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Flammable Gas Deflagration Consequence Calculations for the Tank Waste Remediation System Basis for Interim Operation

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Abstract: This paper calculates the radiological dose consequences and the toxic exposures for deflagration accidents at various Tank Waste Remediation System facilities. These will be used in support of the Tank Waste Remediation System Basis for Interim Operation.

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**FLAMMABLE GAS DEFLAGRATION CONSEQUENCE CALCULATIONS
FOR THE TANK WASTE REMEDIATION SYSTEM
BASIS FOR INTERIM OPERATION**

This calculation note calculates the radiological consequences and toxicological exposures associated with various deflagration accident scenarios. The radiological consequences were calculated using the unit liter doses found in Cowley (1996) and the methodology for calculating consequences is found in Van Keuren and Savino (1996). The unit liter doses are the radiation doses received per liter of tank waste. The doses were calculated using the pathways of submersion (direct radiation), inhalation, and 24-hour ingestion. Cowley (1996) provides the technical basis for the unit liter doses. Van Keuren and Savino (1996) states that the following equation is to be used for calculating the inhalation and submersion dose. Note: generally, the submersion dose is insignificant (orders of magnitude lower) compared to the inhalation dose.

$$EDE_{inhalation} = Q \frac{\chi}{Q'} B_r ULD_{inhalation}$$

where Q is the volume of waste resuspended (L), χ/Q' is the atmospheric dispersion coefficient ($\frac{s}{m^3}$), B_r is the standard man breathing rate during light activity ($\frac{m^3}{s}$), and the $ULD_{inhalation}$ is the unit liter dose (Sv/L) due to inhalation and submersion.

Ingestion doses are calculated using the following equation.

$$EDE_{ingestion} = Q \frac{\chi}{Q'} ULD_{ingestion}$$

where again, Q is the volume of waste resuspended (L), χ/Q' is the atmospheric dispersion coefficient ($\frac{s}{m^3}$) and $ULD_{ingestion}$ is the unit liter dose ($\frac{Sv \cdot m^3}{s \cdot L}$) due to 24-hour ingestion.

The toxicological consequences were calculated using the sum-of-fractions values and methodology found in Van Keuren (1996). For a release of solid or liquid toxic materials, the peak concentration is of concern. The following equation was used to calculate the peak concentration, C ($\frac{mg}{m^3}$) for a continuous release of solid or liquid toxic material.

$$C_i = Q' \frac{\chi}{Q'}$$

where C_i is the concentration of the i^{th} toxic material, Q' is the release rate (mg/s) and χ/Q' is the integrated atmospheric dispersion coefficient (s/m').

This method has been extended to include the multiple chemicals contained in the tank waste. To do this, a sum-of-fractions methodology has been applied. That is, on a per unit basis, the ratio of a chemicals concentration (calculated either at the 100 m receptor or the offsite receptor) is compared to the appropriate limit. This was done for all chemicals involved, then the ratios or fractions were summed.

$$SOF = \frac{C_1}{Limit_1} + \frac{C_2}{Limit_2} + \dots + \frac{C_n}{Limit_n}$$

If the sum-of-fractions is less than or equal to 1, the risk guidelines are considered to have been met. If the sum-of-fractions is greater than 1, the risk guidelines are considered to have been exceeded. Thus, the above equation now becomes,

$$T = Q' SOF$$

where T is the measure of acceptance, Q' is the toxic material release rate (L/s) and SOF is the sum-of-fractions of the risk guidelines (s/L) for either the onsite or offsite receptor. For a puff release, Q' is the amount of toxic material released (L) and SOF is the sum-of-fractions of the risk guidelines (1/L). The sum-of-fractions for each accident has been calculated for each of the frequency categories, i.e., anticipated, unlikely, and extremely unlikely. The following spreadsheet pages document the calculations. The maximum waste material accumulation in ventilation systems is taken from WHC-SD-WM-CN-054, Rev. 0 (Van Vleet 1996). An in-depth example calculation is shown here for the single-shell tanks. Other deflagration accidents in Tank Waste Remediation System facilities are treated in a similar fashion.

EXAMPLE

Radiological Dose Consequences - Onsite

The radiological dose consequences from a deflagration will consist of the sum of two releases. These releases are (1) the material from the ventilation system and (2) the material entrained from the tank waste by the deflagration. The following paragraphs show how the values were calculated for each release.

The cumulative effective dose equivalent for the onsite receptor from the calculated release of waste accumulations in the ventilation system for a single-shell tank due to a high pressure event (such as a deflagration) is

$$\begin{aligned}
 EDE_{inhalation} &= Q \frac{X}{Q'} B_i ULD_{inhalation} \\
 &= (0.00613 \text{ L}) (3.41 \times 10^{-2} \frac{\text{S}}{\text{m}^3}) (3.3 \times 10^{-4} \frac{\text{m}^3}{\text{S}}) (2.2 \times 10^5 \frac{\text{Sv}}{\text{L}}) \\
 &= 1.517 \times 10^{-2} \text{ Sv}
 \end{aligned}$$

where the material released is 0.00613 L (Van Vleet 1996), the acute atmospheric dispersion coefficient is $3.41 \times 10^{-2} \text{ s/m}^3$ (Van Keuren and Savino 1996), the breathing rate for light activity is $3.3 \times 10^{-4} \text{ m}^3/\text{s}$ (Van Keuren and Savino 1996), and the ULD for single-shell tank solids is $2.2 \times 10^5 \text{ Sv/L}$ (Cowley 1996).

The amount of material entrained from the waste surface is a combination of the material in the headspace (that naturally in the headspace and that introduced by the gas release event) and the material entrained by the flame front (LANL 1996).

$$\begin{aligned}
 M_{deflagration} &= M_{headspace} + M_{entrained} \\
 &= 0.35 \text{ kg} + 5.45 \text{ kg} \\
 &= 5.80 \text{ kg}
 \end{aligned}$$

This material is assumed to be 100% respirable material (LANL 1996). Only a portion of this material will exit the tank. The fraction released can be calculated based upon the pressure the tank reaches and atmospheric pressure.

$$\begin{aligned}
 M_{released} &= (5.8 \text{ kg}) \left(\frac{(4 \text{ bar}) (100000 \frac{\text{Pa}}{\text{bar}}) - 101325 \text{ Pa}}{(4 \text{ bar}) (100000 \frac{\text{Pa}}{\text{bar}})} \right) \\
 &= (5.8 \text{ kg}) (0.747) \\
 &= 4.33 \text{ kg}
 \end{aligned}$$

Using an assumed density of 1.65 kg/L, the volume of material released due to the deflagration is

$$\begin{aligned} Q &= \frac{4.33 \text{ kg}}{1.65 \frac{\text{kg}}{\text{L}}} \\ &= 2.62 \text{ L} \end{aligned}$$

The cumulative effective dose equivalent to the onsite receptor from the calculated release of material during a deflagration is

$$\begin{aligned} EDE_{\text{inhalation}} &= Q \frac{X}{Q'} B_r ULD_{\text{inhalation}} \\ &= (2.62 \text{ L}) (3.41 \times 10^{-2} \frac{\text{s}}{\text{m}^3}) (3.3 \times 10^{-4} \frac{\text{m}^3}{\text{s}}) (2.2 \times 10^5 \frac{\text{Sv}}{\text{L}}) \\ &= 6.5 \text{ Sv} \end{aligned}$$

where the material released is 2.62 L, the acute atmospheric dispersion coefficient is $3.41 \times 10^{-2} \text{ s/m}^3$ (Van Keuren and Savino 1996), the breathing rate is $3.3 \times 10^{-4} \text{ m}^3/\text{s}$ (Van Keuren and Savino 1996), and the ULD for single-shell tank solids is $2.2 \times 10^5 \text{ Sv/L}$ (Van Keuren and Savino 1996).

Thus, the total cumulative effective dose equivalent to the onsite receptor is

$$\begin{aligned} CEDE &= CEDE_{\text{ventilation}} + CEDE_{\text{deflagration}} \\ &= 1.517 \times 10^{-2} \text{ Sv} + 6.5 \text{ Sv} \\ &= 6.5 \text{ Sv} \end{aligned}$$

Radiological Dose Consequences - Offsite

The cumulative effective dose equivalent for the offsite receptor from inhalation of the calculated release of waste accumulations in the ventilation system for a single-shell tank due to a high pressure event (such as a deflagration) is

$$\begin{aligned} EDE_{\text{inhalation}} &= Q \frac{X}{Q'} B_r ULD_{\text{inhalation}} \\ &= (0.00613 \text{ L}) (2.83 \times 10^{-5} \frac{\text{s}}{\text{m}^3}) (3.3 \times 10^{-4} \frac{\text{m}^3}{\text{s}}) (2.2 \times 10^5 \frac{\text{Sv}}{\text{L}}) \\ &= 1.259 \times 10^{-5} \text{ Sv} \end{aligned}$$

where the material released is 0.00613 L (Van Vleet 1996), the acute atmospheric dispersion coefficient is $2.83 \times 10^{-5} \text{ s/m}^3$ (Van Keuren and

Savino 1996), the breathing rate is $3.3 \times 10^{-4} \text{ m}^3/\text{s}$ (Van Keuren and Savino 1996), and the ULD for single-shell tank solids is $2.2 \times 10^5 \text{ Sv/L}$ (Cowley 1996).

The cumulative effective dose equivalent to the offsite receptor from inhalation of the calculated release of material during a deflagration is

$$\begin{aligned} EDE_{\text{inhalation}} &= Q \frac{X}{Q'} B_f ULD_{\text{inhalation}} \\ &= (2.62 \text{ L}) (2.83 \times 10^{-5} \frac{\text{s}}{\text{m}^3}) (3.3 \times 10^{-4} \frac{\text{m}^3}{\text{s}}) (2.2 \times 10^5 \frac{\text{Sv}}{\text{L}}) \\ &= 5.383 \times 10^{-3} \text{ Sv} \end{aligned}$$

where the material released is 2.62 L, the acute atmospheric dispersion coefficient is $2.83 \times 10^{-5} \text{ s/m}^3$ (Van Keuren and Savino 1996), the breathing rate for light activity is $3.3 \times 10^{-4} \text{ m}^3/\text{s}$ (Van Keuren and Savino 1996), and the ULD for single-shell tank solids is $2.2 \times 10^5 \text{ Sv/L}$ (Cowley 1996).

The cumulative effective dose equivalent to the offsite receptor due to 24-hour ingestion is

$$\begin{aligned} CEDE_{\text{ingestion}} &= Q \frac{X}{Q'} ULD_{\text{ingestion}} \\ &= (0.00613 \text{ L} + 2.62 \text{ L}) (2.83 \times 10^{-5} \frac{\text{s}}{\text{m}^3}) (4.10 \frac{\text{Sv m}^3}{\text{s L}}) \\ &= 3.05 \times 10^{-4} \text{ Sv} \end{aligned}$$

Thus, the total cumulative effective dose equivalent to the offsite receptor is

$$\begin{aligned} CEDE &= CEDE_{\text{ventilation}} + CEDE_{\text{deflagration}} + CEDE_{\text{ingestion}} \\ &= 1.26 \times 10^{-5} \text{ Sv} + 5.39 \times 10^{-3} \text{ Sv} + 3.05 \times 10^{-4} \text{ Sv} \\ &= 5.7 \times 10^{-3} \text{ Sv} \end{aligned}$$

Toxicological Exposures - Onsite

The sum-of-fractions for each accident has been calculated for each of the frequency categories, i.e., anticipated, unlikely, and extremely unlikely. This example demonstrates the method for anticipated, continuous releases. Calculations for other frequencies or for puff releases are similar.

Toxic exposures were calculated from three sources: (1) material released from the ventilation system, (2) material released from the tank due to the deflagration, and (3) pre-existing (i.e., before the deflagration) material released from the headspace.

For material released from the ventilation system, the onsite sum-of-fractions is:

$$\begin{aligned} T_{\text{ventilation}} &= Q' \text{ SOF} \\ &= \left(\frac{0.00613 \text{ L}}{200 \text{ s}} \right) (40000 \frac{\text{S}}{\text{L}}) \\ &= 1.23 \end{aligned}$$

where 200 s is the duration of the release. The release duration was chosen because the burn is over in approximately 1/10 s (LANL 1995), the pressure pulse is over in approximately 10 s (LANL 1995), then the release continues because of temperature of the tank is still high.

Similarly for the material released from the deflagration.

$$\begin{aligned} T_{\text{deflagration}} &= Q' \text{ SOF} \\ &= \left(\frac{2.62 \text{ L}}{200 \text{ s}} \right) (40000 \frac{\text{S}}{\text{L}}) \\ &= 524 \end{aligned}$$

For the material pre-existing in the headspace, the onsite sum-of-fractions is:

$$\begin{aligned} T_{\text{headspace}} &= Q' \text{ SOF} \\ &= \left(\frac{3350 \text{ m}^3}{200 \text{ s}} \right) (77 \frac{\text{S}}{\text{m}^3}) \\ &= 1290 \end{aligned}$$

where 3350 m³ represents the volume of the headspace in single-shell tank 241-A-103. Thus, the total toxicological exposure to the onsite receptor is

$$\begin{aligned} T &= T_{\text{ventilation}} + T_{\text{deflagration}} + T_{\text{headspace}} \\ &= 1.23 + 524 + 1290 \\ &= 1815 \end{aligned}$$

Toxicological Exposures - Offsite

For the material released from the ventilation system, the offsite sum-of-fractions is:

$$\begin{aligned} T_{\text{ventilation}} &= Q' \text{ SOF} \\ &= \left(\frac{0.00613 \text{ L}}{200 \text{ s}} \right) \left(94 \frac{\text{s}}{\text{L}} \right) \\ &= 2.88 \times 10^{-3} \end{aligned}$$

where 200 s is the duration of the release.

Similarly for the material released from the deflagration.

$$\begin{aligned} T_{\text{deflagration}} &= Q' \text{ SOF} \\ &= \left(\frac{2.62 \text{ L}}{200 \text{ s}} \right) \left(94 \frac{\text{s}}{\text{L}} \right) \\ &= 1.23 \end{aligned}$$

For the material pre-existing in the headspace, the offsite sum-of-fractions is:

$$\begin{aligned} T_{\text{headspace}} &= Q' \text{ SOF} \\ &= \left(\frac{3350 \text{ m}^3}{200 \text{ s}} \right) \left(6.6 \times 10^{-2} \frac{\text{s}}{\text{m}^3} \right) \\ &= 1.106 \end{aligned}$$

where 3350 m³ represents the volume of the headspace in single-shell tank 241-A-103.

Thus, the total toxicological exposure to the offsite receptor is

$$\begin{aligned} T &= T_{\text{ventilation}} + T_{\text{deflagration}} + T_{\text{headspace}} \\ &= 2.88 \times 10^{-3} + 1.23 + 1.11 \\ &= 2.3 \end{aligned}$$

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VENTILATION SYSTEM RELEASES									
Q1a =	0.0010	L	(DST)					(WHC-SD-WM-CN-054, Rev 0)	
Q1b =	0.0056	L	(AWF)					(WHC-SD-WM-CN-054, Rev 0)	
Q1c =	0.0061	L	(SST)	0.7466875				(WHC-SD-WM-CN-054, Rev 0)	
Q1d =	0.0023	L	(DCRT)					(WHC-SD-WM-CN-054, Rev 0)	
DST DEFLAGRATIONS=>DOME FAILURE									
Q2a =	2.76	L		M2a =	4.55	kg	(LA-UR-92-3196, Rev 14, App. D, pg. D-10 to -12)		Note: M2a includes normal dome loading of rads
Q2b =	7.74	L		M2b =	12.77	kg	(LA-UR-92-3196, Rev 14, App. M, pg. M-5)		and has been adjusted for the pressure pulse
				rho =	1.65	kg/L	Waste density based upon 101-SY sample results		Note: M2b is just from the waste on pump column
SST DEFLAGRATIONS=>DOME FAILURE									
Q2c =	2.62	L		M2c =	4.33	kg	(WHC-SD-WM-SAD-036, Rev 0, App. I, pg. I-3 and LA-UR-92-3196, Rev 14, App. D, pg. D-10 to -12)		Note: M2c includes normal dome loading of rads
DCRT DETONATIONS									
Q2d =	21.00	L					(WHC-SD-WM-SAR-065, page 3 4-114)		and has been adjusted for the pressure pulse
X/Q Values									
Cont. (s/m3)			Puff (1/m3)						
Onsite	3.4E-02		9.9E-03				(WHC-SD-WM-SARR-016, Rev 2)		
Offsite	2.8E-05		1.1E-07				(WHC-SD-WM-SARR-016, Rev 2)		
Breathing Rate = 3.3E-04 m3/s (Standard man doing light activity)									
ULD									
	(Sv/L)		(Sv m3)/(s L)						
	Inhalation		Ingestion						
All Liquids	1.2E+04		0.11				(WHC-SD-WM-SARR-037, Rev 0)		
All Solids	1.9E+06		8.20				(WHC-SD-WM-SARR-037, Rev 0)		
SST Liquids	1.1E+04		0.05				(WHC-SD-WM-SARR-037, Rev 0)		
SST Solids	2.2E+05		4.10				(WHC-SD-WM-SARR-037, Rev 0)		
DST Liquids	6.1E+03		0.07				(WHC-SD-WM-SARR-037, Rev 0)		
DST Solids	5.3E+05		0.48				(WHC-SD-WM-SARR-037, Rev 0)		
AWF Liquids	1.4E+03		0.09				(WHC-SD-WM-SARR-037, Rev 0)		
AWF Solids	1.7E+06		8.10				(WHC-SD-WM-SARR-037, Rev 0)		
DST Vapor Space Vol =	2.5E+03	m3		(Represents the headspace volume of DST 103-SY)					
SST Vapor Space Vol =	3.3E+03	m3		(Represents the headspace volume of SST 103-A)					
AWF Vapor Space Vol =	1.8E+03	m3		(Represents the headspace volume of AWF 101-AY)					
Partition Factor =	1.0E-08						(WHC-SD-WM-SAR-065, Rev 0, page 3 4-225)		
Duration =	2.0E+02	s	(Used for toxic calculations)				(LA-UR-92-3196, Rev 14)		
The following Sum-of-Fractions come from WHC-SD-WM-SARR-011, Rev. 2.									
Toxic Sum-of-Fractions of Risk Guidelines per Liter, 10+0 to 10-2 frequency range									
Continuous Release					Puff Release				
	(s/L)			(s/m3)		(1/L)			(1/m3)
DST Solids	DST Liquids	SST Solids	SST Liquids	Vapor Space	DST Solids	DST Liquids	SST Solids	SST Liquids	Vapor Space
Onsite	1.8E+04	1.0E+04	4.0E+04	8.6E+03	7.7E+01	5.2E+03	2.9E+03	1.2E+04	2.8E+03
Offsite	1.9E+02	8.4E+00	9.4E+01	8.0E+00	6.6E-02	7.7E-01	3.4E-02	3.8E-01	3.2E-02
Toxic Sum-of-Fractions of Risk Guidelines per Liter, 10-2 to 10-4 frequency range									
Continuous Release					Puff Release				
	(s/L)			(s/m3)		(1/L)			(1/m3)
DST Solids	DST Liquids	SST Solids	SST Liquids	Vapor Space	DST Solids	DST Liquids	SST Solids	SST Liquids	Vapor Space
Onsite	3.3E+03	7.5E+02	2.1E+03	7.5E+02	9.4E+00	9.7E+02	2.2E+02	6.0E+03	2.2E+02
Offsite	1.5E+01	8.4E+00	3.3E+01	8.0E+00	6.6E-02	5.9E-02	3.4E-02	1.3E-01	3.2E-02
Toxic Sum-of-Fractions of Risk Guidelines per Liter, 10-4 to 10-6 frequency range									
Continuous Release					Puff Release				
	(s/L)			(s/m3)		(1/L)			(1/m3)
DST Solids	DST Liquids	SST Solids	SST Liquids	Vapor Space	DST Solids	DST Liquids	SST Solids	SST Liquids	Vapor Space
Onsite	6.3E+02	2.1E+02	1.0E+03	2.0E+02	1.9E+00	1.8E+02	6.0E+01	2.9E+02	5.7E+01
Offsite	2.8E+00	6.2E-01	1.7E+01	6.2E-01	6.1E-03	1.1E-02	2.5E-03	6.9E-02	2.5E-03

Radiological Consequences (Sv)											
DST HEPA*			DST Deflagration*			TOTAL					
Onsite	Cont	Puff	Cont	Puff	Cont	Puff	Cont	Puff			
Offsite	6 7E-05	Not App	1 6E+01	Not App	1 6E+01	Not App	1 6E+01	Not App	*Assumes DST liquids		
	5 8E-08	Not App	1 4E-02	Not App	1 4E-02	Not App	1 4E-02	Not App			
DST HEPA*			DST Pump Ejection*			TOTAL					
Onsite	Cont	Puff	Cont	Puff	Cont	Puff	Cont	Puff			
Offsite	6 7E-05	Not App	6 3E+01	Not App	6 3E+01	Not App	6 3E+01	Not App	*Assumes DST liquids		
	5 8E-08	Not App	5 2E-02	Not App	5 2E-02	Not App	5 2E-02	Not App			
AWF HEPA*			AWF Deflagration*			TOTAL					
Onsite	Cont	Puff	Cont	Puff	Cont	Puff	Cont	Puff			
Offsite	8 9E-05	Not App	5 3E+01	Not App	5 3E+01	Not App	5 3E+01	Not App	*Assumes AWF liquids		
	8 8E-08	Not App	4 4E-02	Not App	4 4E-02	Not App	4 4E-02	Not App			
SST HEPA*			SST Deflagration*			TOTAL					
Onsite	Cont	Puff	Cont	Puff	Cont	Puff	Cont	Puff			
Offsite	1 5E-02	Not App	6 5E+00	Not App	6 5E+00	Not App	6 5E+00	Not App	*Assumes SST solids		
	1 3E-05	Not App	5 7E-03	Not App	5 7E-03	Not App	5 7E-03	Not App			
DORT HEPA*			DORT Detonation**			TOTAL					
Onsite	Cont	Puff	Cont	Puff	Cont	Puff	Cont	Puff	*Assumes SST liquids		
Offsite	2 8E-04	Not App	1 9E+01	Not App	1 9E+01	Not App	1 9E+01	Not App	**Assumes 2/3 SST liquids & 1/3 SST solids		
	2 4E-07	Not App	1 7E-02	Not App	1 7E-02	Not App	1 7E-02	Not App			
Toxicological Sum-of-Fractions of Risk Guidelines, 10+0 to 10-2 frequency range											
DST HEPA*			DST Deflagration*			DST Vapor Space			TOTAL		
Onsite	Cont	Puff	Cont	Puff	Cont	Puff	Cont	Puff	Cont	Puff	
Offsite	4 9E-02	2 8E+00	1 4E+02	8 0E+03	9 6E+02	5 8E+04	1 1E+03	6 5E+04	1 1E+03	6 5E+04	*Assumes DST liquids
	4 1E-05	3 3E-05	1 2E-01	9 4E-02	8 3E-01	6 8E-01	9 4E-01	7 7E-01	9 4E-01	7 7E-01	
DST HEPA*			DST Pump Ejection*			DST Vapor Space			TOTAL		
Onsite	Cont	Puff	Cont	Puff	Cont	Puff	Cont	Puff	Cont	Puff	
Offsite	4 9E-02	2 8E+00	5 2E+02	3 0E+04	9 6E+02	5 8E+04	1 5E+03	8 8E+04	1 5E+03	8 8E+04	*Assumes DST liquids
	4 1E-05	3 3E-05	4 4E-01	3 6E-01	8 3E-01	6 8E-01	1 3E+00	1 0E+00	1 3E+00	1 0E+00	
AWF HEPA*			AWF Deflagration*			AWF Vapor Space			TOTAL		
Onsite	Cont	Puff	Cont	Puff	Cont	Puff	Cont	Puff	Cont	Puff	
Offsite	2 8E-01	1 6E+01	1 4E+02	8 0E+03	6 8E+02	4 0E+04	8 2E+02	4 8E+04	8 2E+02	4 8E+04	*Assumes AWF liquids
	2 4E-04	1 9E-04	1 2E-01	9 4E-02	5 8E-01	4 7E-01	7 0E-01	5 7E-01	7 0E-01	5 7E-01	
SST HEPA*			SST Deflagration*			SST Vapor Space			TOTAL		
Onsite	Cont	Puff	Cont	Puff	Cont	Puff	Cont	Puff	Cont	Puff	
Offsite	1 2E+00	7 4E+01	5 2E+02	3 1E+04	1 3E+03	7 7E+04	1 8E+03	1 1E+05	1 8E+03	1 1E+05	*Assumes SST solids
	2 9E-03	2 3E-03	1 2E+00	1 0E+00	1 1E+00	9 0E-01	2 3E+00	1 9E+00	2 3E+00	1 9E+00	
DORT HEPA*			DORT Detonation**			TOTAL					
Onsite	Cont	Puff	Cont	Puff	Cont	Puff	Cont	Puff	*Assumes SST liquids		
Offsite	1 1E-01	6 4E+00	2 1E+03	1 2E+05	2 1E+03	1 2E+05	2 1E+03	1 2E+05	**Assumes 2/3 SST liquids & 1/3 SST solids		
	9 1E-05	7 3E-05	3 8E+00	3 1E+00	3 8E+00	3 1E+00	3 8E+00	3 1E+00			

Toxicological Sum-of-Fractions of Risk Guidelines, 10-2 to 10-4 frequency range											
	DST HEPA*		DST Deflagration*		DST Vapor Space		TOTAL				
	Cont.	Puff	Cont.	Puff	Cont.	Puff	Cont.	Puff			
Onsite	3.7E-03	2.2E-01	1.0E+01	6.1E+02	1.2E+02	7.0E+03	1.3E+02	7.6E+03	*Assumes DST liquids		
Offsite	4.1E-05	3.3E-05	1.2E-01	9.4E-02	8.3E-01	6.8E-01	9.4E-01	7.7E-01			
	DST HEPA*		DST Pump Ejection*		DST Vapor Space		TOTAL				
	Cont.	Puff	Cont.	Puff	Cont.	Puff	Cont.	Puff			
Onsite	3.7E-03	2.2E-01	3.9E+01	2.3E+03	1.2E+02	7.0E+03	1.6E+02	9.3E+03	*Assumes DST liquids		
Offsite	4.1E-05	3.3E-05	4.4E-01	3.6E-01	8.3E-01	6.8E-01	1.3E+00	1.0E+00			
	AWF HEPA*		AWF Deflagration*		AWF Vapor Space		TOTAL				
	Cont.	Puff	Cont.	Puff	Cont.	Puff	Cont.	Puff			
Onsite	2.1E-02	1.2E+00	1.0E+01	6.1E+02	8.3E-01	4.9E+03	9.3E+01	5.5E+03	*Assumes AWF liquids		
Offsite	2.4E-04	1.9E-04	1.2E-01	9.4E-02	5.8E-01	4.7E-01	7.0E-01	5.7E-01			
	SST HEPA*		SST Deflagration*		SST Vapor Space		TOTAL				
	Cont.	Puff	Cont.	Puff	Cont.	Puff	Cont.	Puff			
Onsite	6.4E-02	3.7E+01	2.8E+01	1.6E+04	1.6E+02	9.4E+03	1.9E+02	2.5E+04	*Assumes SST solids		
Offsite	1.0E-03	8.0E-04	4.3E-01	3.4E-01	1.1E+00	9.0E-01	1.5E+00	1.2E+00			
	DCRT HEPA*		DCRT Detonation**		TOTAL						
	Cont.	Puff	Cont.	Puff	Cont.	Puff	Cont.	Puff			
Onsite	8.5E-03	5.0E-01	1.3E+02	4.5E+04	1.3E+02	4.5E+04			*Assumes SST liquids		
Offsite	9.1E-05	7.3E-05	1.7E+00	1.4E+00	1.7E+00	1.4E+00			**Assumes 2/3 SST liquids & 1/3 SST solids		
Toxicological Sum-of-Fractions of Risk Guidelines, 10-4 to 10-6 frequency range											
	DST HEPA*		DST Deflagration*		DST Vapor Space		TOTAL				
	Cont.	Puff	Cont.	Puff	Cont.	Puff	Cont.	Puff			
Onsite	1.0E-03	5.9E-02	2.9E+00	1.7E+02	2.4E+01	1.5E+03	2.7E+01	1.6E+03	*Assumes DST liquids		
Offsite	3.0E-06	2.4E-06	8.5E-03	6.9E-03	1.0E-01	8.0E-02	1.1E-01	8.7E-02			
	DST HEPA*		DST Pump Ejection*		DST Vapor Space		TOTAL				
	Cont.	Puff	Cont.	Puff	Cont.	Puff	Cont.	Puff			
Onsite	1.0E-03	5.9E-02	1.1E+01	6.3E+02	2.4E+01	1.5E+03	3.5E+01	2.1E+03	*Assumes DST liquids		
Offsite	3.0E-06	2.4E-06	3.3E-02	2.6E-02	1.0E-01	8.0E-02	1.3E-01	1.1E-01			
	AWF HEPA*		AWF Deflagration*		AWF Vapor Space		TOTAL				
	Cont.	Puff	Cont.	Puff	Cont.	Puff	Cont.	Puff			
Onsite	5.9E-03	3.4E-01	2.9E+00	1.7E+02	1.7E+01	1.0E+03	2.0E+01	1.2E+03	*Assumes AWF liquids		
Offsite	1.7E-05	1.4E-05	8.5E-03	6.9E-03	7.1E-02	5.6E-02	8.0E-02	6.3E-02			
	SST HEPA*		SST Deflagration*		SST Vapor Space		TOTAL				
	Cont.	Puff	Cont.	Puff	Cont.	Puff	Cont.	Puff			
Onsite	3.1E-02	1.8E+00	1.3E+01	7.6E+02	3.2E+01	1.9E+03	4.5E+01	2.7E+03	*Assumes SST solids		
Offsite	5.2E-04	4.2E-04	2.2E-01	1.8E-01	1.4E-01	1.1E-01	3.8E-01	2.9E-01			
	DCRT HEPA*		DCRT Detonation**		TOTAL						
	Cont.	Puff	Cont.	Puff	Cont.	Puff	Cont.	Puff			
Onsite	2.3E-03	1.3E-01	4.9E+01	2.8E+03	4.9E+01	2.8E+03			*Assumes SST liquids		
Offsite	7.1E-06	5.7E-06	6.3E-01	5.1E-01	6.3E-01	5.1E-01			**Assumes 2/3 SST liquids & 1/3 SST solids		

CHECKLIST FOR PEER REVIEW

Document Reviewed: WHC-SD-WM-CN-055, Rev. 0, *Flammable Gas Deflagration Consequence Calculations for the Tank Waste Remediation System Basis for Interim Operation*

Scope of Review: Entire document.

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

C. H. Huang E. H. Huang
Reviewer (Printed Name and Signature)

8/8/1996
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.