H}^+]_{\text{acid}} V_{\text{acid}}}{[\text{OH}^-]_{\text{waste}}}$$

This ensures that the maximum heat of reaction per mole of incoming acid is generated and maximizes the heatup of waste. The hydroxide content is taken to be at the maximum allowed under DCRT corrosion control limits (10 M OH^-). The material at risk is thereby defined by this amount.

5.3. DCRT Radiological and Toxic Inventory

The radiological and toxicological inventory is assumed to be 2/3 DST liquids and 1/3 DST solids.

5.4. Waste Temperature

The waste is assumed to be at 200°F (93°C) ² [5]. This is the maximum allowable temperature for DCRTs based on thermal structural considerations.

5.5. Ventilation system

(SEE SECTION 4.4)
The ventilation rate is assumed to be 250 cfm, which is the maximum flow rate for the DCRTs considered (244-TX). No credit for HEPA filters is taken for the unmitigated case. For the mitigated case, a filtration efficiency of 99.95% is used ($\text{LPF}=5\text{E}-4$).

5.6. Heat Transfer

The DCRT heatup is assumed to be adiabatic and instantaneous. All energy produced from the exothermic acid/base neutralization reaction will be assumed to heat up the waste instantaneously. No energy will be transferred from the DCRT.

The assumed instantaneous heat up is very conservative since the addition of waste to the tank at 100 gpm would occur over 10 to 40 minutes, depending on the total transfer volume. These assumptions maximize the amount of material which could be released to the environment.

5.7. Release Period

The release is assumed to last less than one hour.

5.8. Processing Facilities Acid Inventory

This table summarizes the available inventory of nitric acid on processing facilities which might mistransfer material to the tank farms.

Facility	Amount of Nitric Acid
B-Plant	110 gallon, maximum safety basis limit
PFP	None stored. Maximum 110 gallon allowed.
222-S	Not connected directly to tank farm
PUREX	None.

6. ANALYTICAL METHODS AND CALCULATIONS:

6.1. Method

6.1.1. Dose Calculation Methods

The first step in calculating the dose is to derive the airborne source term, i.e., the amount of airborne radioactive material generated by the accident that is available for transport to the maximum onsite and offsite individuals. The airborne source term is estimated by the following formula:

$$\text{Source Term} = \text{MAR} \times \text{DR} \times \text{ARF} \times \text{RF} \times \text{LPF}$$

where:

- MAR = Material-at-Risk
- DR = Damage Ratio
- ARF = Airborne Release Fraction, or Airborne Release Rate (ARR) for continuous releases
- RF = Respirable Fraction
- LPF = Leakpath Factor.

Given an airborne source term, the doses from the inhalation and ingestion pathways are calculated by the following formulas:

$$\text{Inhalation: } D_{\text{inh}}(Sv) = Q(L) \times \frac{\chi}{Q} \left(\frac{s}{m^3} \right) \times R \left(\frac{m^3}{s} \right) \times \text{ULD}_{\text{inh}} \left(\frac{Sv}{L} \right)$$

$$\text{Ingestion: } D_{\text{ing}}(Sv) = Q(L) \times \frac{\chi}{Q'} \left(\frac{s}{m^3} \right) \times \text{ULD}_{\text{ing}} \left(\frac{Sv}{L} \right) \left(\frac{Sv \cdot m^3}{S - L} \right)$$

where:

- D_{inh} = Dose due to inhalation
- D_{ing} = Dose due to ingestion
- Q = Respirable source term
- χ/Q' = atmospheric dispersion coefficient
- R = Breathing rate

ULD_{inh} = Inhalation Unit liter dose
 ULD_{ing} = Ingestion Unit liter dose.

6.1.2. Toxicological Consequence Calculation Methodology.

Comparison of toxicological consequences to the WHC risk guidelines is made as follows:

1. Determine the accident frequency range of the accident.
2. Determine the type of material being released (i.e., SST solids, SSTs liquids, etc.).
3. Determine whether the release is continuous or instantaneous
4. Determine the release quantity or release rate, i.e., the airborne source term. This is performed in the same manner as for radioactive materials.
5. Multiply the release quantity or release rate determined in step 4 by the appropriate value from the table in section 4.7. Products less than or equal to one indicate that the WHC risk guidelines are met

For a continuous release of solid or liquid toxic material, the peak concentration is calculated using the following equation:

$$C \text{ (mg/m}^3\text{)} = S \text{ (mg/s)} \times \frac{\chi}{Q'} \text{ (s/m}^3\text{)}$$

where

C	=	Peak concentration (mg/m ³)
S	=	Source term release rate (mg/s)
Q'	=	~~Toxic material release rate (L/s)~~
χ/Q'	=	Continuous release atmospheric dispersion coefficient (s/m ³).

7. RESULTS:

The results for the addition of 110 gallons, 57 weight percent nitric acid and 4000 gal of acidic waste (pH=1) into a sufficient amount of basic waste are displayed below. The results are for unmitigated and mitigated (HEPA filters). For the unmitigated case, the offsite doses for both radiological and toxics are below the evaluation guidelines. For the onsite doses, the results are above the evaluation guidelines for the nitric acid addition.

Note that the radiological consequences are expressed in sieverts, whereas the calculations are performed in rem. The conversion from rem to sieverts is 100 rem for every sievert.

Sample Calculation Related to Acid Addition to DCRT, Unmitigated
(sample results may differ from spreadsheet values due to round off)

The analysis starts with 110 gallons of 57 weight percent nitric acid (57% HNO_3) at 12.2 molarity (M). This 110 gallons is converted to liters.

Step 1:

$$110 \text{ gallons} * 3.785411 \text{ liters/gallon} = 4.164\text{E}+2 \text{ liters}$$

It is assumed that there is only as much waste in the DCRT as will completely react with the 110 gallons of HNO_3 . This volume of 57% HNO_3 neutralizes the following volume of 10 M basic waste.

Step 2:

$$4.164\text{E}+2 \text{ liters} * (12.2 \text{ M} \div 10 \text{ M}) = 5.080\text{E}+2 \text{ liters}$$

Therefore the total volume of acid and waste involved in the reaction is calculated and converted to cubic meters (m^3).

Step 3:

$$(4.164\text{E}+2 + 5.080\text{E}+2 \text{ liters}) * (1 \text{ m}^3/1000 \text{ liters}) = 0.9244 \text{ m}^3$$

The heat of reaction is the larger of the two heat of reactions per gram-mole from the table in Section 4.5 converted to Joules (J) per gram-mole.

Step 4:

$$-13.79 \text{ kcal/gram-mole} * 4185 \text{ J/kcal} = -5.771\text{E}+4 \text{ J/gram-mole}$$

The reaction energy in Joules (J) is calculated using the acid molarity (12.2 M), the volume of acid from Step 1, and the heat of reaction per mole from Step 4.

Step 5:

$$|12.2 \text{ gram-moles/liter} * 4.164\text{E}+2 \text{ liters} * -5.771\text{E}+4 \text{ J/gram-mole}| = 2.932\text{E}+8 \text{ J}$$

The temperature increase of the chemical reactants in degrees Kelvin ($^{\circ}\text{K}$) is calculated using reaction energy from Step 5, volume of waste from Step 3, density of water as representing the waste (1000 kg/m^3), heat capacity of water ($4200 \text{ J/kg-}^{\circ}\text{m}$).

Step 6:

$$(2.932\text{E}+8 \text{ J}) / (0.9244 \text{ m}^3 * 1000 \text{ kg/m}^3 * 4200 \text{ J/kg-}^{\circ}\text{K}) = 75.52 \text{ }^{\circ}\text{K or }^{\circ}\text{C}$$

The temperature increase is added to the initial temperature of the waste and acid which is conservatively assumed to be $93.33 \text{ }^{\circ}\text{C}$ ($200 \text{ }^{\circ}\text{F}$) to determine if the chemical reactants reach boiling (which is assumed to be $100 \text{ }^{\circ}\text{C}$).

Step 7:

$$75.52 \text{ }^{\circ}\text{C} + 93.33 \text{ }^{\circ}\text{C} = 168.9 \text{ }^{\circ}\text{C} \geq 100 \text{ }^{\circ}\text{C} \text{ therefore boiling}$$

The heat necessary to raise the chemical reactants from $93.33 \text{ }^{\circ}\text{C}$ to $100 \text{ }^{\circ}\text{C}$ is calculated using the density of water (1000 kg/m^3), heat capacity of water ($4200 \text{ J/kg-}^{\circ}\text{m}$), the volume of waste from Step 3, and the temperature difference between $93.33 \text{ }^{\circ}\text{C}$ and $100 \text{ }^{\circ}\text{C}$.

Step 8:

$$1000 \text{ kg/m}^3 * 4200 \text{ J/kg-}^{\circ}\text{C} * 0.9244 \text{ m}^3 * (100 \text{ }^{\circ}\text{C} - 93.33 \text{ }^{\circ}\text{C}) = 2.590\text{E}+7 \text{ J}$$

The amount of chemical reactant solution that can be vaporized due to boiling is calculated using the total reaction energy from Step 5, the energy required to raise the chemical reactants to $100 \text{ }^{\circ}\text{C}$ from Step 8, and the heat of vaporization for water ($2,256,900 \text{ J/kg}$).

Step 9:

$$(2.932\text{E}+8 \text{ J} - 2.590\text{E}+7 \text{ J}) / (2.2569\text{E}+6 \text{ J/kg}) = 118.4 \text{ kg}$$

The volume of chemical reactant solution vaporized is calculated using the amount from Step 9, the density of water (1000 kg/m³), and conversion from m³ to liters.

Step 10:

$$(118.4 \text{ kg}/(1000 \text{ kg}/\text{m}^3)) * (1000 \text{ liters}/\text{m}^3) = 118.4 \text{ liters}$$

The fraction of the initial volume of acid and waste that was waste is calculated using the volumes from Steps 1 & 2.

Step 11:

$$5.080\text{E}+2 \text{ liters}/(4.164\text{E}+2 \text{ liters} + 5.080\text{E}+2 \text{ liters}) = 0.55$$

The source term in liters that are released and respirable is calculated using the volume released from Step 10, the fraction of the released volume that was waste from Step 11, an Airborne Release Fraction (ARF) of 2E-3, a Respirable Fraction (RF) of 1.0, and a Leak Path Fraction (LPF) of 1.0. This source term volume is used in the radiological and toxicological calculations.

Step 12:

$$118.4 \text{ liters} * 0.55 * 2\text{E}-3 * 1.0 * 1.0 = 0.130 \text{ liters}$$

The onsite inhalation dose in rem (Sv) is calculated using the conversion of 100 rem/Sv, the source term volume from Step 12, the x/Q onsite value (3.41E-2 sec/m³), onsite breathing rate (R) value (3.3E-4 m³/sec), the liquid fraction (0.67), inhalation Unit Liter Dose (ULD_{inh}) for DST_{liquid} value (6.1E+3 Sv/liter), the solids fraction (0.33), and the ULD_{inh} for DST_{solids} value of (5.3E+5 Sv/liter).

Step 13:

$$100 \text{ rem}/\text{Sv} * 0.130 \text{ liters} * 3.41\text{E}-2 \text{ sec}/\text{m}^3 * 3.3\text{E}-4 \text{ m}^3/\text{sec} * ((0.67 * 6.1\text{E}+3 \text{ Sv}/\text{liter}) + (0.33 * 5.3\text{E}+5 \text{ Sv}/\text{liter})) = 26.18 \text{ rem} (0.2618 \text{ Sv})$$

The onsite ingestion dose in rem (Sv) is calculated using the conversion of 100 rem/Sv, the source term volume from Step 12, the χ/Q onsite value ($3.41\text{E-}2 \text{ sec/m}^3$), the liquid fraction (0.67), ingestion ULD_{ing} for $\text{DST}_{\text{liquid}}$ value ($0.068 \text{ Sv-m}^3/\text{sec-liter}$), the solids fraction (0.33), and the ULD_{ing} for $\text{DST}_{\text{solids}}$ value of ($0.48 \text{ Sv-m}^3/\text{sec-liter}$).

Step 14:

$$100 \text{ rem/Sv} * 0.130 \text{ liters} * 3.41\text{E-}2 \text{ sec/m}^3 * ((0.67 * 0.068 \text{ Sv-m}^3/\text{sec-liter}) + (0.33 * 0.48 \text{ Sv-m}^3/\text{sec-liter})) = 0.0904 \text{ rem } (9.04\text{E-}4 \text{ Sv})$$

The total onsite dose from inhalation and ingestion is the sum of Steps 13 and 14.

Step 15:

$$26.18 \text{ rem} + 0.09 \text{ rem} = 26.27 \text{ rem } (0.2627 \text{ Sv})$$

The offsite inhalation dose in rem (Sv) is calculated using the conversion of 100 rem/Sv, the source term volume from Step 12, the χ/Q offsite value ($2.83\text{E-}5 \text{ sec/m}^3$), offsite breathing rate (R) value ($2.7\text{E-}4 \text{ m}^3/\text{sec}$), the liquid fraction (0.67), inhalation ULD_{inh} for $\text{DST}_{\text{liquid}}$ value ($6.1\text{E+}3 \text{ Sv/liter}$), the solids fraction (0.33), and the ULD_{inh} for $\text{DST}_{\text{solids}}$ value of ($5.3\text{E+}5 \text{ Sv/liter}$).

Step 16:

$$100 \text{ rem/Sv} * 0.130 \text{ liters} * 2.83\text{E-}5 \text{ sec/m}^3 * 2.7\text{E-}4 \text{ m}^3/\text{sec} * ((0.67 * 6.1\text{E+}3 \text{ Sv/liter}) + (0.33 * 5.3\text{E+}5 \text{ Sv/liter})) = 1.778\text{E-}2 \text{ rem } (1.778\text{E-}4 \text{ Sv})$$

The offsite ingestion dose in rem (Sv) is calculated using the conversion of 100 rem/Sv, the source term volume from Step 12, the χ/Q offsite value ($2.83\text{E-}5 \text{ sec/m}^3$), the liquid fraction (0.67), ingestion ULD_{ing} for $\text{DST}_{\text{liquid}}$ value ($0.068 \text{ Sv-m}^3/\text{sec-liter}$), the solids fraction (0.33), and the ULD_{ing} for $\text{DST}_{\text{solids}}$ value of ($0.48 \text{ Sv-m}^3/\text{sec-liter}$).

Step 17:

$$100 \text{ rem/Sv} * 0.130 \text{ liters} * 2.83\text{E-}5 \text{ sec/m}^3 * ((0.67 * 0.068 \text{ Sv-m}^3/\text{sec-liter}) + (0.33 * 0.48 \text{ Sv-m}^3/\text{sec-liter})) = 7.504\text{E-}5 \text{ rem } (7.504\text{E-}7 \text{ Sv})$$

The total offsite dose from inhalation and ingestion is the sum of Steps 16 and 17.

Step 18:

$$1.778\text{E-}2 \text{ rem} + 7.504\text{E-}5 \text{ rem} = 1.786\text{E-}2 \text{ rem (1.786E-4 Sv)}$$

The fraction of the headspace that is filled with released waste is calculated using the volume released from Step 12 and the volume of the headspace. The volume of the headspace is calculated by subtracting the volume of acid (Step 1) and waste neutralized (Step 2) from the volume of the tank (61,600 liters). This fraction is used with the toxicological calculations.

Step 19:

$$(0.130 \text{ liters}) / (61,600 - 416.4 - 508.0 \text{ liters}) = 2.143\text{E-}6$$

The toxicological release rate from the DCRT is calculated using the fraction of the headspace volume containing waste and the ventilation rate for the DCRT ventilation system (250 ft³/min or 118 liters/sec).

Step 20:

$$2.143\text{E-}6 * 118 \text{ liters/sec} = 2.529\text{E-}4 \text{ liters/sec}$$

The DST liquid release rate is calculated using the release rate from Step 20 and the fraction of waste that is liquids (0.67).

Step 21:

$$2.529\text{E-}4 \text{ liters/sec} * 0.67 = 1.694\text{E-}4 \text{ liters/sec}$$

The DST solids release rate is calculated using the release rate from Step 20 and the fraction of waste that is solids (0.33).

Step 22:

$$2.529\text{E-}4 \text{ liters/sec} * 0.33 = 8.346\text{E-}5 \text{ liters/sec}$$

The liquids onsite Sum-of-Fractions (SOF) is calculated using the release rate from Step 21 and the SOF Unit Release for DST liquids onsite related to an anticipated frequency ($1.0\text{E}+4$ sec/liter).

Step 23:

$$1.694\text{E}-4 \text{ liters/sec} * 1.0\text{E}+4 \text{ sec/liter} = 1.694$$

The liquids offsite Sum-of-Fractions (SOF) is calculated using the release rate from Step 21 and the SOF Unit Release for DST liquids offsite related to an anticipated frequency (8.4 sec/liter).

Step 24:

$$1.694\text{E}-4 \text{ liters/sec} * 8.4 \text{ sec/liter} = 1.423\text{E}-3$$

The solids onsite Sum-of-Fractions (SOF) is calculated using the release rate from Step 22 and the SOF Unit Release for DST solids onsite related to an anticipated frequency ($1.8\text{E}+4$ sec/liter).

Step 25:

$$8.346\text{E}-5 \text{ liters/sec} * 1.8\text{E}+4 \text{ sec/liter} = 1.502$$

The solids offsite Sum-of-Fractions (SOF) is calculated using the release rate from Step 22 and the SOF Unit Release for DST solids offsite related to an anticipated frequency ($1.9\text{E}+2$ sec/liter).

Step 26:

$$8.346\text{E}-5 \text{ liters/sec} * 1.9\text{E}+2 \text{ sec/liter} = 1.586\text{E}-2$$

The onsite SOF for ammonia release (because ammonia is released during the chemical reaction and is not capable of being filtered by HEPA filters) is calculated using a maximum concentration of ammonia in DST waste (3270 mg/liter) Reference 13, page D-28, release volume from Step 10, fraction of release that is waste from Step 11, volume of the headspace (60,676 liters), ventilation rate found in Step 20 (118 liters/sec), χ/Q onsite value ($3.41\text{E-}2 \text{ sec/m}^3$), and the limit for ammonia for an anticipated event expressed as mg/m^3 (17.25 mg/m^3) from Reference 7, page D-37.

Step 27:

$$\frac{[(3270 \text{ mg/liter} * 118.4 \text{ liters} * 0.55)/60,676 \text{ liters}] * 118 \text{ liters/sec} * (3.41\text{E-}2 \text{ sec/m}^3/17.25 \text{ mg/m}^3)}{1} = 0.8186$$

The total onsite SOF is calculated using SOF for liquids onsite from Step 23, solids onsite from Step 25, and ammonia onsite from Step 27.

Step 28:

$$1.694 + 1.502 + 0.819 = 4.015$$

The offsite SOF for ammonia release is calculated using a maximum concentration of ammonia in DST waste (3270 mg/liter), release volume from Step 10, fraction of release that is waste from Step 11, volume of the headspace (60,676 liters), ventilation rate found in Step 20 (118 liters/sec), χ/Q offsite value ($2.83\text{E-}5 \text{ sec/m}^3$), and the limit for ammonia for an anticipated event expressed as mg/m^3 (17.25 mg/m^3) from Reference 7, page D-37.

Step 29:

$$\frac{[(3270 \text{ mg/liter} * 118.4 \text{ liters} * 0.55)/60,676 \text{ liters}] * 118 \text{ liters/sec} * (2.83\text{E-}5 \text{ sec/m}^3/17.25 \text{ mg/m}^3)}{1} = 6.794\text{E-}4$$

The total offsite SOF is calculated using SOF for liquids offsite from Step 24, solids offsite from Step 26, and ammonia offsite from Step 29.

Step 30:

$$1.423\text{E-}3 + 1.586\text{E-}2 + 6.794\text{E-}4 = 1.796\text{E-}2$$

Mitigating the release by use of HEPA filters brings the results within the onsite evaluation guidelines.

Accident	Consequences							
	Radiological (Sv)				Toxicological			
	Unmitigated		Mitigated		Unmitigated		Mitigated	
	Onsite	Offsite	Onsite	Offsite	Onsite	Offsite	Onsite	Offsite
110 gal 57 wt % Nitric Acid mistransfer	~~26~~ .27	1.8E-04	~~1.21E-04~~ 1.33E-04	~~1.0E-08~~ 9.0E-08	~~3.19~~ 4.03	~~1.73E-02~~ 1.81E-02	~~1.59E-03~~ .82	~~8.67E-04~~ 6.9E-04
4000 gal transfer, 222-S waste, pH=1	0	0	*	*	0	0	*	*

*A mitigated analysis was not performed because the unmitigated consequences were well within the risk evaluation guidelines

N/A = not applicable.

Sv = sieverts.

8. CONCLUSION:

The offsite consequence values for this accident are well within the risk evaluation. Therefore, no DCRT structures, systems, or components have been designated safety class or safety significant. In order to reduce the onsite consequences to within the evaluation guidelines, the HEPA filters will be designated safety significant.

Additional controls which provide defense in depth is the use of formal controls and procedures between sending facilities and the DST tank farm system to ensure that all incoming wastes are neutralized prior to acceptance into a DCRT. ~~Also, the continuation of the Compatible Waste Program to ensure that incoming wastes are compatible with DCRT and DST contents with respect to criticality, chemical reactivity, organics, and other safety and operational considerations.~~

2. APPENDICES

TWRS SAR Section Mixing of Incompatible materials - Tank Pressurization

Response to comments

FAX, Craig Carro to Ron Graves, "Comments on WSRC FSAR text for Hanford TWRS SAR," 7/30/96

Ronald Graves, "Information Validation Form, RDG.3 IVF-Chapter 3, June 13, 1996

Calculations

3.3.2.3.2.2.12 Mixing of Incompatible materials - Tank Pressurization

This accident involves a mistransfer of incompatible materials into a waste tank that could lead to overpressurization and release of both radioactive and toxic chemicals to the environment. This addition may lead to a simple overpressurization which is relieved by the ventilation system or it may lead to catastrophic failure of the vessel. The likelihood of a mixing of wastes resulting in tank failure has been demonstrated to be beyond extremely unlikely and no additional analysis will be performed. [Reynolds].

The hazard analysis performed for incompatible waste issues identified a mistransfer of incompatible waste in a DCRT leading to a chemical reaction release radioactive and toxic aerosols as an accident with potentially significant onsite consequences. Although transfers within the waste tank system will not lead to exothermic reactions, additions of materials from processing facilities or the SST system may lead to exothermic reaction. The most severe addition has been determined to be that addition of acid or acidic waste to a very basic waste tank solution.

A DCRT is a short-term waste storage facility that consists of a tank and related equipment. A DCRT consists of an underground concrete structure that contains a filter pit, pump pit, and a vault in which a catch tank is installed. The DCRT is used for interim storage of liquid waste and as a valve pit for waste transfer operations. Components for mixing steam and water for backflushing and decontamination operations are located in a nearby flush pit.

The exhaust fans in the tank ventilation systems maintain a negative air pressure inside the primary tank to prevent unfiltered air emissions from escaping from the DCRT/catch station. The air exhausted from the tank passes through a heater, prefilter, HEPA filters, and is monitored for radiation before being released into the environment.

The neutralization of nitric acid with sodium hydroxide leads to the following exothermic chemical reaction.

The heat of reaction for the neutralization reaction is given by:

$$\Delta H_r = \sum_{\text{products}} \Delta H_f^\circ - \sum_{\text{reactants}} \Delta H_f^\circ$$

which yields -57.7 kJ/g-mole for this reaction

To assess the potential consequences in the absence of engineered, mitigative systems, a transfer of 110 gallons of 57 weight percent nitric acid into a DCRT was analyzed. A nitric acid transfer was used because:

- Processing facilities contain small amounts of nitric acid, mostly in laboratory scale or 55 gallon drums used for decontamination purposes. A 110 gallon transfer of 57 wt % would bound the transfer from any single source, since this represents the maximum amount of nitric acid allowed to be stored in the connected processing facilities.
- Processing facilities are required to neutralize acidic wastes prior to transfer. Unneutralized wastes would be much more dilute than nitric acid. The only

facility identified which has substantial amounts of acidic waste was 222-S labs which has a 4000 gallon tank which is connected to the tank farm. Waste contained in this tank could have an unneutralized pH of 1 ($[H^+] = 1M$).

The accident scenario assumes that the DCRT contains waste which is sufficiently basic to completely neutralize the incoming acid transfer. This ensures that the maximum heat of reaction per mole of incoming acid is generated and maximizes the heatup of waste. The hydroxide content is taken to be at the maximum allowed under DCRT corrosion control limits (10 M OH). The material at risk is thereby defined by this amount.

The volume for DCRT 244-A is used for this analysis, 16280 gal, since this minimizes the vapor space volume and maximizes the concentration of aerosols released to the environment. [RYAN]

The damage ratio is determined by the fraction of waste which vaporizes as a result of the exothermic reaction. The waste in the DCRT is assumed to be at 200° F (93° C). This is the maximum allowable temperature for DCRTs based on thermal structural considerations. The boiling point is taken to be 212 ° F (100°C). Energy generated from the chemical reaction will first heat up the waste and then lead to boiling. No heat losses are assumed from the tank or from the ventilation system. The ventilation system is assumed to continue to operate during this accident, thereby maximizing the release rate of radionuclides and toxics. No credit is taken for any of the HEPA filters in the ventilation system. The airborne release fraction for boiling of 2×10^{-3} was used for this analysis.

This accident has been analyzed as being an anticipated event.

The material at risk to be released is based on the maximum radionuclide concentration for one-third double shell solids and two thirds double shell liquids. In practice, there is very little DST solids transferred into DCRTs. Therefore, this is a very conservative assumption.

Table DCRT-1 contains a list of radiological and toxicological consequence value for the release from the nitric acid addition. These consequence values are based on the boiling of waste from a liquid pool. Section 3.4.2.x provides a description the methodology used to calculate release from the boiling from liquid pools.

The unmitigated accident offsite consequence values shown in Table DCRT-1 are well within the risk evaluation guidelines as shown in Figure 3.3-x. Therefore, no DCRT structures, systems, or components have been designated as safety class.

In order to reduce the onsite consequences to within the evaluation guidelines, the HEPA filters will be designated safety significant. A mitigated analysis which included the HEPA filters was performed. A leak path factor of 5×10^{-4} was applied for the HEPA filters (99.95% effectiveness). This brings the onsite mitigated consequences within the evaluation guidelines.

Required administrative controls are that all incoming wastes to the TWRS must be neutralized and that the waste compatibility program must be in place.

References:

DOE-HDBK-3010, 1994, *Airborne Release Fractions/Rates and Respirable Fractions for Nonreactor Nuclear Facilities*, U.S. Department of Energy, Washington, D.C.

D. A. Reynolds, "Review of Chemical Mechanisms for Tank Dome Collapse from Incompatible Waste Mistransfer," WHC, to be issued.

RYAN, G.W., 1994, "OPERATIONAL SUMMARIES FOR
AUXILIARY FACILITIES", WHC-SD-WM-SARR-008,
REV. 0, WESTINGHOUSE HANFORD COMPANY,
RICHLAND, WA.

Table 3.3.X.C-1. Accident Consequences and Frequencies for Chemical Reaction in DCRT Chemical Reaction in DCRT.

Accident	Consequences							
	Radiological (Sv)				Toxicological			
	Unmitigated		Mitigated		Unmitigated		Mitigated	
	Onsite	Offsite	Onsite	Offsite	Onsite	Offsite	Onsite	Offsite
110 gal 57 wt % Nitric Acid mistransfer	~~26~~ 1.27	1.8E-04	~~1.31E-04~~ 1.3E-04	~~8.0E-08~~ 9.0E-08	~~3.1E~~ 4.0	~~1.73E-02~~ 1.8E-02	~~1.50E-03~~ .82	~~8.67E-6~~ 6.9E-04
4000 gal transfer, 222-S waste, pH=1	0	0		*	0	0		*

* A mitigated analysis was not performed because the unmitigated consequences were well within the risk evaluation guidelines

N/A = not applicable.

Sv = sieverts.

TABLE 3.3.X.A-2. Defense -In-Depth Controls for Chemical Reaction in DCRT

Control	Function	Remarks
Tank Farm Waste Compatibility Program	Ensures that waste transfers are compatible with regard to criticality, flammable gas generation, heating, organics, and other safety and operational concerns.	K. D. Fowler, <u>Tank Farm Waste Transfer Compatibility Program</u> , WHC-SD-WM-OCD-015, Rev. 1, April 24, 1995
Waste Transfer procedural controls	Ensure correct routing lineup.	
Neutralization of all acid waste transfers prior to shipment to DCRT.	Ensure that no acidic waste is transferred to DCRT. Corrosion control and energetic reaction prevention.	

Response to Comments: Mixing of Incompatible Materials - Tank Pressurization

- 1-10. Incorporated
- 11a. Incorporated
- 11b. Since we have no safety class SSCs or technical specifications, there is no requirement for a Section 3.4 write-up. All controls for this accident are related to worker protection, not offsite dose.
- 11c. There is no energetic event as a result of this accident, but rather a hearup/boiling of liquids. There is no pressurization event that will not be relieved by the ventilation system. Note that I have assumed that the DCRT waste tank is in communication with the vault, although I know that there is not a close coupling between the two vessels. If I assumed there was not communication between the two, the pressurization would be important, but there would be minimal release to the environment unless the vessel failed.
- 12. Comment recognized.
- 13. See response to 11b.
- 14. See response to 11b.

M.H. Chew & Associates, Inc.
Safety Professionals

1933 Jadwin Avenue, Suite 135, Richland, WA 99352
509-943-3634 Fax: 509-946-7365

Date: 7/30

From:

Craig Carro

To:

Ron Graves

Company:

WSRP

Fax No.:

Phone No.:

Total pages: 29

Comments:

*Ron - sorry this is late, people just wouldn't
let me work today.*

Craig

☐ Call to verify receipt

☐ Hard copy to follow
27 of 58 *59*

Initials _____

Jul 30, 1996 11:08AM

M H CHEN RICHLAND

Calc No. MCL-26-00237 (Rev. 3)
Sheet 20

1/89

Ron,

Attached please find:

- (a) peer review comments for "Pipeline Break from Excavation"
- (b) peer review comments for "Addition of Incompatible Material to Waste Leading to Release of Toxic Vapors"
- (c) peer review comments for "Mixing of Incompatible Materials-Tank Pressurization"
- (d) selected controls for Mixing of Incompatible Materials - Tank Pressurization"
- (e) example control tables from the Brett Hall spray release accident
- (f) SARR-016, Rev. 2 X/Q values - these reflect the change in the site boundary to the near side of the Columbia River.
- (g) SARR-011, Rev. 2 sum-of-fraction values that also reflect the change in X/Q.

Per Dirk Leach, the following work is required.

- 1) Priority #1 - Calculation Note Revisions: read the peer review comments and determine what, if any, revisions to the calculation notes are required. Verify X/Q and sum-of-fractions values per (f) and (g) above. Make necessary revisions.

Due date = 8/6

- 2) Priority #2 - Revised FSAR Text: revise section write-ups per peer review comments.

Due date = 8/13

(509)

If you have any questions, give me a call at 943-3634, or 373-3469, or page at 543-0502. If you have questions on the spray/pool consequences, call Brett Hall at 376-3093.

Craig

(c) Peer Review Comments.

"Incompat Waste - Tank Pressurization

PEER REVIEW COMMENTS

MIXING OF INCOMPATIBLE MATERIALS - TANK PRESSURIZATION

- 1) sheet 13, general
- FSM*

The official section number is 3.3.2.3.2.2.12

The official section title is "Mixing of Incompatible Materials - Tank Pressurization"

It is desirable to combine the mixing of incompatible waste - dome collapse analysis with this one. The approach would be to state in the introduction that the hazards analysis identified transfers of incompatible waste resulting in either dome collapse or pressurization. Then quickly dismiss the dome collapse scenario by saying it is beyond extremely unlikely based on the Reynolds letter. Then present the pressurization analysis. This approach is desired as no analysis (i.e., scenario, source term, &c) was performed for the dome collapse case.

The key comment in regards to the tank pressurization analysis is that you have provided an unmitigated analysis and identified controls, you need to also provide a mitigated analysis in which the controls are credited and show that we now meet the guidelines, e.g., the HEPA filters reducing the dose to X and the TSRs on neutralization reduce the frequency to unlikely (or something like that).

- 2) sheet 13, 1st paragraph
- FSM*

Need a different introductory paragraph, see comment #1 and #5

- 3) sheet 13, 1st paragraph, last sentence

This sentence is incomplete.

- 4) sheet 13, 2nd and 3rd paragraphs
- FSM*

Suggest combine these into a single summary paragraph describing a DCRT, then provide a reference to Chapter 2.0 for details.

- 5) sheet 13, 4th paragraph, 1st sentence
- FSM*

(a) Suggest 1st sentence be used as first sentence in a new opening paragraph associated with the pressurization scenario. Follow it with a brief discussion of how you examined the various types of incompatible wastes which could be added and how you ended up choosing HNO₃ for your analysis.

(b) Suggest rephrasing to state "...chemical reaction and subsequent release of..."

- 6) sheet 13, 4th paragraph, 2nd and 3rd sentences and associated equations *FSM*

Suggest these be moved to sheet 14, 2nd paragraph (beginning "The damage ratio....") after 1st sentence, as it is part of the source term calculation as opposed to the scenario.

- 7) sheet 13, last paragraph, 1st sentence

State that this is your "unmitigated analysis" in which no credit is taken for controls. *FSM*

- 8) sheet 14, 2nd paragraph (beginning "The damage ratio....")

- (a) Believe you mean the "source term" as opposed to the damage ratio. ✓
(b) Provide basis for 150 °F temperature assumption.
(c) Give basis for 2E-3 release fraction and explain how it was applied (i.e., to the entire contents of the tank? to the fraction that boiled? &c).
(d) State the actual amount of material released by the accident. *FSM*

- 9) sheet 14, 3rd paragraph

Move this statement regarding frequency to the end of the unmitigated scenario discussion. Provide basis for assigning this frequency bin, e.g., human error - failure to neutralize waste prior to transfer, &c. *FSM*

- 10) sheet 14, 5th paragraph

- (a) Delete reference to 3.4.2.x and boiling liquids. You need to summarize in your source term discussion how you calculated the release, i.e., you applied a release fraction of 2E-3 to something.
(b) Clarify that the numbers are the unmitigated consequences.

- 11) sheet 14, 6th paragraph

- (a) 2nd sentence, delete "... or safety significant." from end of sentence as you state in the next sentence that the HEPA filters are safety significant.
(b) Attached is the Control Decision Record for this accident, need to state that because the onsite guidelines were exceeded, these controls were identified. Then you need to provide a mitigated analysis in which you take credit for these controls. The AC TSRs reduce the frequency of the event and the HEPA filters reduce the dose. This will require new dose calculations.
(b) For your mitigated analysis, You need to state that the pressures generated by the

heat load/gases in the head space does not blow out your HEPA filters (assuming you know this to be true).

- 12) sheet 14, 7th paragraph

Attached is the control decision record for this accident. There is no TSR on 10 M NaOH, there is no TSR on temperature, there is no TSR on interfacing facility tanks.

- 13) sheet 14, 8th paragraph

The controls you have identified as defense-in-depth have been selected as TSR level controls. See attached control decision record.

- 14) sheet 14, 8th paragraph

Need to provide summary tables of SSCs, TSRs, and Defense-in-Depth. See the Brett Hall spray release write-up for examples.

INTER-OFFICE MEMORANDUM
Savannah River Site

29-Aug-1996 04:44pm EST

To: john.norkus
(john.norkus@mailhub.srs.gov@PMDf@SAEMS)
To: Dirk_S_Leach@-HANFORD02B
(Dirk_S_Leach@-HANFORD02B@ccmail.pnl.gov@PMDf@SAEMS)
CC: Lankford_Ruffin
(Lankford_Ruffin@ccmail.pnl.gov@PMDf@SAEMS)
From: Lankford_Ruffin@-WHC338
(Lankford_Ruffin@-WHC338@ccmail.pnl.gov@PMDf@SAEMS)

HNO-3

John, this is a follow-up to the voice message I left you. As I stated, I accepted the bounding amount of 1000 gal. as indicated by the IVF answer to Ron Graves. However, I always try to use an upper number if this upper number allows more flexibility for "all". However, as I stated, the only external facility that indicated it would store HNO-3 (if needed) for future use is B-Plant. B-Plant indicated that their new Interim Safety Basis will only allow for 110 gallons of nitric acid to be stored at the plant. Currently (about 2 months ago) B-Plant had less than 50 gallons of nitric acid. PFP (acronym for another facility) indicated that it currently has no HNO-3. However, if it did require some, it would also use 55 gal. drums. PFP stated that no more than two 55 gal. drums max. would ever be needed to add to there sending tank (D-5), which sends its' waste to tank farm's DCRT. So, my opinion would be that you use the maximum number you can to bound the accident. If this is not acceptable, then use the 150 gallons which is allowed by the safety basis for B-Plant, or the 600 gallons limit you discussed with me on the telephone. If you need to reach me, my number is 509-373-3035. I'll be back next Wednesday (9/4).

Lankford

INTER-OFFICE MEMORANDUM
Savannah River Site

17-Jun-1996 01:41pm EST

To: john.norkus
(john.norkus@mailhdb.srs.gov@PMDf@SAEMS)From: Ronald_D_Ron_Graves
(Ronald_D_Ron_Graves@rl.gov@PMDf@SAEMS)Transfers to DCRT or DST

Ron,

B Plant currently uses one transfer route out of plant. This transfer route is used to move liquid low level waste from B Plant to Tank Farm underground storage. Once the pipeline leaves the wall of B Plant it becomes Tank Farms transfer line. Tank Farms takes control of all route changes from that point. So the question of whether B Plant transfers to a DCRT or to a DST could be better answered by East Tank Farm Engineering.

Duane

INTER-OFFICE MEMORANDUM
Savannah River Site

14-Jun-1996 06:06pm EST

To: john.norkus
(john.norkus@mailhub.srs.gov@PMDf@SAEMS)From: Ronald_D_Ron_Graves
(Ronald_D_Ron_Graves@rl.gov@PMDf@SAEMS)Comment/response to acidic transfer to DST

It is difficult to agree to the statement that a maximum of 1,000 gallons of nitric could be transferred to a DST. The B Plant safety basis says that we have three vertical eight thousand gallon nitric acid tanks. Today, the tanks are empty and there are no plans to refill them. The chemical headers that would deliver the nitric acid are also empty. Currently the plant has less than 50 gallons of nitric acid. The new Interim Safety Basis that is being written allows for 110 gallons to be stored at the plant.

In reality the chance of transferring more than 1000 gallons of nitric to a DST is extremely low when considering the lack of nitric, administrative preventatives and procedural preventatives. The point is, B Plant has the ability to store more than 1000 gallons of nitric. If the quantity of nitric exists then the possibility of transferring the quantity exists.

Duane

INTER-OFFICE MEMORANDUM
Savannah River Site

14-Jun-1996 12:21pm EST

To: john.norkus
(john.norkus@mailrub.srs.gov@PMDf@SAEMS)

From: Ronald_D_Ron_Graves
(Ronald_D_Ron_Graves@rl.gov@PMDf@SAEMS)

Re: NITRIC ACID, 222-S

please include the maximum volume of waste that could be shipped. 4000
gal. ?

Reply Separator

Subject: NITRIC ACID, 222-S
Author: Larry D Goodwin at -WHC169
Date: 6/14/96 8:34 AM

NITRIC ACID CANNOT BE TRANSFERRED DIRECTLY FROM THE 222-S LAB TO TANK
FARMS'. WE DO NOT STORE NITRIC ACID IN BULK FORM.

OUR WASTE IS ACIDIC (pH OF AROUND 1) BEFORE WE TREAT IT.

INTER-OFFICE MEMORANDUM
Savannah River Site

12-Jun-1996 11:52am EST

To: john.norkus
(john.norkus@mail5ub.srs.gov@PMDF@SAEMS)From: Ronald_D_Ron_Graves
(Ronald_D_Ron_Graves@rl.gov@PMDF@SAEMS)Nitric to 244-TX

Ron,

Here is the information you requested in general, if you need more specific information, give me a call.

Greg

1. Physically our Nitric Tank isn't connected to our waste tank that is shipped to tank farms. We would have to install some type of jumper requiring ECNs, USQs, workpackages, etc.

2. We no longer have a nitric acid in bulk. Our bulk nitric acid tank was emptied and shipped off site 6 weeks ago. Our future needs (in any) for nitric acid will be met by using 55 gallon drums.

3. Our waste lines aren't connected directly to the tank that ships to tank farms. All radioactive liquid waste goes to a separate tank, and is sampled for hydroxide ion, solids, Pu content, before transferring to our shipping tank to tank farms. Once it is in our shipping tank to tank farms, hydroxide ion, solids, Pu content are verified again before shipping. Plus we couldn't ship anything to tank farms without them knowing because they have an interlock on our pumps. There would have to be many failures before a acidic shipment could be sent.

John this is a reply I received from PFP concerning nitric acid inventory.

INTER-OFFICE MEMORANDUM
Savannah River Site

12-Jun-1996 11:48am EST

To: john.norkus
(john.norkus@mailhub.srs.gov@PMDF@SAEMS)From: Ronald_D_Ron_Graves
(Ronald_D_Ron_Graves@rl.gov@PMDF@SAEMS)No Potential for Nitric Acid to Tank Farms from PUREX

Ron,

Currently, PUREX is in the process of sending the last batch of solution from Tank U3 to Tank Farms (Tank 105-AW). This transfer solution will contain essentially contaminated water. This will be the final transfer of solution of from a PUREX waste tank to Tank Farms. Also, PUREX does not have an inventory of nitric acid that could be added this waste tank. It is not likely that PUREX will have any acid inventory in the future due to the deactivation of the PUREX facility.

Sean Eiholzer
Process Engineer
PUREX Surveillance Team

DST Acid Mistransfer
Unmitigated
ACIO-237.XLS

M-CLC-G-00237, Rev 4

	A	B	C	D	E	F	G	H	I	J	K	L	M
1		Hf (kcal/g mole)		Density	1000	kg/m3	ULD,inh,DST,llq	6.10E+03	Sv/l	Tank volume	6.10E+04		
2	HNO3	-49.21		cp	4200	J/kg K	ULD,lng,DST,llq	0.088	Sv-m3/s-1				
3	NaOH	-112.193		hfg	2.26E+08	J/kg	ULD,inh,DST,sol	5.30E+05	Sv/l	Ventilation rate	250	cfm	
4	NaNO3	-106.88					ULD,lng,DST,sol	0.48	Sv-m3/s-1		118	l/s	
5	H2O	-68.3174					Solids frac	0.33					
6	Hnzn	-13.7944	kcal/gmol				X/Q, onsite	3.41E-02	s/m3	DST liquid onsite limit	1.00E+04	s/l	
7	Hnzn	-5.78E+04	J/g-mole				X/Q, offsite	2.83E-05	s/m3	DST liquid offsite limit	8.4	s/l	
8							R,onsite	3.30E-04	m3/s	DST solids onsite limit	1.80E+04	s/l	
9	Waste temp	93.33	C				R,offsite	2.70E-04	m3/s	DST solids offsite limit	190	s/l	
10	Boiling temp	100	C				Dose limit onsite	0.5	rem				
11							Dose limit offsite	0.1	rem				
12													
13	Acid				Base Volume		Reaction			Heat up energy	Mass evaporated (Tw		
14	Volume(gal)	Vol (l)	Molarity	Molarity	to neutralize(l)	(gal)	Total volume, m3	energy(J)	Delta T (K)	Boil?	(J)	kg	vol(m3)
15	110	418.4	12.2	5	1016	268.43	1.43	2.93E+08	48.77	boiling	4.01E+07	112.2	0.11
16	110	418.4	12.2	10	508	134.21	0.92	2.93E+08	75.67	boiling	2.59E+07	118.5	0.12
17	4000	15141.6	0.1	10	151	40.00	15.29	8.75E+07	1.36	heat up	8.7E+07	0.00E+00	0.00

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MHC-SD-MM-CN-073, REV. 0

DST Acid Mistransfer
Unmitigated
ACID-237.XLS

	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC
1																
2																
3																
4																
5																
6																
7																
8																
9																
10																
11																
12																
13 Tbol)	Fraction	ARF		RF	LfP	Source term(l)	Inhalation Dose/rem	Ingestion Dose/rem	Total onsite dose/rem	Exceeded limits?	Inhalation Dose/rem	Ingestion Dose/rem	Total offsite dose/rem	Exceeded limits?	Headspace volume(l)	Waste fraction in vapor
14 i)	Waste															
15	112.2	0.7	2E-03	1	1	0.169	32.38	0.11	32.49	Exceed	2.2E-02	9.3E-05	2.2E-02			
16	118.5	0.5	2E-03	1	1	0.130	26.50	0.08	26.59	Exceed	1.8E-02	7.8E-05	1.8E-02			
17	0.0	0.0	2E-03	1	1	0.000	0.00	0.00	0.00		0.0E+00	0.0E+00	0.0E+00			
18																
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M-CLC-GL-00237, Rev. 4

DST Acid Mastercater
Unmitigated
ACID-237.XLS

	AD	AE	AF	AG	AH	AI	AJ	AK	AL	AM	AN
1											
2											
3											
4											
5											
6											
7											
8											
9											
10											
11											
12	Anticipated										
13	Release rate	DST liq release	DST solids	Liquid onsite	Liquid offsite	Solids onsite	Solids offsite	Sum onsite	Sum offsite	Over	Over offsite
14	l/hr	rate(l/hr)	release rate (l/s)	sum	sum	sum	sum			Onsite limit?	limit?
15	3.12E-04	2.08E-04	1.04E-04	2.08E+00	1.76E-03	1.97E+00	1.98E-02	4.96E+00	2.23E-02	Over limit	
16	2.63E-04	1.69E-04	8.44E-05	1.69E+00	1.42E-03	1.52E+00	1.80E-02	4.03E+00	1.81E-02	Over limit	
17	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00		

DST Acid Mixtures
Uninitiated
ACID-237.XLS

M-CLC-G-00237, Rev 4

1	A	B	C	D	E	F	G	H	I
1	Hf (kcal/g mole)	Density	1000	kg/m ³	ULD, h ₂ O, DST, liq	ULD, h ₂ O, DST, liq	8100	SvA	
2	HNO ₃	49.21	cp	4200	J/kg K	ULD, h ₂ O, DST, liq	530000	SvA	
3	NaOH	-112.193	liq	2256900	J/kg	ULD, h ₂ O, DST, sol	0.48	Sv-m ³ /s-l	
4	NaNO ₃	-106.88				ULD, h ₂ O, DST, sol	= 1/3		
5	H ₂ O	-68.3174					0.0341	e/m ³	
6	H ₂ O	= 65 + B4 - (B2 + B3)	kcal/mol				0.000293	e/m ³	
7	H ₂ O	= 86 + 4187	J/g-mole				0.00033	m ³ /s	
8	Waste temp	= (200-32)*5/9	C				0.00027	m ³ /s	
9	Boiling temp	100	C				0.6	rem	
10								rem	
11									
12									
13	Acid								
14	Volume(gal)	Vol (l)	Molarity	Molarity	Base Volume				
15									
16									
17									
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99									
100									

J		K	L
1	Tank volume	= CONVERT(18280,"gal","l")	l
2			
3	Ventilation rate	250	cfm
4		= 28.32 * K3/60	l/s
5			
6	DST liquid onsets limit	10000	s/l
7	DST liquid offsets limit	8.4	s/l
8	DST solids onsets limit	18000	s/l
9	DST solids offsets limit	190	s/l
10			
11			
12			
13		Heat up energy	Mass evaporated (Tw = Tboil)
14	Boil?	(J)	kg
15	=IF(I15 + Waste temp > Boiling temp, "boiling", "heat up")	=IF(J15 = "Boiling", Density*cp*G15*(Boiling temp-Waste temp), Density*cp*(I15*G15))	=(H15-K15)/hfg
16	=IF(I16 + Waste temp > Boiling temp, "boiling", "heat up")	=IF(J16 = "Boiling", Density*cp*G16*(Boiling temp-Waste temp), Density*cp*(I16*G16))	=(H16-K16)/hfg
17	=IF(I17 + Waste temp > Boiling temp, "boiling", "heat up")	=IF(J17 = "Boiling", Density*cp*G17*(Boiling temp-Waste temp), Density*cp*(I17*G17))	=(H17-K17)/hfg

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MHC-SD-MM-CN-073, REV. 0

DST Acid Misttransfer
Unmitigated
ACID-237.XLS

M-CLC-G-00237, Rev 4

	M	N	O	P	Q	R	S
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							Onsite
13			Fraction				Source
14	vol(m3)	l	Waste	ARF	RF	LPF	term(l)
15	=L15/Density	=M15*1000	=E15/(E15+B15)	0.002	1	1	=O15*N15*P15*Q15*R15
16	=L16/Density	=M16*1000	=E16/(E16+B16)	0.002	1	1	=O16*N16*P16*Q16*R16
17	=L17/Density	=M17*1000	=E17/(E17+B17)	0.002	1	1	=O17*N17*P17*Q17*R17

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MHC-SD-MM-CN-073, REV. 0

	T
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	Inhalation
14	Dose ,rem
15	=100*S15*X Q onsite*R onsite*((1-Solids frac)*ULD inh DST liq+Solids frac*ULD inh DST sol)
16	=100*S16*X Q onsite*R onsite*((1-Solids frac)*ULD inh DST liq+Solids frac*ULD inh DST sol)
17	=100*S17*X Q onsite*R onsite*((1-Solids frac)*ULD inh DST liq+Solids frac*ULD inh DST sol)

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MCLG-G-00237, Rev 4

DST Acid Micronifer
 Onsite
 ACD-237.XLS

	U	V	W
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13	Ingestion	Total onsite	Exceed onsite
14	Dose/rem	dose/rem	limits?
15	$= 100 * S16 * X * Q \text{ onsite} * ((1 - \text{Solids frac}) * \text{ULD lng DST lng} + \text{Solids frac} * \text{ULD lng DST sol})$	$= T16 + U16$	$= \text{FRV15} > \text{Dose limit onsite} \text{ "Exceed" } "$
16	$= 100 * S18 * X * Q \text{ onsite} * ((1 - \text{Solids frac}) * \text{ULD lng DST lng} + \text{Solids frac} * \text{ULD lng DST sol})$	$= T16 + U18$	$= \text{FRV16} > \text{Dose limit onsite} \text{ "Exceed" } "$
17	$= 100 * S17 * X * Q \text{ onsite} * ((1 - \text{Solids frac}) * \text{ULD lng DST lng} + \text{Solids frac} * \text{ULD lng DST sol})$	$= T17 + U17$	$= \text{FRV17} > \text{Dose limit onsite} \text{ "Exceed" } "$

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	Y	Z	AA
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13	Ingestion	Total offsite	Exceed offsite
14	Dose,rem	dose,rem	limit?
15	= 100*S15*X Q offsite*((1-Solids frac)*ULD lng DST liq + Solids frac*ULD lng DST sol)	= X15 + Y15	= IF(Z15 > Dose limit offsite, "Exceed limit", "")
16	= 100*S16*X Q offsite*((1-Solids frac)*ULD lng DST liq + Solids frac*ULD lng DST sol)	= X16 + Y16	= IF(Z16 > Dose limit offsite, "Exceed limit", "")
17	= 100*S17*X Q offsite*((1-Solids frac)*ULD lng DST liq + Solids frac*ULD lng DST sol)	= X17 + Y17	= IF(Z17 > Dose limit offsite, "Exceed limit", "")

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59

MHC-SD-MM-CN-073, REV. 0

DST Acid Manufacturer
Unmigated
ACID-237.XLS

M-CLC-G-00237, Rev 4

17	AB	AC	AD	AE	AF	AG
16						
15						
14						
13						
12						
11						
10						
9						
8						
7						
6						
5						
4						
3						
2						
1						
	Headspace	Waste fraction	Released rate	DST liq release	DST solids	Liquid onsite
	in vapor	l/s	rate(l/s)	release rate (l/s)	sum	
14	= Tank volume-E16-B16	= S16/A816	= AC16*Vent rate	= AD16*(1-Solids frac)	= AD16*Solids frac	= AE16*DST liquid onsite limit
15	= Tank volume-E16-B16	= S16/A816	= AC16*Vent rate	= AD16*(1-Solids frac)	= AD16*Solids frac	= AE16*DST liquid onsite limit
16	= Tank volume-E16-B16	= S16/A816	= AC16*Vent rate	= AD16*(1-Solids frac)	= AD16*Solids frac	= AE16*DST liquid onsite limit
17	= Tank volume-E17-B17	= S17/A817	= AC17*Vent rate	= AD17*(1-Solids frac)	= AD17*Solids frac	= AE17*DST liquid onsite limit

DST Acid Mistransfer
Unmitigated
ACID-237.XLS

M-CLC-G-00237, Rev 4

	AH	AI	AJ	AK
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13	Liquid offsite	Solids onsite	Solids offsite	Sum onsite
14	sum	sum	sum	
15	=AE15*DST liquid offsite limit	=AF15*DST solids onsite limit	=AF15*DST solids offsite limit	=AG15+AI15+'[ACID-237.XLS]Ammonia Release'IE17
16	=AE16*DST liquid offsite limit	=AF16*DST solids onsite limit	=AF16*DST solids offsite limit	=AG16+AI16+'[ACID-237.XLS]Ammonia Release'IE18
17	=AE17*DST liquid offsite limit	=AF17*DST solids onsite limit	=AF17*DST solids offsite limit	=AG17+AI17+'[ACID-237.XLS]Ammonia Release'IE19

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MHC-SD-MM-CN-073, REV. 0

DST Acid Mistransfer
Unmitigated
ACID-237.XLS

M-CLC-G-00237, Rev 4

	AL	AM	AN
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13	Sum offsite	Over	Over offsite
14		Onsite limit?	limit?
15	=AH15 + AJ15 + '[ACID-237.XLS]Ammonia Release'!F17	=IF(AK15 > 1,"Over limit","")	=IF(AL15 > 1,"Over limit","")
16	=AH16 + AJ16 + '[ACID-237.XLS]Ammonia Release'!F18	=IF(AK16 > 1,"Over limit","")	=IF(AL16 > 1,"Over limit","")
17	=AH17 + AJ17 + '[ACID-237.XLS]Ammonia Release'!F19	=IF(AK17 > 1,"Over limit","")	=IF(AL17 > 1,"Over limit","")

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MHC-SD-MM-CN-073, REV. 0

DCRT Acid Neutralizer
Mitigated
ACID-237.XLS
M-CLC-G-00237, rev 4

1	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
2																			
3																			
4																			
5																			
6																			
7																			
8																			
9																			
10																			
11																			
12																			
13																			
14																			
15	Vol (l)	Molality	Molality to neutralize(l)	Base Volume (gal)	Total volu energy(l)	Reaction	Delta T (K)	Boil?	(L)	Heat up energy	Mass evaporated (lw = Tboil)	Waste	Fraction	APF	RF	LPF	Source		
16	110	410.4	112.2	1016	1.43	2.93E+08	48.77	boiling	4.01E+07	112.2	0.1	112.2	0.7093	0.0020	1.0	0.0006	0.0001		
17	110	410.4	112.2	508	0.92	2.93E+08	75.67	boiling	2.58E+07	118.6	0.1	118.6	0.6496	0.0020	1.0	0.0006	0.0001		
18	4000	15141.6	0.1	151	15.29	8.75E+07	1.36	Heat up	8.75E+07	0.0	0.0	0.0	0.0099	0.0020	1.0	0.0006	0.0000		

DCRT Acid Misttransfer
Mitigated
ACID-237.XLS

M-CLC-G-00237, rev 4

	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH
1															
2															
3															
4															
5															
6															
7															
8															
9															
10															
11															
12															
13															Toxics
14	Inhalation	Ingestion	Total onsite	Exceed onsite	Inhalation	Ingestion	Total offsite	Exceed offsite	Headspace	Waste fraction	Release rate	DST liq release	DST solids	Liquid onsite	Liquid offsite
15	Dose,rem	Dose,rem	dose,rem	limit?	Dose,rem	Dose,rem	dose,rem	limit?	volume(l)	in vapor	l/y	rate(l/y)	release rate (l/y)	sum	sum
16	1.62E-02	5.67E-05	1.62E-02		1.10E-05	4.63E-08	1.10E-05		6.02E+04	1.32E-09	1.56E-07	1.04E-07	5.20E-08	1.04E-03	6.74E-07
17	1.32E-02	4.56E-05	1.33E-02		8.00E-08	3.79E-08	8.03E-08		6.07E+04	1.07E-09	1.27E-07	8.44E-08	4.22E-08	8.44E-04	7.09E-07
18	0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00		4.63E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

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1	AI	AJ	AK	AL	AM	AN
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14	Soldes on site	Soldes off site	Sum on site	Sum off site	Over	Over off site
15	sum	sum			On site limit?	Over limit?
16	9,36E-04	9,88E-08	1,01E+00	8,48E-04		
17	7,60E-04	8,02E-08	8,20E-01	8,88E-04		
18	0,00E+00	0,00E+00	0,00E+00	0,00E+00		

DCRT Acid Mistransfer
Ammonia Release
ACID-237.XLS

M-CLC-G-00237, Rev 4

	A	B	C	D	E	F	G
1	Ammonia release from acid addition to DCRT.						
2							
3	Tank	liquid (mg/l)	solid (mg/l)	source (mg/l)		Vent. Rate (l/s)	118
4	AW101	172		172		ERPG-1 (mg/m3)	17.25
5	AW105	170		170			
6	AP103	3270		3270			
7	AW101	247		247			
8	AW102	61		61			
9	AW105	894	1590	1123.68			
10	AW106	64		64			
11	AY102	2790		2790			
12	SY101	146	2870	1044.92			
13							
14							
15							
16	mass NH3	Headspace Vol.	C in Headspace (mg/l)		SOF Onsite	SOF Offsite	
17	260317.0936	6.02E+04	4.32E+00		1.01E+00	8.37E-04	
18	213012.8391	6.07E+04	3.51E+00		8.18E-01	6.79E-04	
19	0	4.63E+04	0.00E+00		0.00E+00	0.00E+00	

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MHC-SD-MM-CN-073, REV. 0

DCRT Acid Misttransfer
Ammonia Release
ACID-237.XLS

M-CLC-G-00237, Rev 4

A		B
1	Ammonia release from acid addition to DCRT.	
2		
3	Tank	liquid (mg/l)
4	AW101	172
5	AW105	170
6	AP103	3270
7	AW101	247
8	AW102	61
9	AW105	894
10	AW106	64
11	AY102	2790
12	SY101	146
13		
14		
15		
16	mass NH3	Headspace Vol.
17	=MAX(\$D\$4:\$D\$12)*[ACID-237.XLS]Unmitigated'IN15*[ACID-237.XLS]Unmitigated'IO15	='[ACID-237.XLS]Unmitigated'!AB15
18	=MAX(\$D\$4:\$D\$12)*[ACID-237.XLS]Unmitigated'IN16*[ACID-237.XLS]Unmitigated'IO16	='[ACID-237.XLS]Unmitigated'!AB16
19	=MAX(\$D\$4:\$D\$12)*[ACID-237.XLS]Unmitigated'IN17*[ACID-237.XLS]Unmitigated'IO17	='[ACID-237.XLS]Unmitigated'!AB17

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MHC-SD-MM-CN-073, REV. 0

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[illegible]

DCRT Acid Mistransfer
Ammonia Release
ACID-237.XLS

M-CLC-G-00237, Rev 4

DCRT Acid Mitransfer
Ammonia Release
ACID-237.XLS

	F	G
1		
2		
3	Vent. Rate (l/s)	= 'ACID-237.XLS\Unmitigated'K4
4	ERPG-1 (mg/m3)	= 0.69*26
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16	SOF Offsite	
17	= 'C17'&G\$3*'ACID-237.XLS\Unmitigated'IH\$7/G\$4	
18	= 'C18'&G\$3*'ACID-237.XLS\Unmitigated'IH\$7/G\$4	
19	= 'C19'&G\$3*'ACID-237.XLS\Unmitigated'IH\$7/G\$4	

CHECKLIST FOR PEER REVIEW

Document Reviewed:

Chemical Reaction in a DCRT, WHC-SD-WM-CN-073, Rev 0, [a revised version of M-CLC-G-00237, Rev 2].

Scope of Review:

Scope of Review: This review was limited to confirming that the comments to M-CLC-G-00237, Rev 2, provided by this reviewer were dispositioned and/or incorporated into WHC-SD-WM-CN-073, Rev 0, to my satisfaction.

Yes No NA

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

[X] [ ] [ ] Document approved.

Tom Tomaszewski

Reviewer (Printed Name and Signature)

9/20/96

Date

* Any calculations, comments, or notes generated as part of this review should be signed, dated and attached to this checklist. Such material should be labeled and recorded in such a manner as to be intelligible to a technically qualified third party. **NONE ATTACHED.**

[ ] [ ] [X] Analysis entered into analysis database

Tom Tomaszewski

(Printed Name and Signature)

9/20/96

Date

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