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FROM: R. F. Kehrman LOCATION: Regulatory Compliance

TO: R. R. Chavez LOCATION: Regulatory Compliance

SUBJECT: REVISED CALCULATIONS TO SUPPORT PANEL CLOSURE

Attached is a paper detailing the information needed to evaluate Panel Closure performance. The paper establishes that the compliance point for Panel Closure is the WIPP Site Boundary and assumes an individual resides at the point of greatest concentration. The risk level to this receptor is one excess cancer death in one million or 10^{-6}. This is consistent with the design criteria in the WIPP Permit (Permit Attachment G1, Section 1.3.2.)

The paper assumes that the repository is filled to capacity. That is, risk is calculated when all panels are filled and closed except for Panel 10, which is filled, but not yet closed. This approach is consistent with the original Panel Closure Design submitted in the original Permit Application.

One major difference from the original application is the recalculation of the VOC source term. While the original modeling relied on samples from 930 drums to TRU mixed waste, the current calculation uses over 130,000 headspace measurements made under the Permit, primarily before October 2006. The calculation of the revised source term is included with the Attachment.

Another difference is that I revised the number of containers per room and the filter diffusion rates to reflect the composite of the disposed waste in Panels 1 through 5.

My calculations are documented in the attached paper. I have updated these calculations to accommodate the most recent EPA recommended risk factors and to correct the exposure frequency and duration for non-waste workers on the surface. Previously, these exposure factors were treated as the same as those for members of the public. I also changed the number of containers in the previous version of the paper from 4,800 to 6,050 per room to reflect the number of filters emitting VOCs. This was necessary since many containers have more than one filter.

For convenience, I have also attached my spreadsheet. The last page of the spreadsheet evaluates the effects of leakage through closed panels. Panels can tolerate a leakage equivalent to about 2,000 times the gas generation rate of 0.5 moles/drum/year. There is a leakage rate that will make compliance difficult. This appears to be on the order of 50 cubic feet per minute.

The attached information may be useful to the Panel Closure design team in that it provides the methodology for determining risk consistent with the RCRA regulations and our original Permit Application.

If you have any questions, please call me at 234-7210.

dg

Attachments

cc: RES Managers ED
T. Klein ED

ATTACHMENTS:

ESTABLISHING VOLATILE ORGANIC COMPOUND LIMITS FOR THE PANEL CLOSURE DESIGN
by R. F. Kehrman

RECALCULATION OF THE VOLATILE ORGANIC COMPOUND SOURCE TERM

CALCULATIONS TO SUPPORT PANEL CLOSURE DESIGN PAPER 8 29 12 Documented (Excel Spread Sheet)

ATTACHMENT 1

ESTABLISHING VOLATILE ORGANIC COMPOUND LIMITS FOR THE PANEL CLOSURE DESIGN

by

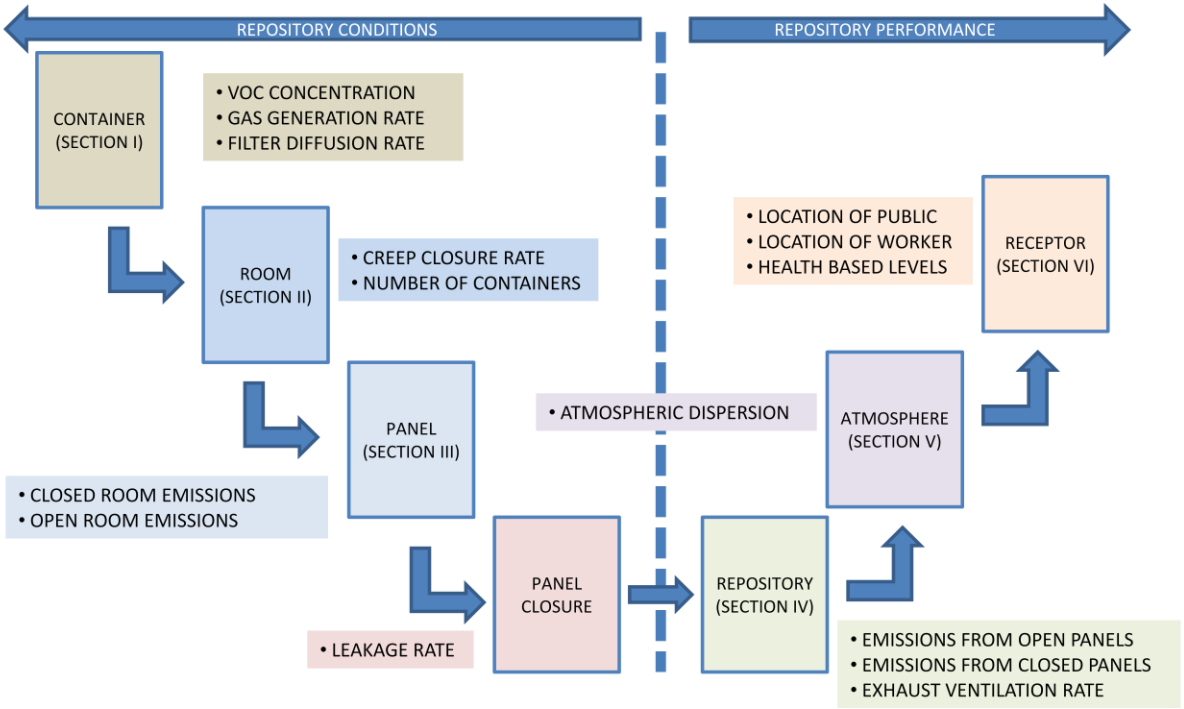
Robert F Kehrman

ESTABLISHING VOLATILE ORGANIC COMPOUND LIMITS FOR THE PANEL CLOSURE DESIGN

R. F. Kehrman

Figure 1 is a block diagram of the elements that go into preparing a risk model to demonstrate operational impacts due to emissions from the Waste Isolation Pilot Plant repository. The goal of this discussion is to provide information needed to specify the design of the Panel Closure which will serve to assure the performance standards to the right on the diagram are met for the conditions in the repository shown on the left in Figure 1. When the original Part B Permit Application for the Waste Isolation Pilot Plant (WIPP) (U. S. Department of Energy, 1996 a) facility was submitted in 1996, one of the design parameters for Panel Closure was that "the panel closure system shall limit the migration of [volatile organic compounds] VOCs to the compliance point so that compliance is achieved by at least one order of magnitude." This criterion has been changed for the current design to only require compliance without an additional compliance margin. The following discusses each element in the order indicated by the Roman Numerals on the Figure.

FIGURE 1: Elements of the Waste Isolation Pilot Plant Air Exposure Pathway



I. Container

VOC CONCENTRATION Information needed on the container scale for air dispersion modeling is the average concentration of VOCs in the headspace of the container which defines the release source term and the gas generation rate which is a driving force to move VOCs from closed rooms and panels into the repository ventilation system. The VOC source term used for the original Panel Closure design effort was developed based on a limited sampling program conducted in Idaho and at Rocky Flats. Subsequent

to that time, a weighted average source term was developed using the same data, however, a weighting process was developed to accommodate the wide variety of waste forms and to weight them in accordance with their prevalence. The process for developing the weighted average source term is described in Appendix C2 of the 1996 Permit Application (U. S. Department of Energy, 1996 a). The results are summarized in Table 1. In 2010, the source term was revised using the same methodology; however, over 130,000 headspace gas measurements were available (Kehrman, 2011). The revised source term is shown in Table 1. The values in Table 1 represent the average concentration that would be expected in a filled, closed room.

TABLE 1: TRU Waste VOC Source Term

Constituent	Original Weighted Average (ppmv)	Revised Weighted Average (ppmv)
ACETONE	79.8	53.1
BENZENE	9.3	4.3
BROMOFORM	9.4	1.8
BUTANOL	78.1	13.8
CARBON DISULFIDE	---	10.5
CARBON TETRACHLORIDE	375.5	921.5
CHLOROBENZENE	12.5	2.7
CHLOROFORM	25.3	16.1
CYCLOHEXANE	27.5	10.8
1,1-DICHLOROETHANE	10.2	9.9
1,2-DICHLOROETHANE	9.1	3.8
1,1-DICHLOROETHYLENE	11.5	12.9
CIS-1,2-DICHLOROETHYLENE	9.0	3.9
TRANS-1,2-DICHLOROETHYLENE	---	4.1
ETHYL BENZENE	11.6	3.6
ETHYL ETHER	13.3	4.8
METHANOL	213.0	71.3
METHYL CHLORIDE	---	15.6
METHYLENE CHLORIDE	368.5	36.0
METHYL ETHYL KETONE	63.7	13.8
METHYL ISOBUTYL KETONE	79.0	12.4
1,1,2,2-TETRACHLOROETHANE	9.4	4.8
TETRACHLOROETHYLENE	9.4	5.1
TOLUENE	19.4	12.2
1,1,1-TRICHLOROETHANE	317.1	739.8
TRICHLOROETHYLENE	25.1	51.2
1,1,2-TRICHLORO-1,2,2-TRIFLUOROETHANE	33.0	208.9
1,2,4-TRIMETHYLBENZENE	12.2	2.6
1,3,5-TRIMETHYLBENZENE	8.6	3.2
M,P-XYLENE	19.3	6.5
O-XYLENE	16.0	3.8

GAS GENERATION Appendix D11 of the 1996 Permit Application (U. S. Department of Energy, 1996 a) includes information on gas generation by WIPP waste. Of the gas-generating mechanisms described in Appendix D11, microbial degradation will contribute the most to the generation rate during the time periods of interest. The best estimate for gas generation from microbial degradation under humid conditions is 0.1 moles of gas per drum per year.

Although Appendix D11 states that the maximum expected value for any one drum of waste is 0.4 moles per drum per year, the lowest expected value for any one drum is 0 moles per drum per year. A discussion of the relationship between gas generation, brine inflow, and creep closure can be found in Section I-1e(4). In reality, under the conditions that will initially exist in a closed panel, the predominant degradation mechanisms may consume gas at a rate faster than it is produced. This outcome is a function of the availability of nutrients to sustain microbial activities. Indications of gas consumption activities are in Francis and Gillow (Francis, A.J. and J.B. Gillow, 1994), where they reported 200-day experiments (see Appendix D11). These data are summarized in Table 2.

TABLE 2: TRU Waste Container Gas Generation Rates Due to Microbial Degradation

	High	Low	Expected
Gas-Generation Rate moles/drum/year	0.4	0.0	0.1

FILTER DIFFUSION RATE The rate at which VOCs will be emitted from containers is a function of the diffusion rate for the individual filter on the containers. These filters are placed on every container to prevent the buildup of hydrogen as the result of radiolysis. Diffusion is relevant for open rooms only. Closed rooms are assumed to be in equilibrium with the average VOC concentration in the containers. Container filters are specified with a hydrogen diffusion rate. The methodology for calculating the VOC diffusion rate based on the hydrogen rate is given in Chapter 5 of the 1996 No-Migration Variance Petition (U. S. Department of Energy, 1996 b).

At the time the original documents were prepared, the number of filters being used was limited to two. Now there are a large number of filters in use. Since filter diffusivity is a parameter that is tracked in the WIPP Waste Data System, filter diffusion rates were compiled as shown in Table 3. These data yield an average filter H_2 diffusion rate for the repository of 1.25×10^{-5} mole/s/mole fraction/drum.

Table 3: Compilation of Filter H_2 Diffusivity for Disposed Waste (Panels 1 through 5) (mole/s/mole fraction)

Panel	Room	Inner Container Count	Outer Container Count	Outer Container Filter Count	Summation of Filter Diffusivity	Diffusivity/Filter	Diffusivity/Outer Container
1	7	9953	9953	10187	3.12E-02	3.06E-06	3.14E-06
1	6	2392	2393	2441	7.72E-03	3.16E-06	3.23E-06
1	5	2403	2404	2427	7.09E-03	2.92E-06	2.95E-06
1	4	2484	2484	2523	7.97E-03	3.16E-06	3.21E-06
1	3	10691	10691	10911	3.31E-02	3.03E-06	3.09E-06
1	2	8368	8368	9115	2.61E-02	2.86E-06	3.12E-06
PANEL TOTAL		**3737**	**3121**	**3975**	**1.47E-02**	**3.70E-06**	**4.71E-06**
2	7	7111	5158	7455	2.85E-02	3.82E-06	5.53E-06
2	5	6965	4219	7115	3.18E-02	4.47E-06	7.55E-06
2	3	6610	5061	7102	3.26E-02	4.58E-06	6.43E-06
2	2	6727	4981	6967	3.93E-02	5.64E-06	7.88E-06
2	1	2179	1785	2214	3.18E-02	1.43E-05	1.78E-05
PANEL TOTAL		**42831**	**29770**	**44596**	**2.29E-01**	**5.13E-06**	**7.69E-06**
3	7	6022	1599	5657	4.91E-02	8.67E-06	3.07E-05
3	6	6678	2399	3713	4.37E-02	1.18E-05	1.82E-05
3	4	6693	3336	4548	5.33E-02	1.17E-05	1.60E-05
3	3	6476	2857	4501	5.06E-02	1.12E-05	1.77E-05

Panel	Room	Inner Container Count	Outer Container Count	Outer Container Filter Count	Summation of Filter Diffusivity	Diffusivity/Filter	Diffusivity/Outer Container
3	2	6588	2734	4300	5.23E-02	1.22E-05	1.91E-05
3	1	4112	2260	3256	3.82E-02	1.17E-05	1.69E-05
PANEL TOTAL		**42000**	**17760**	**28932**	**3.31E-01**	**1.14E-05**	**1.86E-05**
4	7	6063	2890	4574	5.09E-02	1.11E-05	1.76E-05
4	6	6073	3604	4802	6.40E-02	1.33E-05	1.78E-05
4	5	6621	4137	5728	7.21E-02	1.26E-05	1.74E-05
4	4	5870	3945	4928	7.61E-02	1.54E-05	1.93E-05
4	3	5673	4264	4784	8.16E-02	1.70E-05	1.91E-05
4	2	5535	4687	5236	8.93E-02	1.71E-05	1.91E-05
4	1	3545	3035	3280	5.72E-02	1.74E-05	1.89E-05
PANEL TOTAL		**39380**	**26562**	**33332**	**4.91E-01**	**1.47E-05**	**1.85E-05**
5	7	6512	5576	6169	1.07E-01	1.74E-05	1.92E-05
5	6	6568	5945	6442	1.19E-01	1.85E-05	2.00E-05
5	5	6332	5442	6023	1.03E-01	1.71E-05	1.89E-05
5	4	6524	3972	4423	6.85E-02	1.55E-05	1.73E-05
5	3	7223	4331	5120	8.31E-02	1.62E-05	1.92E-05
5	2	7088	5195	6370	1.05E-01	1.66E-05	2.03E-05
5	1	5007	3997	4449	7.81E-02	1.76E-05	1.96E-05
PANEL TOTAL		**45254**	**34458**	**38996**	**6.65E-01**	**1.70E-05**	**1.93E-05**

II. Room

CREEP CLOSURE RATE The average creep closure rate will result in a reduction of the panel void volume of 812 m^3 per year for each panel. Calculations in Appendix D9 of the 1996 Permit Application (U. S. Department of Energy, 1996 a) convert this rate at which air is "squeezed" out of the room to an equivalent gas generation rate of 0.4 moles/drum/year. This is depicted in Table 4.

TABLE 4: Effective Gas Generation Rate

Gas-Generation Rate	moles/drum/year
Microbial Degradation	0.1
Creep Closure	0.4
Total Effective Gas Generation Rate	0.5

NUMBER OF CONTAINERS The original assumption was that each Panel would contain 81,000 containers. This number is important because emissions are related to the filter diffusivity associated with each container; therefore the number of filters emitting VOCs to a room that is being filled is part of the calculation of releases. Closed rooms are unventilated and are conservatively assumed to be at the average concentration of the containers that were disposed and emissions are only related to the gas generation rate and creep closure rate (i.e., equivalent gas generation rate). Table 5 is a compilation of the actual distribution of containers in the five filled panels and Room 7 of Panel 6. These data indicate that a reasonable average for the number of containers per room is about 4,770. Using the ratio of total filters to total containers in Table 3, this number of containers contains about 6,050 filters per room.

TABLE 5: Number of Containers Disposed in Each Panel

Container Type	Panel 1	Panel 2	Panel 3	Panel 4	Panel 5	Panel 6	Container Total
55-gallon drum	38,139	23,865	8,394	12,858	21,255	3,798	108,309
Standard waste box	1,239	3,176	1,730	1,405	2,200	594	10,344
Ten drum overpack	35	1,451	2,227	1,048	788	103	5,652
85-gallon drum	2	0	0	3	0	0	5
100-gallon drum	0	1,278	5,409	11,050	9,951	879	28,567
Standard large box 2	0	0	0	0	0	2	2
Panel Total	39,415	29,770	17,760	26,364	34,194	5,376	152,879
Rooms filled in Panel	4.8	6.6	6.7	6.7	6.7	1.0	32.0
Containers per room	8,211	4,580	2,691	3,995	5,181	5,376	4,777

Note: A room is considered to have 567 linear feet of disposal space. Since Room 1 only has 367 feet (i.e., no waste is placed in the intake or exhaust drifts, a full panel in Table 5 is considered to have 6.7 Rooms

III. Panel

Emission rates from filled rooms depend on whether or not the room is open to the ventilation system. Emissions from open rooms depend on the emission rates through filters and the ventilation rate; emissions from closed rooms depend on the gas generation rate and the volumetric reduction in room volume due to creep closure. For Panel Closure modeling, the most conservative condition is when a panel has six filled and closed rooms and one filled room that remains open. Note that it is conservatively assumed that the average drum headspace concentrations serve as a constant source of VOCs.

OPEN ROOM EMISSIONS The open room emission rate is dependent on the number of drums that have been emplaced in the room and the diffusion of VOCs across the drum vent filters. Assuming a continuous fresh air flow across the filters, VOCs will diffuse from the drums at a rate that is dependent on the concentration gradient across the filters and the diffusion properties of the VOCs. The open room emission rate is calculated using the equation

where

$AORE_{VOC}$ = average open room VOC emission rate, mole/room/year
ADE_{VOC} = average drum VOC emission rate, mole/drum/year
nD = number of drums in the room, drum/room.

EMISSIONS FROM CLOSED ROOMS During the placement of waste at WIPP, as individual rooms are filled; ventilation barriers will be used to eliminate ventilation through the filled rooms and to isolate these rooms. Similarly, closure systems will be used to isolate wastes in a full panel and to remove these filled panels from ventilation. Consequently, the open panel emission rate is dependent on the number of full rooms that have ventilation barriers and the number of drums in rooms without ventilation barriers.

As described previously, VOCs will diffuse from the drums at a rate dependent on the concentration gradient across these filters. After a room is filled and the ventilation barrier is installed, the assumption is that fresh air will no longer flow across the waste drums, and VOC concentrations in the dead air

space above the filter will begin to build up and approach the concentrations in the drum headspace. Therefore, the concentration of VOCs that would be present in the filled room atmosphere would be equivalent to the average drum headspace concentration. It is conservatively assumed that the average drum headspace concentrations serve as a constant source of VOCs.

The ventilation barrier consists of low-permeability materials that restrict ventilation flow through a room. Thus, migration of VOCs past the barriers is assumed to only occur by displacement due to room volume reduction that results from creep closure and by pressurization of the room due to continued gas generation from the waste. Based on discussions above (Table 4), the total effective gas generation rate is 0.5 mole/drum/year. (Note that this equates to a flow rate of 0.067 ft^3 per minute.)

Using this effective gas generation rate for a room of containers that has the ventilation barrier in place, the closed room emission rate for each VOC is calculated as:

where

$ACRE_{VOC}$	=	average closed room VOC emission rate, mole/room/year
GR	=	effective gas generation rate, mole/drum/year
N_{drums}	=	number of drums in a room
MF_{VOC}	=	VOC mole fraction, mole/mole

IV. Repository

EMISSIONS FROM OPEN PANELS

The open panel emission rate for each VOC is based on the number of full rooms, the number of drums in the open room, and the emission rates from each type of room. This can be calculated as follows:

where

$AOPE_{VOC}$	=	average open panel VOC emission rate, mole/panel/year
$AORE_{VOC}$	=	average open room VOC emission rate, mole/room/year
$ACRE_{VOC}$	=	average closed room VOC emission rate, mole/room/year
R_o	=	number of open rooms in the open panel, 1 room/panel
R_c	=	number of closed rooms in the open panel, room/panel

EMISSIONS FROM CLOSED PANELS Volatile organic compounds will diffuse from the drums at a rate dependent on the concentration gradient across the filters. As the concentration gradient decreases, the diffusion rate of each VOC decreases. After a panel is closed, fresh air will no longer flow across the waste drums, and VOC concentrations in the air space above the filter will begin to build up and approach the concentrations in the drum headspace. Therefore, the concentration of VOCs that would be present in the panel atmosphere would be equivalent to the average drum headspace concentration.

For a closed panel of N drums, the closed panel emission rate for each VOC is calculated as:

where

$ACPE_{VOC}$ = average closed panel VOC emission rate, mole/panel/year
GR = effective gas generation rate, mole/drum/year
N_{drums} = number of drums in a panel
MF_{VOC} = VOC mole fraction, mole/mole

The emission rate from the repository can then be calculated as the sum of the open panel and closed panel rates:

where

EC_{VOC} = the emission rate for VOC in mole/year
P_O = the number of open panels
P_C = the number of closed panels

V. Atmosphere

ATMOSPHERIC DISPERSION This section presents the results of air dispersion modeling performed inside and outside the WIPP site boundary. The modeling was performed to evaluate four specific scenarios: the Boundary Public, Livingston Ridge Rancher (grazing allotment on the north side of the WIPP site), Antelope Ridge Rancher (grazing allotment on the south side of the WIPP site), and Surface Worker. The Long-Term Version of the Industrial Source Complex (ISCLT3) model, (U.S. Environmental Protection Agency, 1995), was used for the original air dispersion modeling. Concentrations were modeled in accordance with (U.S. Environmental Protection Agency, 1992) EPA (1992). Details of the modeling are described in Appendix D10 of the 1996 Permit Application. The modeling produced the air dispersion factors (ADFs) listed in the center column of Table 6. In 2010 the modeling was updated in order to use newer EPA analytical tools (AERMOD) and updated physical conditions (new buildings, three exhaust stacks) (URS Corporation, 2010). The revised ADFs are in the right column in Table 11.

TABLE 6: Air Dispersion Factors for WIPP Site Areas

Area	Original Air Dispersion Factor (ADF)	Revised Air Dispersion Factor (ADF)
WIPP Site Boundary	1.2×10^{-4}	8.78×10^{-5}
Livingston Ridge Allotment	9.8×10^{-5}	1.76×10^{-4}
Antelope Ridge Allotment	6.7×10^{-5}	6.72×10^{-4}
Training Building	1.23×10^{-2}	1.14×10^{-2}

VI. RECEPTOR

LOCATION OF PUBLIC AND WORKERS Three classes of exposed individuals (receptors) were presented in Appendix D9 of the 1996 Permit Application (U. S. Department of Energy, 1996 a); a surface worker, an underground worker, and a member of the public. The compliance point for the surface worker is the Training Building. The compliance point for the underground worker is downwind from the waste during initial emplacement in a room. The compliance point for the member of the public is the nearest point outside the controlled area where ranch hands may be working.

HEALTH BASED LEVELS The environmental performance standard proposed for the workers was the Occupational Safety and Health Administration (OSHA) 8-hour time weighted average (TWA) for each compound. The environmental performance standards proposed for the public were 10^{-6} for Class A and B2 carcinogens and 10^{-5} for Class C carcinogens and a Hazard Quotient of 1 for non-carcinogens. These are summarized in Table 7.

TABLE 7 Risk Levels Proposed in the WIPP RCRA Part B Permit Application in 1996 (Appendix D9, Tables D9-5, -6, -8, and -9)

EXPOSED CLASS	COMPLIANCE POINT	CLASS A and B2 CARCINOGENS	CLASS C CARCINOGENS	NON-CARCINOGENS
Surface Worker	Training Building	OSHA 8-HOUR TWA		
Underground Worker	Exhaust drift adjacent to filled room	OSHA 8-HOUR TWA		
Public	Controlled area fence line	10^{-6}	10^{-5}	1

These risk levels were not used by the New Mexico Environment Department (NMED) to develop the standards that eventually were included in the Hazardous Waste Facility Permit (Permit) that was issued in 1999. The NMED reduced the standards to only two receptors: the Underground Worker and the Surface Worker. These standards which are reflected in the VOC limits in the Permit are listed in Table 8.

TABLE 8 Risk Levels Imposed by the NMED in the Permit in 1999

EXPOSED CLASS	COMPLIANCE POINT	CLASS B2 CARCINOGENS	CLASS C CARCINOGENS	NON-CARCINOGENS
Surface Worker	Training Building	10^{-5}	10^{-5}	1
Underground Worker	Exhaust drift adjacent to filled room	OSHA IDLH or LFL	OSHA IDLH or LFL	OSHA IDLH or LFL
Public	Controlled area fence line	Bounded by Surface Worker Limit		

IDLH = Concentration that is immediately dangerous to life and health
LFL = Lower flammability limit

The NMED translated these risk levels into specific concentrations of concern (Cs of C) for each VOC and published them as repository limits and room-based limits. Action levels associated with these limits were also established in the Permit. The NMED modeled cumulative risk and hazard due to exposure to all compounds simultaneously. This required them to develop a process for translating the total risk into a specific risk associated with each VOC involved. The rationale used is documented in a memorandum to file issued by the NMED in 1998 (Zappe, 1998) and in written testimony submitted at the 1999 Permit Hearing (New Mexico Environment Department, 1999). The NMED accepted the Permittees limited list of analytes (which constituted 99 percent of the risk or hazard) and apportioned risk among the nine compounds. This risk apportionment has been modified over time. The most recent apportionment is shown in Table 8, along with the percentage of the total risk assigned to the compound. Table 9 focuses on repository limits since room-based limits are now monitored separately using a Disposal Room VOC Monitoring System.

TABLE 9 Repository Limits for Specific Compounds and their Related Risk Portions

VOC OF INTEREST	TYPE	LIMIT IN PERMIT (ppbv)	ASSOCIATED RISK	ASSOCIATED HAZARD	PERCENT OF TOTAL RISK	PERCENT OF TOTAL HAZARD
Carbon Tetrachloride	C	960	4.3E-06		44.6	
Chlorobenzene	N	220		2.4E-03		88.5
Chloroform	C	180	2.4E-06		24.9	
1,1-Dichloroethene	N	100		2.3E-04		8.7
1,2-Dichloroethane	C	45	5.6E-07		5.8	
Methylene Chloride	C	1,930	1.9E-08		0.2	
1,1,2,2-Tetrachloroethane	C	50	2.3E-06		24.5	
Toluene	N	190		1.2E-04		4.4
1,1,1-Trichloroethane	N	590		7.6E-05		2.8
		TOTAL	9.6E-6	2.7E-3	100 %	100 %

C = Carcinogen
N = Non-carcinogen

The limit represents a concentration measured in the underground at Station VOC-A.

In the design of the current Panel Closure, performance criteria were established in the form of health based levels (HBLs) that could be applied at any appropriate point of compliance (the Land Withdrawal boundary was used in the Panel Closure design document titled *Conceptual Design for Operational Phase Panel Closure Systems,* Appendix I1 of the 1996 Permit Application (U. S. Department of Energy, 1996 a)). This approach was driven by the no-migration standard found in 40 CFR 268 which applied at the time. The methodology for calculating HBLs that was used was described in the proposed ruling on Subpart S, Corrective Action for Solid Waste Management Units at Hazardous Waste Management Facilities (Federal Register, 1990).

In the proposed 40 CFR 264 Subpart S, the action levels, or HBLs, are calculated given the exposure assumptions for the media of interest and the toxic or carcinogenic effects for each hazardous constituent. The proposed Subpart S recommended that continuous lifetime exposure duration of 70 years be assumed; however, because the operational/closure phase of the facility is 35 years, a 35-year exposure is assumed in determining HBLs for the assessment. The assumed risk levels for carcinogens are 10^{-6} for Class A or B2 carcinogens and 10^{-5} for Class C carcinogens. In determining HBLs for non-carcinogens, the chemical-specific reference concentrations are used, which estimate the daily exposure an individual can experience without appreciable risk of adverse effects during a lifetime. Because the guidelines refer to excess health risks, the calculated HBLs are applied only to potential migration of hazardous constituents from the disposed waste.

The methodology for determining HBLs is derived from the EPA's Risk Assessment Guidance for Superfund (U. S. Environmental Protection Agency, 1989). Although the EPA provides alternate "standard default exposure factors," exposure assumptions outlined in the proposed Subpart S were used.

To calculate the HBLs in air for carcinogens with an absorption factor conservatively assumed to be

equal to 1, the following equation is used:

where:

HBL	=	HBL for carcinogen, $\mu g/m^3$
TRL	=	target risk level (TRL), 10^{-5} (Class C) or 10^{-6} (Class A and B2)
AT	=	averaging time, 25,550 days for carcinogens (70 years × 365 days/year)
EF	=	exposure frequency, 365 days/year
ED	=	exposure duration, 35 years
IUR	=	inhalation unit risk factor (IUR) for carcinogen, $(\mu g/m^3)^{-1}$

For non-carcinogens, the HBLs in air are calculated as follows:

where:

HBL	=	HBL for non-carcinogen, $\mu g/m^3$
THQ	=	target hazard quotient (THQ), assumed to be 1
RfC	=	reference concentration for the non-carcinogen, mg/m^3
AT_P	=	averaging time, 12,775 days for non-carcinogenic exposure for public (ED × 365 days/year)
AT_w	=	averaging time, 87,600 for non-carcinogenic exposure for non-waste surface workers based on exposure duration)
EF_p	=	exposure frequency for public, 365 days/year
EF_w	=	exposure frequency for non-waste surface worker, 1,920 hours/year
ED_p	=	exposure duration for public, 35 years
ED_w	=	exposure duration, non-waste surface worker, 10 years.

The derivation of both of these equations can be found in DOE/CAO-96-2160, Chapter 5 (U. S. Department of Energy, 1996 b).

The toxicity measures (i.e., IURs and reference concentrations [RfCs]) used in the calculations are presented in Table 10. The main source of these data is the EPA Integrated Risk Information System (IRIS); the data in the IRIS system are updated monthly and are reviewed and approved by the EPA. Values not in the IRIS system are based on EPA recommended sources. This list has been updated from the original study in the Permit Application.

TABLE 10: EPA Risk Factor for Volatile Organic Compounds (as of 4/2/2012)

VOLATILE ORGANIC COMPOUND	Inhalation Unit Risk (IUR) $(ug/m^3)^{-1}$	Reference concentration (RfC) mg/m^3
Acetone	---	3.10E+01
Benzene	7.80E-06	3.00E-02
Bromoform	1.10E-06	---
Butanol	---	6.00E-02
Carbon Disulfide	---	7.00E-01
Carbon Tetrachloride	6.00E-06	1.00E-01
Chlorobenzene	---	5.00E-02
Chloroform	2.30E-05	9.80E-02
Cyclohexane	---	6.00E+00
1,1-Dichloroethane	1.60E-06	---
1,2-Dichloroethane	2.60E-05	7.00E-03
1,1-Dichloroethylene	---	2.00E-01
cis-1,2-Dichloroethylene	---	---
trans-1,2-Dichloroethylene	---	6.00E-02
Ethyl Benzene	2.50E-06	1.00E+00
Ethyl Ether	---	---
Methanol	---	4.00E+00
Methyl Chloride	---	9.00E-02
Methylene Chloride	1.00E-08	6.00E-01
Methyl Ethyl Ketone	---	5.00E+00
Methyl Isobutyl Ketone	---	3.00E+00
1,1,2,2-Tetrachloroethane	5.80E-05	---
Tetrachloroethylene	2.60E-07	4.00E-02
Toluene	---	5.00E+00
1,1,1-Trichloroethane	---	5.00E+00
Trichloroethylene	4.10E-06	2.00E-03
1,1,2-Trichloro-1,2,2-Trifluoroethane	---	3.00E+01
1,2,4-Trimethlybenzene	---	7.00E-03
1,3,5-Trimethylbenzene	---	---
m,p-Xylene	---	1.00E-01
o-Xylene	---	1.00E-01

--- No data/not classifiable/inadequate data

In calculating the HBLs for both carcinogens and non-carcinogens, exposure duration of 35 years was assumed for the public and 10 years for the non-waste surface worker. For non-carcinogens, the averaging time is equivalent to the exposure duration; therefore, this assumption has no effect on the calculated value of the HBL. This assumption is reasonable, because waste emplacement is expected to last 25 years, and a ten-year closure period follows. For the non-waste surface worker, the assumption is based on an employment period of 10-years at 40 hours per week for 48 weeks per year in the Training Building. The averaging time for carcinogens is 70 years, consistent with EPA guidance. The calculated HBL for each indicator VOC in air is listed in Table 11. Values are shown for two risk levels.

The public risk is 10^{-6} and the surface worker risk is 10^{-5}. The original Panel Closure design uses the public risk values.

TABLE 11: Health Based Levels for various Risk Scenarios

VOLATILE ORGANIC COMPOUND	HEALTH BASED LEVELS (µg/m^3)			
	CARCINOGENIC		NON-CARCINOGENIC	
	10^{-6} RISK LEVEL (Public)	10^{-5} RISK LEVEL (Surface Worker)	Public	Surface Worker
Acetone	---	---	31,000	141,438
Benzene	0.26	41	30	137
Bromoform	1.82	290	---	---
Butanol	---	---	60	274
Carbon Disulfide	---	---	700	3,194
Carbon Tetrachloride	0.33	53	100	456
Chlorobenzene	---	---	50	228
Chloroform	0.09	14	98	447
Cyclohexane	---	---	6,000	27,375
1,1-Dichloroethane	1.25	200	---	---
1,2-Dichloroethane	0.08	12	7	32
1,1-Dichloroethylene	---	---	200	913
cis-1,2-Dichloroethylene	---	---	---	---
trans-1,2-Dichloroethylene	---	---	60	274
Ethyl Benzene	0.80	128	1,000	4,563
Ethyl Ether	---	---	---	---
Methanol	---	---	4,000	18,250
Methyl Chloride	---	---	90	411
Methylene Chloride	200	31,938	600	2,738
Methyl Ethyl Ketone	---	---	5,000	22,813
Methyl Isobutyl Ketone	---	---	3,000	13,688
1,1,2,2-Tetrachloroethane	0.03	6	---	---
Tetrachloroethylene	7.69	1,228	40	183
Toluene	---	---	5,000	22,813
1,1,1-Trichloroethane	---	---	5,000	22,813
Trichloroethylene	0.49	78	2	9
1,1,2-Trichloro-1,2,2-Trifluoroethane	---	---	30,000	136,875
1,2,4-Trimethlybenzene	---	---	7	32
1,3,5-Trimethylbenzene	---	---	---	---
m,p-Xylene	---	---	100	456
o-Xylene	---	---	100	456

VII. SAMPLE CALCULATION

Table 12 provides the expected emission rates for the following:

- Drum
- Open room
- Closed room
- Open panel (with 6 filled rooms and 1 open room)
- Closed panel
- Repository (9 closed panels, one open panel with 6 closed rooms and one open room)

The following assumptions are used:

- Recalculated source term (Table 1)
- Containers have filters with the repository average H_2 diffusion rate of 1.25×10^{-5} mole/s/mole fraction installed (Table 3)
- Effective gas generation rate of 0.5 mole/drum/year (Table 4)
- 4,777 drums containing 6,050 filters per room (Table 5)
- There is no ventilation leakage through closed areas.

The term "average" is used to indicate that the source term is the weighted average concentration. The term "maximum" is used to describe the repository emission rate, since the calculation is for a full repository with one open panel containing a full open room and 6 filled rooms that are isolated from the ventilation.

Concentrations at the receptor points on the surface can be calculated by applying the ADFs in Table 6. The results are shown in Table 13 as a fraction of the HBLs for each compound. The totals show that the HBLs are not exceeded for a repository filled with TRU mixed waste at the weighted average VOC concentrations. The total risk line in Table 13 can be viewed as the compliance margin for each receptor location.

TABLE 12: Annual Emission Rates for Drums, Rooms, Panels, and the Repository

COMPOUND	AVERAGE DRUM EMISSION RATE (mole/drum/ year)	AVERAGE OPEN ROOM EMISSION RATE (mole/room/ year)	AVERAGE CLOSED ROOM EMISSION RATE (mole/room/ year)	AVERAGE OPEN PANEL EMISSION RATE (mole/panel/ year)	AVERAGE CLOSED PANEL EMISSION RATE (mole/panel /year)	MAXIMUM REPOSITORY EMISSION RATE (moles/year)	FULL REPOSITORY CONCENTRATION AT THE EXHAUST SHAFT (ug/m^3)
Acetone	2.58E-03	15.61	0.16	16.57	1.12	26.70	0.40
Benzene	1.89E-04	1.14	0.01	1.22	0.09	2.04	0.04
Bromoform	6.24E-05	0.38	0.01	0.41	0.04	0.75	0.05
Butanol	6.01E-04	3.64	0.04	3.89	0.29	6.52	0.12
Carbon Disulfide	5.54E-04	3.35	0.03	3.55	0.04	3.89	0.08
Carbon Tetrachloride	3.74E-02	226.54	2.79	243.28	19.52	418.95	16.67
Chlorobenzene	1.04E-04	0.63	0.01	0.68	0.06	1.19	0.03
Chloroform	7.25E-04	4.38	0.05	4.68	0.34	7.75	0.24
Cyclohexane	4.50E-04	2.72	0.03	2.92	0.23	4.98	0.11
1,1-Dichloroethane	4.55E-04	2.75	0.03	2.93	0.21	4.82	0.12
1,2-Dichloroethane	1.68E-04	1.02	0.01	1.09	0.08	1.80	0.05
1,1-Dichloroethylene	6.07E-04	3.67	0.04	3.91	0.27	6.37	0.16
cis-1,2-Dichloroethylene	1.84E-04	1.11	0.01	1.18	0.08	1.93	0.05
trans-1,2-	1.93E-04	1.17	0.01	1.24	0.09	2.02	0.05

COMPOUND	AVERAGE DRUM EMISSION RATE (mole/drum/ year)	AVERAGE OPEN ROOM EMISSION RATE (mole/room/ year)	AVERAGE CLOSED ROOM EMISSION RATE (mole/room/ year)	AVERAGE OPEN PANEL EMISSION RATE (mole/panel/ year)	AVERAGE CLOSED PANEL EMISSION RATE (mole/panel /year)	MAXIMUM REPOSITORY EMISSION RATE (moles/year)	FULL REPOSITORY CONCENTRATION AT THE EXHAUST SHAFT (ug/m^3)
Dichloroethylene							
Ethyl Benzene	1.34E-04	0.81	0.01	0.88	0.08	1.56	0.04
Ethyl Ether	2.13E-04	1.29	0.01	1.38	0.10	2.29	0.04
Methanol	4.58E-03	27.70	0.22	28.99	1.51	42.59	0.35
Methyl Chloride	8.39E-04	5.08	0.05	5.36	0.33	8.34	0.11
Methylene Chloride	1.79E-03	10.81	0.11	11.47	0.76	18.33	0.40
Methyl Ethyl Ketone	6.10E-04	3.69	0.04	3.94	0.29	6.57	0.12
Methyl Isobutyl Ketone	4.60E-04	2.79	0.04	3.01	0.26	5.37	0.14
1,1,2,2-Tetrachloroethane	1.12E-04	0.68	0.01	0.73	0.06	1.25	0.05
Tetrachloroethylene	2.51E-04	1.52	0.02	1.61	0.11	2.59	0.11
Toluene	4.90E-04	2.96	0.04	3.19	0.26	5.52	0.13
1,1,1-Trichloroethane	3.01E-02	182.32	2.24	195.76	15.67	336.79	11.62
Trichloroethylene	2.14E-03	12.95	0.15	13.88	1.08	23.64	0.80
1,1,2-Trichloro-1,2,2-Trifluoroethane	9.46E-03	57.23	0.63	61.02	4.42	100.84	6.59
1,2,4-Trimethlybenzene	9.00E-05	0.54	0.01	0.59	0.06	1.09	0.03
1,3,5-Trimethylbenzene	1.11E-04	0.67	0.01	0.73	0.07	1.34	0.04
o-Xylene	1.39E-04	0.84	0.01	0.91	0.08	1.63	0.04
m,p-Xylene	2.38E-04	1.44	0.02	1.56	0.14	2.80	0.08

Table 13: Risk as a Fraction of the Health-Based Levels for Four Exposure Scenarios

COMPOUND	RISK AS A FRACTION OF THE HEALTH BASED LEVEL							
	WORKER TRAINING BUILDING		PUBLIC LIVINGSTON RIDGE		PUBLIC ANTELOPE RIDGE		PUBLIC WIPP SITE BOUNDARY	
	CARCINOGENIC	NON-CARCINOGENIC	CARCINOGENIC	NON-CARCINOGENIC	CARCINOGENIC	NON-CARCINOGENIC	CARCINOGENIC	NON-CARCINOGENIC
Acetone	---	3.23E-08	---	2.28E-09	---	8.69E-09	---	1.14E-09
Benzene	1.15E-05	3.44E-06	2.79E-05	2.42E-07	1.07E-04	9.24E-07	1.39E-05	1.21E-07
Bromoform	1.93E-06	---	4.76E-06	---	1.82E-05	---	2.38E-06	---
Butanol	---	5.20E-06	---	3.67E-07	---	1.40E-06	---	1.83E-07
Carbon Disulfide	---	2.73E-07	---	1.92E-08	---	7.35E-08	---	9.60E-09
Carbon Tetrachloride	3.57E-03	4.17E-04	8.89E-03	2.93E-05	3.39E-02	1.12E-04	4.44E-03	1.46E-05
Chlorobenzene	---	1.73E-06	---	1.22E-07	---	4.65E-07	---	6.07E-08
Chloroform	1.96E-04	6.10E-06	4.68E-04	4.30E-07	1.79E-03	1.64E-06	2.33E-04	2.14E-07
Cyclohexane	---	4.51E-08	---	3.18E-09	---	1.21E-08	---	1.59E-09
1,1-Dichloroethane	7.05E-06	---	1.74E-05	---	6.63E-05	---	8.67E-06	---
1,2-Dichloroethane	4.29E-05	1.65E-05	1.02E-04	1.16E-06	3.88E-04	4.43E-06	5.07E-05	5.79E-07
1,1-Dichloroethylene	---	2.00E-06	---	1.41E-07	---	5.37E-07	---	7.01E-08
cis-1,2-Dichloroethylene	---	---	---	---	---	---	---	---
trans-1,2-Dichloroethylene	---	2.11E-06	---	1.49E-07	---	5.69E-07	---	7.43E-08
Ethyl Benzene	3.68E-06	1.03E-07	9.08E-06	7.26E-09	3.47E-05	2.77E-08	4.53E-06	3.62E-09
Ethyl Ether	---	---	---	---	---	---	---	---
Methanol	---	2.20E-07	---	1.55E-08	---	5.93E-08	---	7.75E-09
Methyl Chloride	---	3.02E-06	---	2.13E-07	---	8.13E-07	---	1.06E-07
Methylene Chloride	1.44E-07	1.68E-06	3.54E-07	1.18E-07	1.35E-06	4.51E-07	1.77E-07	5.89E-08
Methyl Ethyl Ketone	---	6.13E-08	---	4.32E-09	---	1.65E-08	---	2.15E-09
Methyl Isobutyl Ketone	---	1.16E-07	---	8.17E-09	---	3.12E-08	---	4.08E-09
1,1,2,2-Tetrachloroethane	1.12E-04	---	3.19E-04	---	1.22E-03	---	1.59E-04	---
Tetrachloroethylene	1.03E-06	6.93E-06	2.54E-06	4.88E-07	9.69E-06	1.86E-06	1.27E-06	2.43E-07

COMPOUND	RISK AS A FRACTION OF THE HEALTH BASED LEVEL							
	WORKER TRAINING BUILDING		PUBLIC LIVINGSTON RIDGE		PUBLIC ANTELOPE RIDGE		PUBLIC WIPP SITE BOUNDARY	
	CARCINOGENIC	NON-CARCINOGENIC	CARCINOGENIC	NON-CARCINOGENIC	CARCINOGENIC	NON-CARCINOGENIC	CARCINOGENIC	NON-CARCINOGENIC
Toluene	---	6.57E-08	---	4.63E-09	---	1.77E-08	---	2.31E-09
1,1,1-Trichloroethane	---	5.81E-06	---	4.09E-07	---	1.56E-06	---	2.04E-07
Trichloroethylene	1.18E-04	1.00E-03	2.89E-04	7.07E-05	1.10E-03	2.70E-04	1.44E-04	3.53E-05
1,1,2-Trichloro-1,2,2-Trifluoroethane	---	5.49E-07	---	3.87E-08	---	1.48E-07	---	1.93E-08
1,2,4-Trimethlybenzene	---	1.21E-05	---	8.50E-07	---	3.25E-06	---	4.24E-07
1,3,5-Trimethylbenzene	---	---	---	---	---	---	---	---
m,p-Xylene	---	1.62E-04	---	1.14E-05	---	4.37E-05	---	5.71E-06
o-Xylene	---	1.12E-06	---	7.90E-08	---	3.02E-07	---	3.94E-08
Total	4.07E-03	1.65E-03	1.01E-02	1.16E-04	3.87E-02	4.44E-04	5.05E-03	5.81E-05

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ATTACHMENT 2

RECALCULATION OF THE VOLATILE ORGANIC COMPOUND SOURCE TERM

by

Robert F Kehrman

RECALCULATION OF THE VOLATILE ORGANIC COMPOUND SOURCE TERM

The volatile organic compound (VOC) source term that was used in the Resource Conservation and Recovery Act (RCRA) no- migration variance petition (NMVP)[1] and the Part B Permit Application[2] was based on the headspace gas samples taken from 930 drums of waste stored at the Idaho National Laboratory and the Rocky Flats Plant. These containers represented the entire spectrum of transuranic (TRU) waste that was expected to be shipped to the Waste Isolation Plant (WIPP) with the exception of the soils waste form. The measured concentrations were accumulated by "Waste Matrix Code Group" (WMCG), which is nomenclature used to express the physical form of the waste. The following WMCGs were used: Combustible waste, Filter waste, Graphite waste, Heterogeneous waste, Inorganic non-metal waste, Lead/cadmium metal waste, Salt waste, Soils, Solidified inorganic waste, Solidified organic waste, Uncategorized metal waste, and Unknown waste. In order to extend the data from the 930 containers to the entire inventory of WIPP-bound waste, a weighting scheme was developed. The TRU Waste Baseline Inventory Report (TWBIR) was used to determine the then current and projected inventory of TRU waste in each of the WMCGs. This information was tabulated (Table C2-2 in the NMVP Appendix WAP). Since the total volume of stored and projected waste did not add up to the approved inventory limit for the WIPP facility, the quantities were scaled up so that the total added up to the approved limit. A weighting factor was then calculated which represented the percentage of each of the WMCGs in the total (scaled inventory).

In order to calculate the source term, the average concentration of each VOC had to be weighted for each WMCG and then summed. This is represented by the following equation:

$$\bar{X} = \sum_{j=1}^{t} w_j * \bar{x}_j$$

where,

$\bar{X} = weighted\ average$
$\bar{x}_j = average\ concentration\ for\ WMCG\ j$
$w_j = weighting\ factor\ for\ WMCG\ j$
$t = number\ of\ WMCG\ s$

and $\bar{x}_j$ is calcualted by:

$$\bar{x}_j = \frac{1}{n_j} * \sum_{j=1}^{n_j} x_{jk}$$

where,

[1] DOE/CAO-96-2160 (Appendix WAP, Appendix VOC)
[2] DOE/WIPP 91-005, Rev. 6 (Appendix C2, Appendix D13)

n_j = number of samples in $WMCG\ j$
x_{jk} = analysis k for $WMCG\ j$.

The new calculations use over 136,000 sample results collected from TRU waste prior to shipment to the WIPP facility. These analyses were conducted in accordance with the WIPP Permit. Prior to October 2006, analyses were required on 100 percent of the containers. After this time, only representative sampling was required resulting in fewer sampled per waste stream.

The process for developing the new source term is as follows:

Step 1—a data dump of all headspace gas measurements was obtained from the WIPP Waste Information System beginning with the first shipment in 1999 through October 6, 2010. The data were provided as concentrations in parts per million by volume (ppmv) for each VOC plus hydrogen and methane for each container.

Step 2—the data were separated by year in order to provide manageable record sizes.

Step 3—measurements that were shown with a "U" flag were undetected. The values shown represent the method detection limit. These values were divided by 2 prior to including them in the total.

Step 4—each container was assigned to a WMCG based on the TRUCON code. During this process, 71 RH waste containers included in the database were removed (TRUCON codes beginning with a "3").

Step 5—the data were sorted by WMCG.

Step 6—the number of measurements for each VOC was determined for each WMCG using the "COUNT" function in Excel.

Step 7—the concentrations were summed

Step 8—the sum was divided by the number of samples to determine the average concentration for each VOC for each WMCG. Because there is a spreadsheet for each year, the yearly totals and counts were rolled up to a single table and then re-averaged for each WMCG and each VOC. Attachment A contains the averages for each year for each WMCG. The rollup is on the last page.

Step 9—the average concentrations for each compound and each WMCG was multiplied by the weighting factor to simulate the average concentration for each VOC in a full repository. This is shown in Attachment B. The following is an explanation of the different sets of concentrations in Attachment B.

Three sets of calculations are provided in Attachment B. All three use the measured repository headspace data from Attachment A. The first set of calculations uses the 2004 Compliance Recertification Application inventory projections for determining the weighting factors.[3] The results of

[3] Title 40 CFR Part 191 Subparts B and C Compliance Recertification Application 2004 March 2004 DOE/WIPP 2004-3231, Appendix DATA, Attachment F

this evaluation should be used in the Risk Screening exercise to determine the VOCs that make up 99 percent of the risk. The second set uses the same weighting factors that were used in the Permit Application and the NMVP. However, the results of the 930 drum sampling campaign is replaced with the new sampling results. This provides a comparison of the original assumptions regarding the VOC source term and the actual results. The third set of calculations modifies the Permit Application and NMVP weighting factors in two ways. The total volume of waste to be disposed is set by the Land Withdrawal Act (LWA) (which was not considered in the original scaling), so the total waste was adjusted to the LWA limits. Second, the original scaling appears to contain some unspecified factor for each WMCG that affected the scaled result. This was changed to a linear scaling of the total stored and projected waste. This resulted in slightly different weighting factors.

Note that the last page in Attachment B compares the various calculations of weighted VOC concentrations to the original source term.

Prepared by: Bob Kehrman
575 234 7210

Revision 3 dated 11.21.11

ATTACHMENT A

ALL WASTE TYPES

		HYDROGEN	METHANE	BENZENE	BROMOFORM	CARBON TETRACHLORIDE	CHLOROBENZENE	CHLOROFORM	CYCLOHEXANE	1,1-DICHLOROETHANE	1,2-DICHLOROETHANE	1,1-DICHLOROETHYLENE	CIS-1,2-DICHLOROETHYLENE	TRANS-1,2-DICHLOROETHYLENE	ETHYL BENZENE	ETHYL ETHER	METHYLENE CHLORIDE	1,1,2,2-TETRACHLOROETHANE	TETRACHLOROETHYLENE
1999	COUNT	253	253	253	253	253	253	253	253	253	253	253	253	0	253	253	253	253	253
	TOTAL (ppmv)	231835.00	71806.00	125.99	145.19	147.61	129.04	118.94	138.01	127.77	136.33	64.44	133.76	0.00	135.22	152.85	177.80	139.17	104.48
	AVERAGE (ppmv)	916.34	283.82	0.50	0.57	0.58	0.51	0.47	0.55	0.51	0.54	0.25	0.53	0.00	0.53	0.60	0.70	0.55	0.41
2000	COUNT	2830	2055	2737	2737	2737	2737	2737	2459	2737	2737	2737	2737	0	2737	2737	2737	2737	2737
	TOTAL (ppmv)	105442.00	12356.00	740.25	379.17	830.74	388.53	686.37	781.58	411.04	389.98	547.90	375.42	0.00	451.02	441.51	1285.65	415.57	416.77
	AVERAGE (ppmv)	37.26	6.01	0.27	0.14	0.30	0.14	0.25	0.32	0.15	0.14	0.20	0.14	0.00	0.16	0.16	0.47	0.15	0.15
2001	COUNT	5128	1191	10421	10421	10421	10421	10421	10209	10421	10421	10421	10421	0	10421	10421	10421	10421	10421
	TOTAL (ppmv)	765049.00	19205.00	6151.14	2242.58	13505.38	2315.60	6744.41	10312.98	5297.09	2317.35	7055.94	2422.48	0.00	3431.28	4555.26	22863.38	2376.15	3795.42
	AVERAGE (ppmv)	149.19	16.13	0.59	0.22	1.30	0.22	0.65	1.01	0.51	0.22	0.68	0.23	0.00	0.33	0.44	2.19	0.23	0.36
2002	COUNT	12678	9200	23450	23450	23450	23450	23450	21889	23450	23450	23450	23450	13222	23450	23450	23450	23450	23450
	TOTAL (ppmv)	1819063.50	336611.50	18677.29	6325.26	56568.34	7474.35	16189.83	37210.52	15468.41	7141.14	16002.83	7828.33	4964.57	12161.16	12680.07	39675.02	6937.45	20152.67
	AVERAGE (ppmv)	143.48	36.59	0.80	0.27	2.41	0.32	0.69	1.70	0.66	0.30	0.68	0.33	0.38	0.52	0.54	1.69	0.30	0.86
2003	COUNT	14595	14579	18374	18375	18374	18374	18375	10300	18375	18373	18375	18374	16758	18375	18375	18374	18375	18375
	TOTAL (ppmv)	1886285.00	819813.50	29629.80	16533.29	242060.93	22060.71	30412.84	10278.79	25232.00	20553.99	23394.42	21061.53	18504.00	26194.61	24248.35	69175.21	21846.22	24718.54
	AVERAGE (ppmv)	129.24	56.23	1.61	0.90	13.17	1.20	1.66	1.00	1.37	1.12	1.27	1.15	1.10	1.43	1.32	3.76	1.19	1.35
2004	COUNT	17032	17032	20100	20098	20100	20100	20100	10913	20100	20100	20099	20100	19433	20100	20099	20100	20099	20100
	TOTAL (ppmv)	3363889.00	1755870.50	44805.37	23191.41	357635.63	32173.63	73317.69	23896.51	34723.77	32416.76	35003.04	29142.78	29300.56	38503.11	33659.56	121035.91	38188.52	38488.45
	AVERAGE (ppmv)	197.50	103.09	2.23	1.15	17.79	1.60	3.65	2.19	1.73	1.61	1.74	1.45	1.51	1.92	1.67	6.02	1.90	1.91
2005	COUNT	20861	20861	20863	20863	20863	20863	20863	14120	20863	20863	20863	20862	20750	20863	20863	20863	20862	20863
	TOTAL (ppmv)	11268765.50	1895636.50	40518.47	27712.05	19733760.60	30681.81	180482.74	142319.43	203042.71	42237.49	305579.24	33953.99	32932.97	43912.18	34371.16	424144.52	33221.58	76465.15
	AVERAGE (ppmv)	540.18	90.87	1.94	1.33	945.87	1.47	8.65	10.08	9.73	2.02	14.65	1.63	1.59	2.10	1.65	20.33	1.59	3.67
2006	COUNT	25638	25638	25876	25876	25876	25876	25876	20181	25876	25876	25876	25876	25876	25876	25876	25876	25876	25876
	TOTAL (ppmv)	19622674.50	2448359.50	183817.42	70797.39	14753266.80	103038.10	486144.16	473663.18	822143.16	145403.45	888073.52	165872.04	160762.63	201140.15	185373.49	5501788.79	105907.54	236865.96
	AVERAGE (ppmv)	765.37	95.50	7.10	2.74	570.15	3.98	18.79	23.47	31.77	5.62	34.32	6.41	6.21	7.77	7.16	212.62	4.09	9.15
2007	COUNT	10742	10742	10750	10727	10727	10750	10727	9271	10749	10749	10749	10750	10749	10750	10750	10727	10727	10727
	TOTAL (ppmv)	11482140.50	919975.00	28650.00	15804.41	1992316.45	19118.07	89759.37	128876.40	125028.78	23739.73	200794.73	26256.43	27977.16	32363.56	29580.94	544321.12	17805.47	77545.36
	AVERAGE (ppmv)	1068.90	85.64	2.67	1.47	185.73	1.78	8.37	13.90	11.63	2.21	18.68	2.44	2.60	3.01	2.75	50.74	1.66	7.23
2008	COUNT	2715	2715	2742	2742	2742	2742	2742	2473	2742	2742	2742	2742	2742	2742	2742	2742	2742	2741
	TOTAL (ppmv)	2003300.00	168958.88	3909.57	2506.53	39647.49	2438.26	6693.61	11014.18	42745.60	3333.33	17259.39	3020.07	3213.82	4379.06	2805.32	188222.40	2947.37	10982.16
	AVERAGE (ppmv)	737.86	62.23	1.43	0.91	14.46	0.89	2.44	4.45	15.59	1.22	6.29	1.10	1.17	1.60	1.02	68.64	1.07	4.01
2009	COUNT	90	90	113	113	113	113	113	112	112	113	113	112	113	113	112	113	113	113
	TOTAL (ppmv)	33031.13	7648.63	148.12	143.86	748.71	176.03	218.30	323.05	1944.19	968.69	2173.45	178.70	182.01	452.95	202.43	3672.61	189.70	340.32
	AVERAGE (ppmv)	367.01	84.98	1.31	1.27	6.63	1.56	1.93	2.88	17.36	8.57	19.23	1.60	1.61	4.01	1.81	32.50	1.68	3.01
2010	COUNT	461	461	536	531	531	536	531	245	536	536	536	536	531	536	536	531	531	531
	TOTAL (ppmv)	161911.92	18879.31	1292.02	639.50	1759.00	633.75	702.46	3234.54	7265.52	657.50	2860.26	908.99	1492.57	1496.70	655.93	10775.43	692.38	7026.82
	AVERAGE (ppmv)	351.22	40.95	2.41	1.20	3.31	1.18	1.32	13.20	13.56	1.23	5.34	1.70	2.81	2.79	1.22	20.29	1.30	13.23
TOTAL	COUNT	113023	104817	136215	136186	136187	136215	136188	102425	136214	136213	136214	136213	110174	136216	136214	136187	136186	136187
	TOTAL (ppmv)	52743387.05	8475120.31	358465.43	166420.63	37192247.67	220627.88	891470.73	842049.16	1283430.06	279295.73	1498809.15	291154.52	279330.28	364621.01	328726.87	6927137.84	230667.13	496902.10
	AVERAGE (ppmv)	466.66	80.86	2.63	1.22	273.10	1.62	6.55	8.22	9.42	2.05	11.00	2.14	2.54	2.68	2.41	50.86	1.69	3.65

ALL WASTE TYPES

		TOLUENE	1,1,1-TRICHLOROETHANE	TRICHLOROETHYLENE	1,1,2-TRICHLORO-1,2,2-TRIFLUOROETHANE	1,2,4-TRIMETHYLBENZENE	1,3,5-TRIMETHYLBENZENE	M,P-XYLENE	O-XYLENE	ACETONE	BUTANOL	METHANOL	METHYL ETHYL KETONE	METHYL ISOBUTYL KETONE	METHYL CHLORIDE	CARBON DISULFIDE
1999	COUNT	253	253	253	253	127	253	253	253	253	253	253	253	253	0	0
	TOTAL (ppmv)	223.77	3171.19	118.31	106.97	176.64	197.41	263.41	140.22	5961.67	1201.43	3317.70	1716.37	1340.84	0.00	0.00
	AVERAGE (ppmv)	0.88	12.53	0.47	0.42	1.39	0.78	1.04	0.55	23.56	4.75	13.11	6.78	5.30	0.00	0.00
2000	COUNT	2737	2737	2737	2737	2459	2459	2737	2737	2737	2737	2737	2737	2737	0	1791
	TOTAL (ppmv)	7893.90	24718.24	1972.02	662.61	374.58	337.15	597.82	449.07	13169.50	5813.05	16058.50	3786.47	2946.44	0.00	868.06
	AVERAGE (ppmv)	2.88	9.03	0.72	0.24	0.15	0.14	0.22	0.16	4.81	2.12	5.87	1.38	1.08	0.00	0.48
2001	COUNT	10421	10421	10421	10421	9928	10209	10421	10421	10421	10421	10421	10421	10421	85	5997
	TOTAL (ppmv)	37784.43	247049.29	44930.26	12022.98	2418.46	2263.63	6103.96	2875.18	58282.48	44853.77	113820.53	21316.99	16390.76	28.80	4354.37
	AVERAGE (ppmv)	3.63	23.71	4.31	1.15	0.24	0.22	0.59	0.28	5.59	4.30	10.92	2.05	1.57	0.34	0.73
2002	COUNT	23450	23450	23450	23450	21889	21889	23450	23450	23450	23450	23450	23450	23450	1618	11858
	TOTAL (ppmv)	98774.05	378815.80	59074.68	100483.22	5069.20	4738.93	25481.04	10115.79	143426.15	122447.30	266409.54	63483.53	52453.73	2262.78	6060.93
	AVERAGE (ppmv)	4.21	16.15	2.52	4.28	0.23	0.22	1.09	0.43	6.12	5.22	11.36	2.71	2.24	1.40	0.51
2003	COUNT	18375	18374	18375	18374	10680	10680	18367	18374	18375	18374	18375	18375	18374	2075	9809
	TOTAL (ppmv)	110051.35	253019.57	31543.97	69592.02	7894.41	7476.50	45118.52	24950.16	311734.48	153503.43	337931.64	148243.69	135609.89	6826.50	12710.00
	AVERAGE (ppmv)	5.99	13.77	1.72	3.79	0.74	0.70	2.46	1.36	16.97	8.35	18.39	8.07	7.38	3.29	1.30
2004	COUNT	20100	20100	20099	20100	10965	10966	20099	20100	20100	20100	20100	20100	20100	1928	12076
	TOTAL (ppmv)	113736.25	428128.39	59282.70	231410.92	14611.69	14153.76	67592.54	41033.03	345042.00	205387.33	273231.82	210319.08	235227.64	2957.91	18586.93
	AVERAGE (ppmv)	5.66	21.30	2.95	11.51	1.33	1.29	3.36	2.04	17.17	10.22	13.59	10.46	11.70	1.53	1.54
2005	COUNT	20863	20863	20863	20863	14109	14120	20863	20863	20863	20863	20863	20863	20863	11484	11309
	TOTAL (ppmv)	104773.25	16473601.26	1355794.96	3760207.65	22954.19	22254.73	74360.73	41643.42	601901.66	284601.73	1029352.97	240562.09	257553.21	58702.82	21836.15
	AVERAGE (ppmv)	5.02	789.61	64.99	180.23	1.63	1.58	3.56	2.00	28.85	13.64	49.34	11.53	12.34	5.11	1.93
2006	COUNT	25876	25876	25876	25876	20180	20181	25876	25876	25876	25876	25876	25876	25876	22200	19860
	TOTAL (ppmv)	1233323.29	18032738.19	3852478.65	4579212.17	98941.73	121305.14	492018.22	181423.67	4659199.33	584846.27	3295637.71	792919.19	703322.97	464501.27	1299056.89
	AVERAGE (ppmv)	47.66	696.89	148.88	176.97	4.90	6.01	19.01	7.01	180.06	22.60	127.36	30.64	27.18	20.92	65.41
2007	COUNT	10750	10727	10727	10727	9270	9270	10750	10750	10750	10750	10750	10750	10750	10603	10523
	TOTAL (ppmv)	117817.22	4555537.36	1198984.78	873524.73	18306.05	18731.96	64379.83	27927.13	624731.08	175606.36	479158.65	142861.54	175502.56	60210.39	118124.54
	AVERAGE (ppmv)	10.96	424.68	111.77	81.43	1.97	2.02	5.99	2.60	58.11	16.34	44.57	13.29	16.33	5.68	11.23
2008	COUNT	2742	2742	2742	2742	2473	2473	2742	2742	2742	2742	2742	2742	2742	2727	2710
	TOTAL (ppmv)	24454.11	317712.72	417446.22	10517.26	2414.76	2444.18	8992.71	4142.91	69660.12	39341.76	127238.57	26309.88	31878.35	4262.31	7424.62
	AVERAGE (ppmv)	8.92	115.87	152.24	3.84	0.98	0.99	3.28	1.51	25.40	14.35	46.40	9.60	11.63	1.56	2.74
2009	COUNT	113	113.00	113.00	113.00	112.00	112.00	113.00	113.00	112.00	112.00	112.00	112.00	112.00	112.00	83.00
	TOTAL (ppmv)	1323.27	31183.55	22761.84	315.77	199.48	176.42	984.13	427.51	1436.75	1173.89	2036.65	764.30	1033.19	223.90	113.20
	AVERAGE (ppmv)	11.71	275.96	201.43	2.79	1.78	1.58	8.71	3.78	12.83	10.48	18.18	6.82	9.22	2.00	1.36
2010	COUNT	531	531.00	531.00	531.00	245.00	245.00	536.00	536.00	536.00	536.00	536.00	536.00	536.00	529.00	464.00
	TOTAL (ppmv)	3392.31	43729.96	43758.78	3122.14	389.46	365.71	3002.63	1141.72	15451.54	5835.04	20019.71	3993.83	5059.62	1098.92	449.07
	AVERAGE (ppmv)	6.39	82.35	82.41	5.88	1.59	1.49	5.60	2.13	28.83	10.89	37.35	7.45	9.44	2.08	0.97
TOTAL	COUNT	136211	136187.00	136187.00	136187.00	102437.00	102857.00	136207.00	136215.00	136215.00	136214.00	136215.00	136215.00	136214.00	53361.00	86480.00
	TOTAL (ppmv)	1853547.19	40789405.53	7088147.19	9641178.45	173750.64	194445.54	788895.55	336269.81	6849996.75	1624611.36	5964213.98	1656276.95	1618319.22	601075.59	1489584.76
	AVERAGE (ppmv)	13.61	299.51	52.05	70.79	1.70	1.89	5.79	2.47	50.29	11.93	43.79	12.16	11.88	11.26	17.22

ATTACHMENT B

MOST RECENT CRA INVENTORY (cubic meters)

Final Waste Forms	Stored Waste	Projected Waste	Emplaced Waste	Total Waste	SCALED	Weighting Factor	
Combustible Material	4300	1900	610	6800	8149	0.05	
Filter Material	990	590	340	1900	2277	0.01	
Graphite	120	1.3	0	130	156	0.00	
Heterogeneous Debris	49000	9700	570	59000	70706	0.42	
Inorganic Non-Metal	11000	68	970	12000	14381	0.09	
Lead/Cadmium Metal	140	32	81	260	312	0.00	
Salt	150	190	1500	1800	2157	0.01	
Soil	300	6000	0	6300	7550	0.04	
Solidified Inorganic Material	35000	730	3300	39000	46738	0.28	
Solidified Organic Material	5200	380	0	5500	6591	0.04	
Uncategorized Metal	2400	5100	360	7900	9467	0.06	
Unknown							

	HYDROGEN	METHANE	BENZENE	BROMOFORM	CARBON TETRACHLORIDE	CHLOROBENZENE	CHLOROFORM	CYCLOHEXANE	1,1-DICHLOROETHANE	1,2-DICHLOROETHANE	1,1-DICHLOROETHYLENE	CIS-1,2-DICHLOROETHYLENE	TRANS-1,2-DICHLOROETHYLENE	ETHYL BENZENE	ETHYL ETHER	METHYLENE CHLORIDE	1,1,2,2-TETRACHLOROETHANE	TETRACHLOROETHYLENE
WEIGHTED CONCENTRATION FOR EACH WASTE FORM (ppmv)																		
Combustible Material	16.41	1.93	0.21	0.06	2.14	0.10	0.52	1.43	1.75	0.14	0.99	0.19	0.23	0.39	0.16	22.29	0.08	0.34
Filter Material	8.09	1.59	0.02	0.01	0.30	0.01	0.04	0.01	0.09	0.01	0.16	0.01	0.01	0.01	0.01	0.08	0.01	0.01
Graphite	0.07	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Heterogeneous Debris	231.75	35.79	0.94	0.47	3.51	0.61	0.91	2.44	2.14	0.67	1.73	0.59	0.60	0.73	0.66	9.28	0.66	0.92
Inorganic Non-Metal	9.69	3.62	0.04	0.04	0.22	0.04	0.11	0.36	0.05	0.04	0.04	0.04	0.05	0.04	0.04	0.08	0.04	0.03
Lead/Cadmium Metal	2.36	0.16	0.00	0.00	0.38	0.00	0.03	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00
Salt	5.65	0.52	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00
Soil	4.83	4.70	0.04	0.05	0.37	0.04	0.05	0.08	0.07	0.05	0.09	0.04	0.05	0.04	0.05	0.06	0.06	0.06
Solidified Inorganic Material	115.70	26.36	0.34	0.28	3.18	0.27	0.32	0.75	2.67	0.26	4.64	0.31	0.43	0.62	0.31	0.63	0.31	1.24
Solidified Organic Material	10.07	2.15	2.63	0.89	911.03	1.57	14.07	5.64	2.99	2.55	5.14	2.64	2.63	1.67	3.46	3.44	1.54	2.42
Uncategorized Metal	10.14	3.40	0.10	0.04	0.38	0.04	0.07	0.04	0.12	0.04	0.09	0.04	0.05	0.07	0.04	0.13	0.04	0.04
TOTAL WEIGHTED CONCENTRATIONS (ppmv)																		
	414.76	80.25	4.32	1.84	921.52	2.67	16.12	10.76	9.89	3.77	12.91	3.87	4.07	3.57	4.76	36.01	2.75	5.07

	TOLUENE	1,1,1-TRICHLOROETHANE	TRICHLOROETHYLENE	1,1,2-TRICHLORO-1,2,2-TRIFLUOROETHANE	1,2,4-TRIMETHYLBENZENE	1,3,5-TRIMETHYLBENZENE	M,P-XYLENE	O-XYLENE	ACETONE	BUTANOL	METHANOL	METHYL ETHYL KETONE	METHYL ISOBUTYL KETONE	METHYL CHLORIDE	CARBON DISULFIDE
WEIGHTED CONCENTRATION FOR EACH WASTE FORM (ppmv)															
Combustible Material	4.49	5.01	3.29	1.93	0.10	0.10	1.24	0.27	14.62	0.76	1.72	1.91	1.70	0.84	6.39
Filter Material	0.09	1.59	0.28	0.19	0.01	0.01	0.01	0.01	0.43	0.12	0.34	0.12	0.12	0.17	0.02
Graphite	0.00	0.03	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.01	0.00	0.00	0.05	0.00
Heterogeneous Debris	2.77	20.13	3.76	2.28	0.51	0.50	1.39	0.75	12.63	4.76	8.30	4.14	4.34	4.10	0.68
Inorganic Non-Metal	0.50	0.71	0.09	0.04	0.04	0.04	0.07	0.04	0.73	0.48	1.61	0.41	0.37	1.91	0.06
Lead/Cadmium Metal	0.01	0.13	0.01	0.01	0.00	0.00	0.00	0.00	0.07	0.02	0.03	0.02	0.02	0.05	0.00
Salt	0.02	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.04	0.09	0.17	0.03	0.03	0.00	0.01
Soil	0.06	0.19	0.05	0.05	0.05	0.05	0.09	0.06	0.47	0.33	0.51	0.41	0.30	0.00	0.07
Solidified Inorganic Material	1.29	81.52	38.55	8.33	0.33	0.31	1.30	0.46	3.00	3.21	17.08	2.30	2.60	0.49	0.33
Solidified Organic Material	2.51	629.34	4.98	196.00	1.48	2.09	2.20	2.13	20.34	3.58	40.89	4.04	2.35	7.74	2.90
Uncategorized Metal	0.49	1.16	0.17	0.10	0.04	0.04	0.17	0.07	0.76	0.42	0.62	0.42	0.57	0.25	0.04
TOTAL WEIGHTED CONCENTRATIONS (ppmv)															
	12.23	739.815	51.184	208.93	2.57	3.15	6.461	3.8005	53.096	13.775	71.28	13.788	12.393	15.578	10.49

ORIGINAL NMVP AND PART B (cubic meters)

Final Waste Forms	Stored volume	Projected volumes		Total Waste	Scaled Volumes	Weighting Factor		
Combustible	7100	27000		34100	62000	0.35		
Filter	430	1100		1530	2600	0.01		
Graphite	670	43		713	760	0.00		
Heterogeneous	30000	4600		34600	39000	0.22		
Inorganic non-metal	1200	320		1520	1800	0.01		
Lead/cadmium metal	56	130		186	310	0.00		
Salt waste	33	60		93	150	0.00		
Soils	370	450		820	1300	0.01		
Solidified inorganics	17000	8000		25000	34000	0.19		
Solidified organics	1500	300		1800	2100	0.01		
Uncategorized metal	12000	8600		20600	30000	0.17		
Unknown	1700	0		1700	1700	0.01		

	HYDROGEN	METHANE	BENZENE	BROMOFORM	CARBON TETRACHLORIDE	CHLOROBENZENE	CHLOROFORM	CYCLOHEXANE	1,1-DICHLOROETHANE	1,2-DICHLOROETHANE	1,1-DICHLOROETHYLENE	CIS-1,2-DICHLOROETHYLENE	TRANS-1,2-DICHLOROETHYLENE	ETHYL BENZENE	ETHYL ETHER	METHYLENE CHLORIDE	1,1,2,2-TETRACHLOROETHANE	TETRACHLOROETHYLENE
WEIGHTED CONCENTRATION FOR EACH WASTE FORM (ppmv)																		
Combustible	119.78	14.08	1.51	0.40	15.63	0.71	3.77	10.46	12.75	1.00	7.23	1.42	1.67	2.82	1.17	162.66	0.59	2.51
Filter	8.86	1.74	0.03	0.01	0.32	0.01	0.04	0.01	0.10	0.01	0.17	0.01	0.01	0.01	0.01	0.09	0.01	0.01
Graphite	0.31	0.15	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Heterogeneous	122.60	18.93	0.49	0.25	1.86	0.32	0.48	1.29	1.13	0.36	0.91	0.31	0.32	0.39	0.35	4.91	0.35	0.48
Inorganic non-metal	1.16	0.43	0.01	0.00	0.03	0.00	0.01	0.04	0.01	0.00	0.00	0.00	0.01	0.00	0.01	0.01	0.00	0.00
Lead/cadmium metal	2.30	0.15	0.00	0.00	0.37	0.00	0.03	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00
Salt waste	0.38	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Soils	0.80	0.77	0.01	0.01	0.06	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Solidified inorganics	80.91	18.44	0.23	0.20	2.23	0.19	0.22	0.52	1.86	0.18	3.24	0.22	0.30	0.43	0.21	0.44	0.22	0.87
Solidified organics	3.09	0.66	0.81	0.27	279.45	0.48	4.32	1.73	0.92	0.78	1.58	0.81	0.81	0.51	1.06	1.05	0.47	0.74
Uncategorized metal	30.85	10.34	0.30	0.11	1.16	0.11	0.20	0.13	0.36	0.11	0.28	0.12	0.15	0.20	0.13	0.39	0.13	0.13
Unknown																		
TOTAL WEIGHTED CONCENTRATIONS (ppmv)																		
	371.02	65.74	3.39	1.26	301.11	1.83	9.09	14.21	17.18	2.46	13.58	2.90	3.28	4.38	2.96	169.59	1.79	4.77

	TOLUENE	1,1,1-TRICHLOROETHANE	TRICHLOROETHYLENE	1,1,2-TRICHLORO-1,2,2-TRIFLUOROETHANE	1,2,4-TRIMETHYLBENZENE	1,3,5-TRIMETHYLBENZENE	M,P-XYLENE	O-XYLENE	ACETONE	BUTANOL	METHANOL	METHYL ETHYL KETONE	METHYL ISOBUTYL KETONE	METHYL CHLORIDE	CARBON DISULFIDE
WEIGHTED CONCENTRATION FOR EACH WASTE FORM (ppmv)															
Combustible	32.79	36.55	23.98	14.12	0.76	0.75	9.03	2.01	106.72	5.53	12.57	13.96	12.38	6.15	46.65
Filter	0.10	1.74	0.31	0.21	0.01	0.01	0.02	0.01	0.47	0.13	0.37	0.13	0.13	0.18	0.02
Graphite	0.01	0.14	0.04	0.00	0.00	0.00	0.00	0.00	0.06	0.01	0.04	0.01	0.01	0.25	0.00
Heterogeneous	1.47	10.65	1.99	1.21	0.27	0.27	0.73	0.40	6.68	2.52	4.39	2.19	2.30	2.17	0.36
Inorganic non-metal	0.06	0.09	0.01	0.00	0.00	0.00	0.01	0.00	0.09	0.06	0.19	0.05	0.04	0.23	0.01
Lead/cadmium metal	0.01	0.13	0.01	0.01	0.00	0.00	0.00	0.00	0.07	0.02	0.03	0.02	0.01	0.04	0.00
Salt waste	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00
Soils	0.01	0.03	0.01	0.01	0.01	0.01	0.01	0.01	0.08	0.05	0.08	0.07	0.05	0.00	0.01
Solidified inorganics	0.90	57.01	26.96	5.83	0.23	0.22	0.91	0.32	2.10	2.25	11.94	1.61	1.82	0.34	0.23
Solidified organics	0.77	193.04	1.53	60.12	0.45	0.64	0.67	0.65	6.24	1.10	12.54	1.24	0.72	2.37	0.89
Uncategorized metal	1.49	3.53	0.52	0.29	0.12	0.12	0.52	0.23	2.31	1.28	1.90	1.27	1.74	0.75	0.11
Unknown															
TOTAL WEIGHTED CONCENTRATIONS (ppmv)															
	37.61	302.91	55.35	81.79	1.86	2.02	11.91	3.63	124.81	12.95	44.07	20.54	19.20	12.48	48.28

REVISED FOR LWA LIMITS (cubic meters)

Final Waste Forms	Stored volume	Projected volumes		Total Waste	Scaled Volumes	Weighting Factor		
Combustible	7100	27000		34100	46839	0.28		
Filter	430	1100		1530	2102	0.01		
Graphite	670	43		713	979	0.01		
Heterogeneous	30000	4600		34600	47526	0.28		
Inorganic non-metal	1200	320		1520	2088	0.01		
Lead/cadmium metal	56	130		186	255	0.00		
Salt waste	33	60		93	128	0.00		
Soils	370	450		820	1126	0.01		
Solidified inorganics	17000	8000		25000	34339	0.20		
Solidified organics	1500	300		1800	2472	0.01		
Uncategorized metal	12000	8600		20600	28296	0.17		
Unknown	1700	0		1700	2335	0.01		

	HYDROGEN	METHANE	BENZENE	BROMOFORM	CARBON TETRACHLORIDE	CHLOROBENZENE	CHLOROFORM	CYCLOHEXANE	1,1-DICHLOROETHANE	1,2-DICHLOROETHANE	1,1-DICHLOROETHYLENE	CIS-1,2-DICHLOROETHYLENE	TRANS-1,2-DICHLOROETHYLENE	ETHYL BENZENE	ETHYL ETHER	METHYLENE CHLORIDE	1,1,2,2-TETRACHLOROETHANE	TETRACHLOROETHYLENE
WEIGHTED CONCENTRATION FOR EACH WASTE FORM (ppmv)																		
Combustible	94.33	11.09	1.19	0.32	12.31	0.56	2.97	8.24	10.04	0.79	5.70	1.12	1.32	2.22	0.93	128.10	0.47	1.98
Filter	7.47	1.47	0.02	0.01	0.27	0.01	0.03	0.01	0.08	0.01	0.15	0.01	0.01	0.01	0.01	0.08	0.01	0.01
Graphite	0.41	0.21	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.00	0.18	0.00	0.00	0.00	0.00	0.01	0.00	0.00
Heterogeneous	155.77	24.06	0.63	0.31	2.36	0.41	0.61	1.64	1.44	0.45	1.16	0.40	0.40	0.49	0.45	6.24	0.44	0.62
Inorganic non-metal	1.41	0.53	0.01	0.01	0.03	0.01	0.02	0.05	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Lead/cadmium metal	1.94	0.13	0.00	0.00	0.31	0.00	0.03	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00
Salt waste	0.33	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Soils	0.72	0.70	0.01	0.01	0.06	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Solidified inorganics	85.00	19.37	0.25	0.21	2.34	0.20	0.23	0.55	1.96	0.19	3.41	0.23	0.32	0.46	0.22	0.46	0.23	0.91
Solidified organics	3.78	0.80	0.99	0.34	341.73	0.59	5.28	2.12	1.12	0.96	1.93	0.99	0.99	0.63	1.30	1.29	0.58	0.91
Uncategorized metal	30.30	10.16	0.29	0.11	1.14	0.11	0.20	0.13	0.35	0.11	0.28	0.12	0.15	0.20	0.13	0.38	0.13	0.13
Unknown																		
TOTAL WEIGHTED CONCENTRATIONS (ppmv)																		
	381.46	68.54	3.38	1.31	360.56	1.88	9.38	12.75	15.06	2.53	12.81	2.88	3.21	4.02	3.05	136.59	1.88	4.57

	TOLUENE	1,1,1-TRICHLOROETHANE	TRICHLOROETHYLENE	1,1,2-TRICHLORO-1,2,2-TRIFLUOROETHANE	1,2,4-TRIMETHYLBENZENE	1,3,5-TRIMETHYLBENZENE	M,P-XYLENE	O-XYLENE	ACETONE	BUTANOL	METHANOL	METHYL ETHYL KETONE	METHYL ISOBUTYL KETONE	METHYL CHLORIDE	CARBON DISULFIDE
WEIGHTED CONCENTRATION FOR EACH WASTE FORM (ppmv)															
Combustible	25.82	28.79	18.88	11.12	0.60	0.59	7.11	1.58	84.05	4.36	9.90	10.99	9.75	4.84	36.74
Filter	0.08	1.47	0.26	0.18	0.01	0.01	0.01	0.01	0.40	0.11	0.31	0.11	0.11	0.15	0.01
Graphite	0.01	0.19	0.05	0.00	0.00	0.00	0.00	0.00	0.08	0.02	0.06	0.01	0.01	0.34	0.00
Heterogeneous	1.86	13.53	2.53	1.53	0.34	0.34	0.93	0.50	8.49	3.20	5.58	2.78	2.92	2.75	0.45
Inorganic non-metal	0.07	0.10	0.01	0.01	0.01	0.01	0.01	0.01	0.11	0.07	0.23	0.06	0.05	0.28	0.01
Lead/cadmium metal	0.01	0.11	0.01	0.01	0.00	0.00	0.00	0.00	0.06	0.02	0.02	0.01	0.01	0.04	0.00
Salt waste	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00
Soils	0.01	0.03	0.01	0.01	0.01	0.01	0.01	0.01	0.07	0.05	0.08	0.06	0.04	0.00	0.01
Solidified inorganics	0.95	59.89	28.32	6.12	0.24	0.23	0.95	0.34	2.20	2.36	12.55	1.69	1.91	0.36	0.24
Solidified organics	0.94	236.07	1.87	73.52	0.55	0.78	0.82	0.80	7.63	1.34	15.34	1.51	0.88	2.90	1.09
Uncategorized metal	1.47	3.47	0.51	0.29	0.11	0.11	0.52	0.22	2.26	1.25	1.87	1.25	1.71	0.73	0.11
Unknown															
TOTAL WEIGHTED CONCENTRATIONS (ppmv)															
	31.22	343.64	52.45	92.78	1.88	2.08	10.37	3.47	105.35	12.78	45.94	18.48	17.40	12.40	38.67

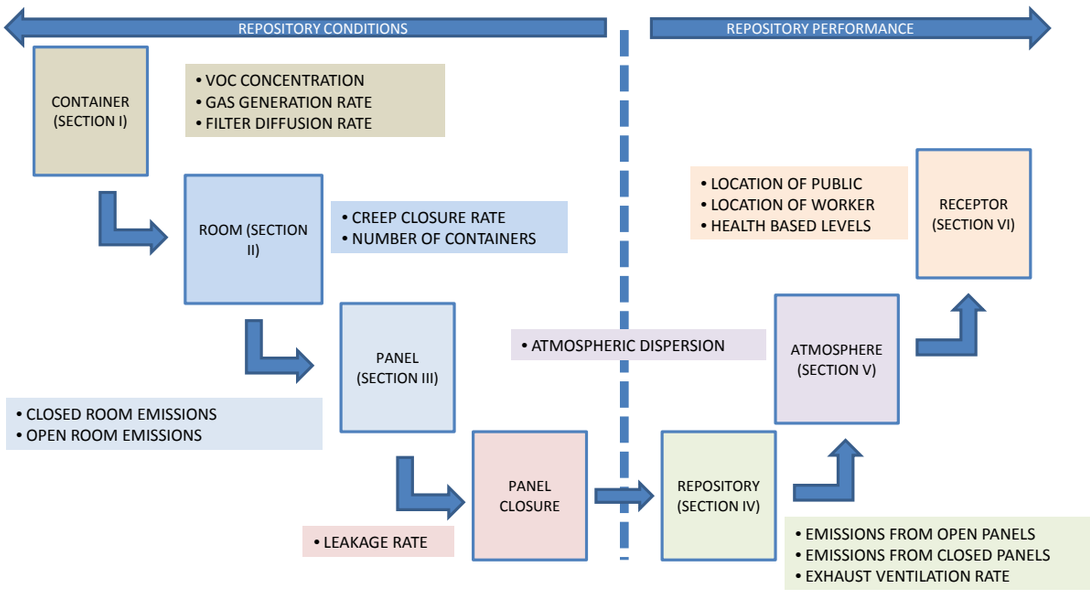
	MW	930 DRUMS	RECALC WITH HSG DATA		
		APP13	APP13	LWA	CRA
Carbon tetrachloride	153.8	375.5	301.1	360.6	921.5
1,1,2,2-Tetrachloroethane	167.9	9.4	1.8	1.9	4.8
Chloroform	119.4	25.3	9.1	9.4	16.1
1,2-Dichloroethane	99.0	9.1	17.2	2.5	3.8
Methylene chloride	84.9	368.5	169.6	136.6	36.0
Benzene	78.1	9.3	3.4	3.4	4.3
Trichloroethylene	131.4	25.1	55.3	52.5	51.2
Bromoform	252.8	9.4	1.3	1.3	1.8
Tetrachloroethylene	165.9	9.4	4.8	4.6	5.1
Vinyl chloride	62.5	0.2			
1 , 1 ,2-Trichloroethane	133.4	0.1			
Chlorobenzene	112.6	12.5	1.8	1.9	2.7
1,1,1 -Trichloroethane	133.4	317.1	302.9	343.6	739.8
1 ,1-Dichloroethylene	97.0	11.5	13.6	12.8	12.9
Methyl ethyl ketone	72.1	63.7	20.5	18.5	13.8
Toluene	92.1	19.4	37.6	31.2	12.2
Carbon disulfide	76.1	0.1	48.3	38.7	10.5
Trichlorofluoromethane	137.4	0.1			
(cis)-1, 2-Dichloroethylene	97.0	9.0	2.9	2.9	3.9
Isobutanol	74.1	0.1			

ATTACHMENT 3

CALCULATIONS TO SUPPORT PANEL CLOSURE DESIGN PAPER 8 29 12

Figure 1 is a block diagram of the elements that go into preparing a risk model to demonstrate operational impacts due to emissions from the Waste Isolation Pilot Plant repository. The goal of this discussion is to provide information needed to specify the design of the Panel Closure which will serve to assure the performance standards to the right on the diagram are met for the conditions in the repository shown on the left in Figure 1. When the original Part B Permit Application for the Waste Isolation Pilot Plant (WIPP) (U. S. Department of Energy, 1996 a) facility was submitted in 1996, one of the design parameters for Panel Closure was that "the panel closure system shall limit the migration of [volatile organic compounds] VOCs to the compliance point so that compliance is achieved by at least one order of magnitude." This criterion has been changed for the current design to only require compliance without an additional compliance margin. The following discusses each element in the order indicated by the Roman Numerals on the Figure.

FIGURE 1: Elements of the Waste Isolation Pilot Plant Air Exposure Pathway



VOC CONCENTRATION	is in Sheet *Weighted HS Conc*
GAS GENERATION RATE	is in Sheet *Inputs and Outputs*
FILTER DIFFUSION RATE	is in Sheet *Filter Information and Inputs and*
CREEP CLOUSRE RATE	is in Sheet *Inputs and Outputs*
NUMBER OF CONTAINERS	is in Sheet *Containers*
LEAKAGE RATE	is in Sheet *Leakage* , however it is not considered in the Panel Closure Paper.
EMISSIONS FROM OPEN PANELS	is in Sheet *Inputs and Outputs*
EMISSIONS FROM CLOSED PANELS	is in Sheet *Inputs and Outputs*
EXHAUST VENTILATION RATE	is in Sheet *Inputs and Outputs*
ATMOSPHERIC DISPERSION	is in Sheet *Risk Factors, ADFs and HBLs*
LOCATION OF THE WORKER	is in Sheet *Risk Factors, ADFs and HBLs*
LOCATION OF THE PUBLIC	is in Sheet *Risk Factors, ADFs and HBLs*
HEALTH BASED LEVELS	is in Sheet *Risk Factors, ADFs and HBLs*

References:

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The following is from Section 1 of the paper: "ESTABLISHING VOLATILE ORGANIC COMPOUND LIMITS FOR THE PANEL CLOSURE DESIGN". VOC CONCENTRATION Information needed on the container scale for air dispersion modeling is the average concentration of VOCs in the headspace of the container which defines the release source term and the gas generation rate which is a driving force to move VOCs from closed rooms and panels into the repository ventilation system. The VOC source term used for the original Panel Closure design effort was developed based on a limited sampling program conducted in Idaho and at Rocky Flats. Subsequent to that time, a weighted average source term was developed using the same data, however, a weighting process was developed to accommodate the wide variety of waste forms and to weight them in accordance with their prevalence. The process for developing the weighted average source term is described in Appendix C2 of the 1996 Permit Application (U. S. Department of Energy, 1996 a). The results are summarized in Table 1. In 2010, the source term was revised using the same methodology; however, over 130,000 headspace gas measurements were available (Kehrman, 2011). The revised source term is shown in Table 1. The values in Table 1 represent the average concentration that would be expected in a filled, closed room.

THESE VALUES COME FROM A SHEET TITLED "HSGD ROLLUP 11- 21 2011 CORRECTED FILE"

MOST RECENT CRA INVENTORY (cubic meters)										HYDROGEN	METHANE	BENZENE	BROMOFORM	CARBON TETRACHLORIDE	CHLORIDRENZENE	CHLOROFORM	CYCLOHEXANE	1,1-DICHLOROETHANE	1,2-DICHLOROETHANE	1,1-DICHLOROETHYLENE	CIS-1,2-DICHLOROETHYLENE	TRANS-1,2-DICHLOROETHYLENE	ETHYL BENZENE	ETHYL ETHER	METHYLENE CHLORIDE	1,1,2,2-TETRACHLOROETHANE	TETRACHLOROETHYLENE
Final Waste Forms	Stored Waste	Projected Waste	Emplaced Waste	Total Waste	SCALED	Weighting Factor			WEIGHTED CONCENTRATION FOR EACH WASTE FORM (ppmv)																		
Combustible Material	4300.00	1900.00	610.00	6810.00	8136.18	0.05			Combustible Material	16.41	1.93	0.21	0.06	2.14	0.10	0.52	1.43	1.75	0.14	0.99	0.19	0.23	0.39	0.16	22.29	0.08	0.34
Filter Material	990.00	590.00	340.00	1920.00	2293.90	0.01			Filter Material	8.09	1.59	0.02	0.01	0.30	0.01	0.04	0.01	0.09	0.01	0.16	0.01	0.01	0.01	0.01	0.08	0.01	0.01
Graphite	120.00	1.30	0.00	121.30	144.92	0.00			Graphite	0.07	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Heterogeneous Debris	49000.00	9700.00	570.00	59270.00	70812.25	0.42			Heterogeneous Debris	231.75	35.79	0.94	0.47	3.51	0.61	0.91	2.44	2.14	0.67	1.73	0.59	0.60	0.73	0.66	9.28	0.66	0.92
Inorganic Non-Metal	11000.00	68.00	970.00	12038.00	14382.28	0.09			Inorganic Non-Metal	9.69	3.62	0.04	0.04	0.22	0.04	0.11	0.36	0.05	0.04	0.04	0.04	0.05	0.04	0.04	0.08	0.04	0.03
Lead/Cadmium Metal	140.00	32.00	81.00	253.00	302.27	0.00			Lead/Cadmium Metal	2.36	0.16	0.00	0.00	0.38	0.00	0.03	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00
Salt	150.00	190.00	1500.00	1840.00	2198.32	0.01			Salt	5.65	0.52	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00
Soil	300.00	6000.00	0.00	6300.00	7526.86	0.04			Soil	4.83	4.70	0.04	0.05	0.37	0.04	0.05	0.08	0.07	0.05	0.09	0.04	0.05	0.04	0.05	0.06	0.06	0.06
Solidified Inorganic Material	35000.00	730.00	3300.00	39030.00	46630.71	0.28			Solidified Inorganic Material	115.70	26.36	0.34	0.28	3.18	0.27	0.32	0.75	2.67	0.26	4.64	0.31	0.43	0.62	0.31	0.63	0.31	1.24
Solidified Organic Material	5200.00	380.00	0.00	5580.00	6666.65	0.04			Solidified Organic Material	10.07	2.15	2.63	0.89	911.03	1.57	14.07	5.64	2.99	2.55	5.14	2.64	2.63	1.67	3.46	3.44	1.54	2.42
Uncategorized Metal	2400.00	5100.00	360.00	7860.00	9390.66	0.06			Uncategorized Metal	10.14	3.40	0.10	0.04	0.38	0.04	0.07	0.04	0.12	0.04	0.09	0.04	0.05	0.07	0.04	0.13	0.04	0.04
Unknown																											
									TOTAL WEIGHTED CONCENTRATIONS (ppmv)																			
										414.76	80.25	4.32	1.84	921.52	2.67	16.12	10.76	9.89	3.77	12.91	3.87	4.07	3.57	4.76	36.01	2.75	5.07

MOST RECENT CRA INVENTORY (cubic meters)										TOLUENE	1,1,1-TRICHLOROETHANE	TRICHLOROETHYLENE	1,1,2-TRICHLORO-1,2,2-TRIFLUOROETHANE	1,2,4-TRIMETHYLBENZENE	1,3,5-TRIMETHYLBENZENE	M,P-XYLENE	O-XYLENE	ACETONE	BUTANOL	METHANOL	METHYL ETHYL KETONE	METHYL ISOBUTYL KETONE	METHYL CHLORIDE	CARBON DISULFIDE
Final Waste Forms	Stored Waste	Projected Waste	Emplaced Waste	Total Waste	SCALED	Weighting Factor			WEIGHTED CONCENTRATION FOR EACH WASTE FORM (ppmv)															
Combustible Material	4300.00	1900.00	610.00	6810.00	8136.18	0.05			Combustible Material	4.49	5.01	3.29	1.93	0.10	0.10	1.24	0.27	14.62	0.76	1.72	1.91	1.70	0.84	6.39
Filter Material	990.00	590.00	340.00	1920.00	2293.90	0.01			Filter Material	0.09	1.59	0.28	0.19	0.01	0.01	0.01	0.01	0.43	0.12	0.34	0.12	0.12	0.17	0.02
Graphite	120.00	1.30	0.00	121.30	144.92	0.00			Graphite	0.00	0.03	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.01	0.00	0.00	0.05	0.00
Heterogeneous Debris	49000.00	9700.00	570.00	59270.00	70812.25	0.42			Heterogeneous Debris	2.77	20.13	3.76	2.28	0.51	0.50	1.39	0.75	12.63	4.76	8.30	4.14	4.34	4.10	0.68
Inorganic Non-Metal	11000.00	68.00	970.00	12038.00	14382.28	0.09			Inorganic Non-Metal	0.50	0.71	0.09	0.04	0.04	0.04	0.07	0.04	0.73	0.48	1.61	0.41	0.37	1.91	0.06
Lead/Cadmium Metal	140.00	32.00	81.00	253.00	302.27	0.00			Lead/Cadmium Metal	0.01	0.13	0.01	0.01	0.00	0.00	0.00	0.00	0.07	0.02	0.03	0.02	0.02	0.05	0.00
Salt	150.00	190.00	1500.00	1840.00	2198.32	0.01			Salt	0.02	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.04	0.09	0.17	0.03	0.03	0.00	0.01
Soil	300.00	6000.00	0.00	6300.00	7526.86	0.04			Soil	0.06	0.19	0.05	0.05	0.05	0.05	0.09	0.06	0.47	0.33	0.51	0.41	0.30	0.00	0.07
Solidified Inorganic Material	35000.00	730.00	3300.00	39030.00	46630.71	0.28			Solidified Inorganic Material	1.29	81.52	38.55	8.33	0.33	0.31	1.30	0.46	3.00	3.21	17.08	2.30	2.60	0.49	0.33
Solidified Organic Material	5200.00	380.00	0.00	5580.00	6666.65	0.04			Solidified Organic Material	2.51	629.34	4.98	196.00	1.48	2.09	2.20	2.13	20.34	3.58	40.89	4.04	2.35	7.74	2.90
Uncategorized Metal	2400.00	5100.00	360.00	7860.00	9390.66	0.06			Uncategorized Metal	0.49	1.16	0.17	0.10	0.04	0.04	0.17	0.07	0.76	0.42	0.62	0.42	0.57	0.25	0.04
Unknown																								
									TOTAL WEIGHTED CONCENTRATIONS (ppmv)															
										12.23	739.81	51.18	208.93	2.57	3.15	6.46	3.80	53.10	13.77	71.28	13.79	12.39	15.58	10.49

ORIGINAL NMVP AND PART B (cubic meters)										HYDROGEN	METHANE	BENZENE	BROMOFORM	CARBON TETRACHLORIDE	CHLORIDRENZENE	CHLOROFORM	CYCLOHEXANE	1,1-DICHLOROETHANE	1,2-DICHLOROETHANE	1,1-DICHLOROETHYLENE	CIS-1,2-DICHLOROETHYLENE	TRANS-1,2-DICHLOROETHYLENE	ETHYL BENZENE	ETHYL ETHER	METHYLENE CHLORIDE	1,1,2,2-TETRACHLOROETHANE	TETRACHLOROETHYLENE
Final Waste Forms	Stored volume	Projected volumes		Total Waste	Scaled Volumes	Weighting Factor			WEIGHTED CONCENTRATION FOR EACH WASTE FORM (ppmv)																		
Combustible	7100.00	27000.00		34100.00	62000.00	0.35			Combustible	119.78	14.08	1.51	0.40	15.63	0.71	3.77	10.46	12.75	1.00	7.23	1.42	1.67	2.82	1.17	162.66	0.59	2.51
Filter	430.00	1100.00		1530.00	2600.00	0.01			Filter	8.86	1.74	0.03	0.01	0.32	0.01	0.04	0.01	0.10	0.01	0.17	0.01	0.01	0.01	0.01	0.09	0.01	0.01
Graphite	670.00	43.00		713.00	760.00	0.00			Graphite	0.31	0.15	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Heterogeneous	30000.00	4600.00		34600.00	39000.00	0.22			Heterogeneous	122.60	18.93	0.49	0.25	1.86	0.32	0.48	1.29	1.13	0.36	0.91	0.31	0.32	0.39	0.35	4.91	0.35	0.48
Inorganic non-metal	1200.00	320.00		1520.00	1800.00	0.01			Inorganic non-metal	1.16	0.43	0.01	0.00	0.03	0.00	0.01	0.04	0.01	0.00	0.00	0.00	0.01	0.00	0.01	0.01	0.00	0.00
Lead/cadmium metal	56.00	130.00		186.00	310.00	0.00			Lead/cadmium metal	2.30	0.15	0.00	0.00	0.37	0.00	0.03	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00
Salt waste	33.00	60.00		93.00	150.00	0.00			Salt waste	0.38	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Soils	370.00	450.00		820.00	1300.00	0.01			Soils	0.80	0.77	0.01	0.01	0.06	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Solidified inorganics	17000.00	8000.00		25000.00	34000.00	0.19			Solidified inorganics	80.91	18.44	0.23	0.20	2.23	0.19	0.22	0.52	1.86	0.18	3.24	0.22	0.30	0.43	0.21	0.44	0.22	0.87
Solidified organics	1500.00	300.00		1800.00	2100.00	0.01			Solidified organics	3.09	0.66	0.81	0.27	279.45	0.48	4.32	1.73	0.92	0.78	1.58	0.81	0.81	0.51	1.06	1.05	0.47	0.74
Uncategorized metal	12000.00	8600.00		20600.00	30000.00	0.17			Uncategorized metal	30.85	10.34	0.30	0.11	1.16	0.11	0.20	0.13	0.36	0.11	0.28	0.12	0.15	0.20	0.13	0.39	0.13	0.13
Unknown	1700.00	0.00		1700.00	1700.00	0.01			Unknown																		
									TOTAL WEIGHTED CONCENTRATIONS (ppmv)																			
										371.02	65.74	3.39	1.26	301.11	1.83	9.09	14.21	17.18	2.46	13.58	2.90	3.28	4.38	2.96	169.59	1.79	4.77

ORIGINAL NMVP AND PART B (cubic meters)										TOLUENE	1,1,1-TRICHLOROETHANE	TRICHLOROETHYLENE	1,1,2-TRICHLORO-1,2,2-TRIFLUOROETHANE	1,2,4-TRIMETHYLBENZENE	1,3,5-TRIMETHYLBENZENE	M,P-XYLENE	O-XYLENE	ACETONE	BUTANOL	METHANOL	METHYL ETHYL KETONE	METHYL ISOBUTYL KETONE	METHYL CHLORIDE	CARBON DISULFIDE
Final Waste Forms	Stored volume	Projected volumes		Total Waste	Scaled Volumes	Weighting Factor			WEIGHTED CONCENTRATION FOR EACH WASTE FORM (ppmv)															
Combustible	7100.00	27000.00		34100.00	62000.00	0.35			Combustible	32.79	36.55	23.98	14.12	0.76	0.75	9.03	2.01	106.72	5.53	12.57	13.96	12.38	6.15	46.65
Filter	430.00	1100.00		1530.00	2600.00	0.01			Filter	0.10	1.74	0.31	0.21	0.01	0.01	0.02	0.01	0.47	0.13	0.37	0.13	0.13	0.18	0.02
Graphite	670.00	43.00		713.00	760.00	0.00			Graphite	0.01	0.14	0.04	0.00	0.00	0.00	0.00	0.00	0.06	0.01	0.04	0.01	0.01	0.25	0.00
Heterogeneous	30000.00	4600.00		34600.00	39000.00	0.22			Heterogeneous	1.47	10.65	1.99	1.21	0.27	0.27	0.73	0.40	6.68	2.52	4.39	2.19	2.30	2.17	0.36
Inorganic non-metal	1200.00	320.00		1520.00	1800.00	0.01			Inorganic non-metal	0.06	0.09	0.01	0.00	0.00	0.00	0.01	0.00	0.09	0.06	0.19	0.05	0.04	0.23	0.01
Lead/cadmium metal	56.00	130.00		186.00	310.00	0.00			Lead/cadmium metal	0.01	0.13	0.01	0.01	0.00	0.00	0.00	0.00	0.07	0.02	0.03	0.02	0.01	0.04	0.00
Salt waste	33.00	60.00		93.00	150.00	0.00			Salt waste	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00
Soils	370.00	450.00		820.00	1300.00	0.01			Soils	0.01	0.03	0.01	0.01	0.01	0.01	0.01	0.01	0.08	0.05	0.08	0.07	0.05	0.00	0.01
Solidified inorganics	17000.00	8000.00		25000.00	34000.00	0.19			Solidified inorganics	0.90	57.01	26.96	5.83	0.23	0.22	0.91	0.32	2.10	2.25	11.94	1.61	1.82	0.34	0.23
Solidified organics	1500.00	300.00		1800.00	2100.00	0.01			Solidified organics	0.77	193.04	1.53	60.12	0.45	0.64	0.67	0.65	6.24	1.10	12.54	1.24	0.72	2.37	0.89
Uncategorized metal	12000.00	8600.00		20600.00	30000.00	0.17			Uncategorized metal	1.49	3.53	0.52	0.29	0.12	0.12	0.52	0.23	2.31	1.28	1.90	1.27	1.74	0.75	0.11
Unknown	1700.00	0.00		1700.00	1700.00	0.01			Unknown															
									TOTAL WEIGHTED CONCENTRATIONS (ppmv)															
										37.61	302.91	55.35	81.79	1.86	2.02	11.91	3.63	124.81	12.95	44.07	20.54	19.20	12.48	48.28

REVISED FOR LWA LIMITS (cubic meters)										HYDROGEN	METHANE	BENZENE	BROMOFORM	CARBON TETRACHLORIDE	CHLORIDRENZENE	CHLOROFORM	CYCLOHEXANE	1,1-DICHLOROETHANE	1,2-DICHLOROETHANE	1,1-DICHLOROETHYLENE	CIS-1,2-DICHLOROETHYLENE	TRANS-1,2-DICHLOROETHYLENE	ETHYL BENZENE	ETHYL ETHER	METHYLENE CHLORIDE	1,1,2,2-TETRACHLOROETHANE	TETRACHLOROETHYLENE
Final Waste Forms	Stored volume	Projected volumes		Total Waste	Scaled Volumes	Weighting Factor			WEIGHTED CONCENTRATION FOR EACH WASTE FORM (ppmv)																		
Combustible	7100.00	27000.00		34100.00	46838.78	0.28			Combustible	94.33	11.09	1.19	0.32	12.31	0.56	2.97	8.24	10.04	0.79	5.70	1.12	1.32	2.22	0.93	128.10	0.47	1.98
Filter	430.00	1100.00		1530.00	2101.56	0.01			Filter	7.47	1.47	0.02	0.01	0.27	0.01	0.03	0.01	0.08	0.01	0.15	0.01	0.01	0.01	0.01	0.08	0.01	0.01
Graphite	670.00	43.00		713.00	979.36	0.01			Graphite	0.41	0.21	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.00	0.18	0.00	0.00	0.00	0.00	0.01	0.00	0.00
Heterogeneous	30000.00	4600.00		34600.00	47525.57	0.28			Heterogeneous	155.77	24.06	0.63	0.31	2.36	0.41	0.61	1.64	1.44	0.45	1.16	0.40	0.40	0.49	0.45	6.24	0.44	0.62
Inorganic non-metal	1200.00	320.00		1520.00	2087.83	0.01			Inorganic non-metal	1.41	0.53	0.01	0.01	0.03	0.01	0.02	0.05	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Lead/cadmium metal	56.00	130.00		186.00	255.48	0.00			Lead/cadmium metal	1.94	0.13	0.00	0.00	0.31	0.00	0.03	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00
Salt waste	33.00	60.00		93.00	127.74	0.00			Salt waste	0.33	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Soils	370.00	450.00		820.00	1126.33	0.01			Soils	0.72	0.70	0.01	0.01	0.06	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Solidified inorganics	17000.00	8000.00		25000.00	34339.28	0.20			Solidified inorganics	85.00	19.37	0.25	0.21	2.34	0.20	0.23	0.55	1.96	0.19	3.41	0.23	0.32	0.46	0.22	0.46	0.23	0.91
Solidified organics	1500.00	300.00		1800.00	2472.43	0.01			Solidified organics	3.78	0.80	0.99	0.34	341.71	0.59	5.28	2.12	1.12	0.96	1.93	0.99	0.99	0.63	1.30	1.29	0.58	0.91
Uncategorized metal	12000.00	8600.00		20600.00	28295.57	0.17			Uncategorized metal	30.30	10.16	0.29	0.11	1.14	0.11	0.20	0.13	0.35	0.11	0.28	0.12	0.15	0.20	0.13	0.38	0.13	0.13
Unknown	1700.00	0.00		1700.00	2335.07	0.01			Unknown																		
									TOTAL WEIGHTED CONCENTRATIONS (ppmv)																		
										381.46	68.54	3.38	1.31	360.56	1.88	9.38	12.75	15.06	2.53	12.81	2.88	3.21	4.02	3.05	136.59	1.88	4.57

REVISED FOR LWA LIMITS (cubic meters)										TOLUENE	1,1,1-TRICHLOROETHANE	TRICHLOROETHYLENE	1,1,2-TRICHLORO-1,2,2-TRIFLUOROETHANE	1,2,4-TRIMETHYLBENZENE	1,3,5-TRIMETHYLBENZENE	M,P-XYLENE	O-XYLENE	ACETONE	BUTANOL	METHANOL	METHYL ETHYL KETONE	METHYL ISOBUTYL KETONE	METHYL CHLORIDE	CARBON DISULFIDE
Final Waste Forms	Stored volume	Projected volumes		Total Waste	Scaled Volumes	Weighting Factor			WEIGHTED CONCENTRATION FOR EACH WASTE FORM (ppmv)															
Combustible	7100.00	27000.00		34100.00	46838.78	0.28			Combustible	25.82	28.79	18.88	11.12	0.60	0.59	7.11	1.58	84.05	4.36	9.90	10.99	9.75	4.84	36.74
Filter	430.00	1100.00		1530.00	2101.56	0.01			Filter	0.08	1.47	0.26	0.18	0.01	0.01	0.01	0.01	0.40	0.11	0.31	0.11	0.11	0.15	0.01
Graphite	670.00	43.00		713.00	979.36	0.01			Graphite	0.01	0.19	0.05	0.00	0.00	0.00	0.00	0.00	0.08	0.02	0.06	0.01	0.01	0.34	0.00
Heterogeneous	30000.00	4600.00		34600.00	47525.57	0.28			Heterogeneous	1.86	13.53	2.53	1.53	0.34	0.34	0.93	0.50	8.49	3.20	5.58	2.78	2.92	2.75	0.45
Inorganic non-metal	1200.00	320.00		1520.00	2087.83	0.01			Inorganic non-metal	0.07	0.10	0.01	0.01	0.01	0.01	0.01	0.01	0.11	0.07	0.23	0.06	0.05	0.28	0.01
Lead/cadmium metal	56.00	130.00		186.00	255.48	0.00			Lead/cadmium metal	0.01	0.11	0.01	0.01	0.00	0.00	0.00	0.00	0.06	0.02	0.02	0.01	0.01	0.04	0.00
Salt waste	33.00	60.00		93.00	127.74	0.00			Salt waste	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00
Soils	370.00	450.00		820.00	1126.33	0.01			Soils	0.01	0.03	0.01	0.01	0.01	0.01	0.01	0.01	0.07	0.05	0.08	0.06	0.04	0.00	0.01
Solidified inorganics	17000.00	8000.00		25000.00	34339.28	0.20			Solidified inorganics	0.95	59.89	28.32	6.12	0.24	0.23	0.95	0.34	2.20	2.36	12.55	1.69	1.91	0.36	0.24
Solidified organics	1500.00	300.00		1800.00	2472.43	0.01			Solidified organics	0.94	236.07	1.87	73.52	0.55	0.78	0.82	0.80	7.63	1.34	15.34	1.51	0.88	2.90	1.09
Uncategorized metal	12000.00	8600.00		20600.00	28295.57	0.17			Uncategorized metal	1.47	3.47	0.51	0.29	0.11	0.11	0.52	0.22	2.26	1.25	1.87	1.25	1.71	0.73	0.11
Unknown	1700.00	0.00		1700.00	2335.07	0.01			Unknown															
									TOTAL WEIGHTED CONCENTRATIONS (ppmv)															
										31.22	343.64	52.45	92.78	1.88	2.08	10.37	3.47	105.35	12.78	45.94	18.48	17.40	12.40	38.67

	MW	930 DRUMS	APP13	RECALC WITH HSG DATA APP13	LWA	CRA
Carbon tetrachloride	153.84	375.50	301.11		360.56	921.52
1,1,2,2-Tetrachloroethane	167.86	9.35	1.79		1.88	4.76
Chloroform	119.39	25.33	9.09		9.38	16.12
1,2-Dichloroethane	98.96	9.07	17.18		2.53	3.77
Methylene chloride	84.94	368.50	169.59		136.59	36.01
Benzene	78.11	9.25	3.39		3.38	4.32
Trichloroethylene	131.40	25.10	55.35		52.45	51.18
Bromoform	252.77	9.38	1.26		1.31	1.84
Tetrachloroethylene	165.85	9.40	4.77		4.57	5.07
Vinyl chloride	62.50	0.16				
1 , 1 ,2-Trichloroethane	133.42	0.07				
Chlorobenzene	112.56	12.52	1.83		1.88	2.67
1,1,1 -Trichloroethane	133.40	317.10	302.91		343.64	739.81
1 ,1-Dichloroethylene	96.95	11.46	13.58		12.81	12.91
Methyl ethyl ketone	72.10	63.66	20.54		18.48	13.79
Toluene	92.13	19.40	37.61		31.22	12.23
Carbon disulfide	76.14	0.13	48.28		38.67	10.49
Trichlorofluoromethane	137.38	0.07				
(cis)-1, 2-Dichloroethylene	96.95	8.97	2.90		2.88	3.87
Isobutanol	74.12	0.13				
1,1,2-TRICHLORO-1,2,2-TRIFLUOROETHANE		33.00				208.93
1,1-DICHLOROETHANE		10.20				9.89
1,2,4-TRIMETHYLBENZENE		12.20				2.57
1,3,5-TRIMETHYLBENZENE		8.60				3.15
BUTANOL		78.10				13.77
METHYL ISOBUTYL KETONE		79.00				12.39
ACETONE		79.80				53.10
CYCLOHEXANE		27.50				10.76
ETHYL BENZENE		11.60				3.57
ETHYL ETHER		13.30				4.76
METHANOL		213.00				71.28
O-XYLENE		16.00				3.80
M,P-XYLENE		19.30				6.46
METHYL CHLORIDE						15.58
CARBON DISULFIDE						10.49
TRANS-1,2-DICHLOROETHYLENE						4.07

FILTER DIFFUSION RATE The rate at which VOCs will be emitted from containers is a function of the diffusion rate for the individual filter on the containers. These filters are placed on every container to prevent the buildup of hydrogen as the result of radiolysis. Diffusion is relevant for open rooms only. Closed rooms are assumed to be in equilibrium with the average VOC concentration in the containers. Container filters are specified with a hydrogen diffusion rate. The methodology for calculating the VOC diffusion rate based on the hydrogen rate is given in Chapter 5 of the 1996 No-Migration Variance Petition (U. S. Department of Energy, 1996 b).

This sheet contains input values taken for the analytes of interest. (Rows 15 to 50) The headspace concentration value are the revised weighted average which is an update to the values in the Permit Application in 1995. The diffusivity numbers are copied from column H and were calculated using the following formula from the Permit Application. Critical values were taken from compound specific searches of the Internet.

$$\frac{D_{VOC-air}}{D_{H_2-air}} = \left(\frac{P_{c,VOC}}{P_{c,H_2}}\right)^{1/3} \times \left(\frac{T_{c,VOC}}{T_{c,H_2}}\right)^{-1/2} \times \left[\frac{\left(\frac{1}{MW_{air}} + \frac{1}{MW_{VOC}}\right)}{\left(\frac{1}{MW_{air}} + \frac{1}{MW_{H_2}}\right)}\right]^{1/2}$$

Compound	Mol Wt	Headspace Concentration (ppmv)	Diffusivity VOC-air (298.15 K, 1 atm)	Tc (K)	Pc (bar)	Pc (atm)	Diffusivity for specific compound (Use Permit Formula)
Hydrogen	2.02		0.758078	33.30	12.97	12.80	
Air	29.00			132.00	36.88	36.40	
Carbon Tetrachloride	153.82	921.5	0.078381	556.40	45.60	45.00	0.078381
Methylene Chloride	84.90	36.0	0.095732	510.00	60.80	60.00	0.095732
Chlorobenzene	112.56	2.7	0.075401	632.40	45.19	44.60	0.075401
Chloroform	119.39	16.1	0.086747	536.40	54.72	54.00	0.086747
1,1-Dichloroethylene	96.95	12.9	0.090757	495.00	51.98	51.30	0.090757
1,2-Dichloroethane	98.97	3.8	0.085942	561.50	53.70	53.00	0.085942
1.1.2.2-Tetrachloroethane	167.86	2.7	0.078545	644.50	58.36	57.60	0.078545
Toluene	92.13	12.2	0.077245	591.70	41.14	40.60	0.077245
1,1,1-Trichloroethane	133.42	739.8	0.078575	545.00	42.96	42.40	0.078575
Acetone	58.08	53.10	0.093721	508.00	48.00	47.37	0.093721
Benzene	78.11	4.30	0.084859	562.00	47.40	46.78	0.084859
Bromoform	252.73	1.8	0.066869	698.00	43.80	43.23	0.066869
Butanol	74.12	13.8	0.084007	562.00	45.00	44.41	0.084007
Carbon Disulfide	76.13	10.5	0.101875	552.00	79.00	77.97	0.101875
Cyclohexane	84.16	10.8	0.080441	554.00	40.70	40.17	0.080441
1,1-Dichloroethane	98.96	9.9	0.088633	502.70	49.90	49.25	0.088633
cis-1,2-Dichloroethylene	96.94	3.9	0.090883	545.00	60.30	59.51	0.090883
trans-1,2-Dichloroethylene	96.94	4.1	0.090883	545.00	60.30	59.51	0.090883
Ethyl Benzene	106.17	3.6	0.071910	616.00	37.00	36.52	0.071910
Ethyl Ether	74.12	4.8	0.085550	467.00	36.00	35.53	0.085550
Methanol	32.04	71.3	0.123861	513.00	78.50	77.47	0.123861
Methyl Chloride	50.49	15.6	0.103822	510.00	61.00	60.20	0.103822
Methyl Ethyl Ketone	72.11	13.8	0.085297	533.00	43.00	42.44	0.085297
Methyl Isobutyl Ketone	100.16	12.4	0.071618	571.00	32.00	31.58	0.071618
Tetrachloroethylene	165.83	5.1	0.095074	620.00	97.40	96.12	0.095074
Trichloroethylene	131.39	51.2	0.080663	573.00	49.90	49.25	0.080663
1,1,2-Trichloro-1,2,2-Trifluoroethane	102	208.9	0.087344	487.00	46.00	45.40	0.087344
1,2,4-Trimethlybenzene	120.2	2.6	0.066788	664.50	34.50	34.05	0.066788
1,3,5-Trimethylbenzene	120.2	3.2	0.066788	664.50	34.50	34.05	0.066788
m,p-Xylene	106.17	6.5	0.070533	617.00	35.00	34.54	0.070533
o-Xylene	106.17	3.8	0.070533	617.00	35.00	34.54	0.070533

INPUT PARAMETERS			VARIABLE
DRUMS PER ROOM	6050	DRUMS	nD
EFFECTIVE GAS GENERATION RATE	0.5	MOLES/DRUM/YEAR	GR
REPOSITORY VENTILATION RATE	425000	CUBIC FEET PER MINUTE	V_O
VENTILATION RATE AT VOC A	260000	CUBIC FEET PER MINUTE	V_{E-300}
PANEL VENTILATION RATE	130000	CUBIC FEET PER MINUTE	V_{PANEL}
PERMIT APPLICATION FILTER RATE	0.0000117	MOLE/S/MOLE FRACTION	D_{H2}
OPEN ROOMS IN A PANEL	1	ROOMS/PANEL	R_O
CLOSED ROOMS IN A PANEL	6	ROOMS/PANEL	R_C
CLOSED PANELS	9	PANELS	P_C
OPEN PANELS	1	PANELS	P_O
EXPOSURE FREQUENCY CARCINOGENS	8760	hours/year	EF_c
EXPOSURE FREQUENCY NON CARCINOGENS WORKER	1920	hours/year	EF_{nc}
EXPOSURE FREQUENCY NON CARCINOGENS PUBLIC	8760	hours/year	EF_{nc}
EXPOSURE DURATION CARCINOGENS	35	years	ED_c
EXPOSURE DURATION NON CARCINOGENS WORKER	10	years	ED_{nc}
EXPOSURE DURATION NON CARCINOGENS PUBLIC	35	years	ED_{nc}
AVERAGING TIME CARCINOGENS	613200	hours	AT_c
AVERAGING TIME NON CARCINOGENS WORKER	87600	hours	AT_{nc}
AVERAGING TIME NON CARCINOGENS PUBLIC	306600	hours	AT_{nc}

GAS GENERATION Appendix D11 of the 1996 Permit Application (U. S. Department of Energy, 1996 a) includes information on gas generation by WIPP waste. Of the gas-generating mechanisms described in Appendix D11, microbial degradation will contribute the most to the generation rate during the time periods of interest. The best estimate for gas generation from microbial degradation under humid conditions is 0.1 moles of gas per drum per year. Although Appendix D11 states that the maximum expected value for any one drum of waste is 0.4 moles per drum per year, the lowest expected value for any one drum is 0 moles per drum per year. A discussion of the relationship between gas generation, brine inflow, and creep closure can be found in Section I-1e(4). In reality, under the conditions that will initially exist in a closed panel, the predominant degradation mechanisms may consume gas at a rate faster than it is produced. This outcome is a function of the availability of nutrients to sustain microbial activities. Indications of gas consumption activities are in Francis and Gillow (Francis, A.J. and J.B. Gillow, 1994), where they reported 200-day experiments (see Appendix D11).

CREEP CLOSURE RATE The average creep closure rate will result in a reduction of the panel void volume of 812 m^3 per year for each panel. Calculations in Appendix D9 of the 1996 Permit Application (U. S. Department of Energy, 1996 a) convert this rate at which air is "squeezed" out of the room to an equivalent gas generation rate of 0.4 moles/drum/year.

EFFECTIVE GAS GENERATION RATE: The Effectve Gas Generation Rate is the Gas generation rate plus the Creep closure Rate converted to moles/drum/year.

These factor are as follows: For exposure to cancer causing compounds, the receptor is a member of the public. The exposure is 24 hours per day for 35 years. The exposure is averaged over 70 year lifetime. For exposure to non cancer causing compounds, the public receptor is exposed for 24 hours per day for 35 years and the exposure is averaged of the the duration of the exposure (35 years); for the worker inthe training building, the exposure is for 40 hours per week for 48 weeks per year for ten years and the exposure is averaged of the the duration of ten years.

THESE ARE THE FORMULAE USED IN THE CALCULATIONS. SEE THE NARRATIVE FOR FURTHER EXPLANATION.

HS_{VOC}

$$MF_{VOC} = (HS_{VOC}) \times (10^{-6} \text{ mole fraction/ppmv})$$

$$D_{VOC} = \left(\frac{D_{VOC-air}}{D_{H_2-air}}\right) \times D_{H_2}$$

$$ADE = D_{VOC} \times MF_{VOC} \times 31{,}536{,}000 \text{ s/year}$$

OPEN ROOM EMISSIONS The open room emission rate is dependent on the number of drums that have been emplaced in the room and the diffusion of VOCs across the drum vent filters. Assuming a continuous fresh air flow across the filters, VOCs will diffuse from the drums at a rate that is dependent on the concentration gradient across the filters and the diffusion properties of the VOCs. The open room emission rate is calculated using the equation below:

$$AORE_{VOC} = ADE_{VOC} \times nD$$

EMISSIONS FROM CLOSED ROOMS Using this effective gas generation rate for a room of containers that has the ventilation barrier in place, the closed room emission rate for each VOC is calculated as shown below:

$$ACRE_{VOC} = (GR) \times (11{,}571 \text{ drum/roompanel}) \times MF_{VOC}$$

EMISSIONS FROM OPEN PANELS The open panel emission rate for each VOC is based on the number of full rooms, the number of drums in the open room, and the emission rates from each type of room. This can be calculated as shown below:

$$AOPE_{VOC} = (R_o \times AORE_{VOC}) + (R_{cr} \times ACRE_{VOC})$$

EMISSIONS FROM CLOSED PANELS Volatile organic compounds will diffuse from the drums at a rate dependent on the concentration gradient across the filters. As the concentration gradient decreases, the diffusion rate of each VOC decreases. After a panel is closed, fresh air will no longer flow across the waste drums, and VOC concentrations in the air space above the filter will begin to build up and approach the concentrations in the drum headspace. Therefore, the concentration of VOCs that would be present in the panel atmosphere would be equivalent to the average drum headspace concentration. For a closed panel of N drums, the closed panel emission rate for each VOC is calculated as shown below:

$$ACPE = (GR) \times (81{,}000 \text{ drums/panel}) \times MF_{VOC}$$

The emission rate from the repository can then be calculated as the sum of the open panel and closed panel rates as folllows:

$$EC_{VOC} = P_O \times AORE_{VOC} + P_C \times ACPE_{VOC}$$

MW_{VOC}

$$ER_{VOC} = EC_{VOC} \times MW_{VOC}/(454 \times 2{,}000)$$

$$ER_{VOC} = ER_{VOC} \times 2{,}000/(365 \times 24)$$

This value (SXPE) is calculated by multiplying AOPE times the molecular weight times 1,000,000 micrograms per gram and dividing by the E-300 ventilation rate (260,000 scfm) times 525,600 minutes per year times 0.0283 cubic meters per cubic foot

This value (SCPE) is calculated by multiplying AOPE times the molecular weight times 1,000,000 micrograms per gram and dividing by the E-300 ventilation rate (260,000 scfm) times 525,600 minutes per year times 0.0283 cubic meters per cubic foot

This value is the concentration at VOC A and is SXPE plus 9 times SCPE

This value is the concentration at VOC A and is SXPE plus 9 times SCPE in ppbv

This is the concentration at VOC A for a full repository normalized to the ventilation rates assumed when the concentrations of concern were calculated (425,000 and 130,000).

SCENARIO: OBSERVED FILTER, WEIGHTED AVERAGE HEADSPACE CONCENTRATION EXCEPT FOR CARBON TETRACHLORIDE HAS MAXIMUM AVERAGE FOR ANY ROOM, ACTUAL AVERAGE NUMBER OF CONTAINERS

COMPOUND	AVERAGE CONCENTRATION (ppmv)	MOLE FRACTION	D_{VOC}[1] (mole/s/mole fraction/drum)	AVERAGE DRUM EMISSION RATE (mole/drum/year)	AVERAGE OPEN ROOM EMISSION RATE (mole/room/year)	AVERAGE CLOSED ROOM EMISSION RATE (mole/room/year)	AVERAGE OPEN PANEL EMISSION RATE (mole/panel/year)	AVERAGE CLOSED PANEL EMISSION RATE (mole/panel/year)	REPOSITORY EMISSION RATE (moles/year)	MOLECULAR WEIGHT (g/mole)	REPOSITORY EMISSION RATE (tons/year)	REPOSITORY EMISSION RATE (pounds/hour)	OPEN PANEL CONCENTRATION AT VOC A (ug/m^3)	SINGLE CLOSED PANEL CONCENTRATION AT VOC A (ug/m^3)	FULL REPOSITORY CONCENTRATION AT VOC A (ug/m^3)	FULL REPOSITORY CONCENTRATION AT VOC A (ppbv)	FULL REPOSITORY CONCENTRATION REALTIVE TO THE COMPLIANCE LIMIT (ppbv)
Carbon Tetrachloride	921.5	9.22E-04	1.29E-06	3.74E-02	226.47	2.79	243.20	19.51	4.19E+02	153.82	7.10E-02	1.62E-02	9.67	0.78	16.67	2.65	4.33
Methylene Chloride	36.0	3.60E-05	1.57E-06	1.79E-03	1.08E+01	1.09E-01	1.15E+01	7.63E-01	1.83E+01	84.94	1.72E-03	3.92E-04	0.25	0.02	0.40	0.12	0.38
Chlorobenzene	2.7	2.67E-06	1.24E-06	1.04E-04	6.31E-01	8.07E-03	6.79E-01	5.65E-02	1.19E+00	112.56	1.47E-04	3.36E-05	0.02	0.00	0.03	0.01	0.02
Chloroform	16.1	1.61E-05	1.43E-06	7.25E-04	4.38E+00	4.87E-02	4.68E+00	3.41E-01	7.75E+00	119.39	1.02E-03	2.33E-04	0.14	0.01	0.24	0.05	0.16
1,1-Dichloroethylene	12.9	1.29E-05	1.49E-06	6.07E-04	3.67E+00	3.90E-02	3.91E+00	2.73E-01	6.37E+00	96.95	6.80E-04	1.55E-04	0.10	0.01	0.16	0.04	0.13
1,2-Dichloroethane	3.8	3.77E-06	1.41E-06	1.68E-04	1.02E+00	1.14E-02	1.08E+00	7.99E-02	1.80E+00	98.97	1.97E-04	4.49E-05	0.03	0.00	0.05	0.01	0.04
1,1,2,2-Tetrachloroethane	2.7	2.75E-06	1.29E-06	1.12E-04	6.77E-01	8.31E-03	7.27E-01	5.82E-02	1.25E+00	167.86	2.31E-04	5.28E-05	0.03	0.00	0.05	0.01	0.03
Toluene	12.2	1.22E-05	1.27E-06	4.90E-04	2.96E+00	3.70E-02	3.18E+00	2.59E-01	5.51E+00	92.13	5.60E-04	1.28E-04	0.08	0.01	0.13	0.03	0.11
1,1,1-Trichloroethane	739.8	7.40E-04	1.29E-06	3.01E-02	1.82E+02	2.24E+00	1.96E+02	1.57E+01	3.37E+02	133.42	4.95E-02	1.13E-02	6.75	0.54	11.62	2.13	6.96
Acetone	53.1	5.31E-05	1.54E-06	2.58E-03	1.56E+01	1.61E-01	1.66E+01	1.12E+00	2.67E+01	58.08	1.71E-03	3.90E-04	0.25	0.02	0.40	0.17	0.55
Benzene	4.3	4.30E-06	1.39E-06	1.89E-04	1.14E+00	1.30E-02	1.22E+00	9.11E-02	2.04E+00	78.11	1.76E-04	4.01E-05	0.02	0.00	0.04	0.01	0.04
Bromoform	1.8	1.80E-06	1.10E-06	6.24E-05	3.77E-01	5.45E-03	4.10E-01	3.81E-02	7.53E-01	252.73	2.10E-04	4.79E-05	0.03	0.00	0.05	0.00	0.02
Butanol	13.8	1.38E-05	1.38E-06	6.01E-04	3.63E+00	4.17E-02	3.89E+00	2.92E-01	6.52E+00	74.12	5.32E-04	1.22E-04	0.07	0.01	0.12	0.04	0.13
Carbon Disulfide	10.5	1.05E+01	1.67E-06	5.54E-04	3.35E+00	3.18E-02	3.54E+00	3.81E-02	3.89E+00	76.13	3.26E-04	7.45E-05	0.07	0.00	0.08	0.02	0.08
Cyclohexane	10.8	1.08E-05	1.32E-06	4.50E-04	2.72E+00	3.27E-02	2.92E+00	2.29E-01	4.98E+00	84.16	4.62E-04	1.05E-04	0.06	0.00	0.11	0.03	0.10
1,1-Dichloroethane	9.9	9.90E-06	1.46E-06	4.55E-04	2.75E+00	2.99E-02	2.93E+00	2.10E-01	4.82E+00	98.96	5.26E-04	1.20E-04	0.07	0.01	0.12	0.03	0.10
cis-1,2-Dichloroethylene	3.9	3.90E-06	1.49E-06	1.84E-04	1.11E+00	1.18E-02	1.18E+00	8.26E-02	1.93E+00	96.94	2.06E-04	4.70E-05	0.03	0.00	0.05	0.01	0.04
trans-1,2-Dichloroethylene	4.1	4.10E-06	1.49E-06	1.93E-04	1.17E+00	1.24E-02	1.24E+00	8.68E-02	2.02E+00	96.94	2.16E-04	4.94E-05	0.03	0.00	0.05	0.01	0.04
Ethyl Benzene	3.6	3.60E-06	1.18E-06	1.34E-04	8.12E-01	1.09E-02	8.77E-01	7.62E-02	1.56E+00	106.17	1.83E-04	4.18E-05	0.02	0.00	0.04	0.01	0.03
Ethyl Ether	4.8	4.80E-06	1.41E-06	2.13E-04	1.29E+00	1.45E-02	1.37E+00	1.02E-01	2.29E+00	74.12	1.87E-04	4.27E-05	0.03	0.00	0.04	0.01	0.05
Methanol	71.3	7.13E-05	2.04E-06	4.58E-03	2.77E+01	2.16E-01	2.90E+01	1.51E+00	4.26E+01	32.04	1.50E-03	3.43E-04	0.24	0.01	0.35	0.27	0.88
Methyl Chloride	15.6	1.56E-05	1.71E-06	8.39E-04	5.08E+00	4.72E-02	5.36E+00	3.30E-01	8.33E+00	50.49	4.64E-04	1.06E-04	0.07	0.00	0.11	0.05	0.17
Methyl Ethyl Ketone	13.8	1.38E-05	1.40E-06	6.10E-04	3.69E+00	4.17E-02	3.94E+00	2.92E-01	6.57E+00	72.11	5.22E-04	1.19E-04	0.07	0.01	0.12	0.04	0.14
Methyl Isobutyl Ketone	12.4	1.24E-05	1.18E-06	4.60E-04	2.78E+00	3.75E-02	3.01E+00	2.63E-01	5.37E+00	100.16	5.93E-04	1.35E-04	0.08	0.01	0.14	0.03	0.11
Tetrachloroethylene	5.1	5.10E-06	1.56E-06	2.51E-04	1.52E+00	1.54E-02	1.61E+00	1.08E-01	2.58E+00	165.83	4.72E-04	1.08E-04	0.07	0.00	0.11	0.02	0.05
Trichloroethylene	51.2	5.12E-05	1.33E-06	2.14E-03	1.29E+01	1.55E-01	1.39E+01	1.08E+00	2.36E+01	131.39	3.42E-03	7.82E-04	0.47	0.04	0.80	0.15	0.49
1,1,2-Trichloro-1,2,2-Trifluoroethane	208.9	2.09E-04	1.44E-06	9.46E-03	5.72E+01	6.32E-01	6.10E+01	4.42E+00	1.01E+02	252.73	2.81E-02	6.41E-03	3.99	0.29	6.59	0.64	2.08
1,2,4-Trimethlybenzene	2.6	2.60E-06	1.10E-06	9.00E-05	5.44E-01	7.87E-03	5.92E-01	5.51E-02	1.09E+00	120.20	1.44E-04	3.29E-05	0.02	0.00	0.03	0.01	0.02
1,3,5-Trimethylbenzene	3.2	3.20E-06	1.10E-06	1.11E-04	6.70E-01	9.68E-03	7.28E-01	6.78E-02	1.34E+00	120.20	1.77E-04	4.05E-05	0.02	0.00	0.04	0.01	0.03
m,p-Xylene	6.5	6.50E-06	1.16E-06	2.38E-04	1.44E+00	1.97E-02	1.56E+00	1.38E-01	2.79E+00	106.17	3.27E-04	7.47E-05	0.04	0.00	0.08	0.02	0.06
o-Xylene	3.8	3.80E-06	1.16E-06	1.39E-04	8.40E-01	1.15E-02	9.09E-01	8.05E-02	1.63E+00	106.17	1.91E-04	4.36E-05	0.02	0.00	0.04	0.01	0.03
											1.66E-01	3.78E-02					

FILTER DIFFUSION RATE The rate at which VOCs will be emitted from containers is a function of the diffusion rate for the individual filter on the containers. These filters are placed on every container to prevent the buildup of hydrogen as the result of radiolysis. Diffusion is relevant for open rooms only. Closed rooms are assumed to be in equilibrium with the average VOC concentration in the containers. Container filters are specified with a hydrogen diffusion rate. The methodology for calculating the VOC diffusion rate based on the hydrogen rate is given in Chapter 5 of the 1996 No-Migration Variance Petition (U. S. Department of Energy, 1996 b).

Panel	Room	Inner Container Count	Outer Container Count	Outer Container Filter Count	Summation of Filter Diffusivity	Diffusivity/Filter	Diffusivity/Outer Container			
									0.078	0.758078
1	7	9,953	9,953	10,187	3.12E-02	3.06E-06	3.14E-06			
1	6	2,392	2,393	2,441	7.72E-03	3.16E-06	3.23E-06			
1	5	2,403	2,404	2,427	7.09E-03	2.92E-06	2.95E-06			
1	4	2,484	2,484	2,523	7.97E-03	3.16E-06	3.21E-06			
1	3	10,691	10,691	10,911	3.31E-02	3.03E-06	3.09E-06			
1	2	8,368	8,368	9,115	2.61E-02	2.86E-06	3.12E-06			
1	1	3,737	3,121	3,975	1.47E-02	3.70E-06	4.71E-06			
		40,028	39,414	41,579	1.28E-01	3.08E-06	3.24E-06	3.3544E-07		
2	7	7,111	5,158	7,455	2.85E-02	3.82E-06	5.53E-06			
2	6	6,807	4,393	6,981	3.05E-02	4.37E-06	6.94E-06			
2	5	6,965	4,219	7,115	3.18E-02	4.47E-06	7.55E-06			
2	4	6,432	4,173	6,762	3.45E-02	5.10E-06	8.26E-06			
2	3	6,610	5,061	7,102	3.26E-02	4.58E-06	6.43E-06			
2	2	6,727	4,981	6,967	3.93E-02	5.64E-06	7.88E-06			
2	1	2,179	1,785	2,214	3.18E-02	1.43E-05	1.78E-05			
		42,831	29,770	44,596	2.29E-01	5.13E-06	7.69E-06	7.9495E-07		
3	7	6,022	1,599	5,657	4.91E-02	8.67E-06	3.07E-05			
3	6	6,678	2,399	3,713	4.37E-02	1.18E-05	1.82E-05			
3	5	5,431	2,575	2,957	4.37E-02	1.48E-05	1.70E-05			
3	4	6,693	3,336	4,548	5.33E-02	1.17E-05	1.60E-05			
3	3	6,476	2,857	4,501	5.06E-02	1.12E-05	1.77E-05			
3	2	6,588	2,734	4,300	5.23E-02	1.22E-05	1.91E-05			
3	1	4,112	2,260	3,256	3.82E-02	1.17E-05	1.69E-05			
		42,000	17,760	28,932	3.31E-01	1.14E-05	1.86E-05	1.9261E-06		
4	7	6,063	2,890	4,574	5.09E-02	1.11E-05	1.76E-05			
4	6	6,073	3,604	4,802	6.40E-02	1.33E-05	1.78E-05			
4	5	6,621	4,137	5,728	7.21E-02	1.26E-05	1.74E-05			
4	4	5,870	3,945	4,928	7.61E-02	1.54E-05	1.93E-05			
4	3	5,673	4,264	4,784	8.16E-02	1.70E-05	1.91E-05			
4	2	5,535	4,687	5,236	8.93E-02	1.71E-05	1.91E-05			
4	1	3,545	3,035	3,280	5.72E-02	1.74E-05	1.89E-05			
		39,380	26,562	33,332	4.91E-01	1.47E-05	1.85E-05	1.9121E-06		
5	7	6,512	5,576	6,169	1.07E-01	1.74E-05	1.92E-05			
5	6	6,568	5,945	6,442	1.19E-01	1.85E-05	2.00E-05			
5	5	6,332	5,442	6,023	1.03E-01	1.71E-05	1.89E-05			
5	4	6,524	3,972	4,423	6.85E-02	1.55E-05	1.73E-05			
5	3	7,223	4,331	5,120	8.31E-02	1.62E-05	1.92E-05			
5	2	7,088	5,195	6,370	1.05E-01	1.66E-05	2.03E-05			
5	1	5,007	3,997	4,449	7.81E-02	1.76E-05	1.96E-05			
		45,254	34,458	38,996	6.65E-01	1.70E-05	1.93E-05	1.994E-06		
			147964	187435	1.8433428	9.83457E-06	1.2458E-05	1.2881E-06		

Filters per container 1.26676083

NUMBER OF CONTAINERS The original assumption was that each Panel would contain 81,000 containers. This number is important because emissions are related to the filter diffusivity associated with each container; therefore the number of filters emitting VOCs to a room that is being filled is part of the calculation of releases. Closed rooms are unventilated and are conservatively assumed to be at the average concentration of the containers that were disposed and emissions are only related to the gas generation rate and creep closure rate (i.e., equivalent gas generation rate). The following is a compilation of the number of containers disposed by Panel, inlcuding Room 7 of Panel 6. A room is considered to have 567 linear feet of disposal space. Since Room 1 only has 367 feet (i.e., no waste is placed in the intake or exhaust drifts, a full panel is considered to have 6.7 Rooms

WIPP DISPOSAL VOLUMES (cubic meters)
(as of January 14, 2012)

Container Type	Panel 1	Panel 2	Panel 3	Panel 4	Panel 5	Panel 6	Panel 7	Panel 8	Panel 9	Panel 10	Totals
55-gal. Drums	38,139	23,865	8,394	12,858	21,255	6,339					110,850
Volume	8,009.19	5,011.65	1,762.74	2,700.18	4,463.55	1,331.19					23,278.50
SWB	1,239	3,176	1,730	1,405	2,200	741					10,491
Volume	2,329.32	5,970.88	3,252.40	2,641.40	4,136.00	1,393.08					19,723.08
TDOPS	35	1,451	2,227	1,048	788	131					5,680
Volume	157.50	6,529.50	10,021.50	4,716.00	3,546.00	589.50					25,560.00
85-gal drums	2	0	0	3	0	0					5
Volume	0.64	0.00	0.00	0.96	0.00	0.00					1.60
100-gal. Drums	0	1,278	5,409	11,050	9,951	1,218					28,906
Volume	0.00	485.64	2,055.42	4,199.00	3,781.38	462.84					10,984.28
SLB2s	0	0	0	0	0	5					5
Volume	0.00	0.00	0.00	0.00	0.00	36.95					36.95

	Panel 1	Panel 2	Panel 3	Panel 4	Panel 5	Panel 6	Container Total	55-gallon Eq
55-Gallon Drum	38,139	23,865	8,394	12,858	21,255	6,339	110,850	110,850
Standard Waste Boxes	1,239	3,176	1,730	1,405	2,200	741	10,491	41,964
10-Drum Overpack	35	1,451	2,227	1,048	788	131	5,680	56,800
85-Gallon Drum	2	0	0	3	0	0	5	9
100-Gallon Drum	0	1,278	5,409	11,050	9,951	1,218	28,906	67,447
Standard Large Box 2	0	0	0	0	0	5	5	100
Panel Total	39,415	29,770	17,760	26,364	34,194	5,376	152,879	277,170
Rooms per Panel	4.8	6.5	6.6	6.6	6.6	1.0	32.0	32
Containers per Room	8211	4580	2691	3995	5181	5376	4777	8635
Filters per rRoom	10402	5802	3409	5060	6563	6810	6052	

VOC	Mol Wt (g/mole)	Drum Headspace Concentration (ppmv)	Drum Headspace Concentration (mole fraction)	Diffusivity VOC-air (298.15 K, 1 atm Slattery & Bird)	Diffusivity H2-air (298.15 K, 1 atm Slattery & Bird)	Filter Model on Container	Filter Diffusivity for Hydrogen	VOC Filter Diffusivity Coefficient (mole/sec/mf)	VOC Emission Rate per Drum (mole/sec)	Drums per Room	VOC Emission Rate per Room (mole/sec)	Open Room Emission (mole/room/year)	Effective Gas Generation Rate (mole/drum/year)	Closed Room Emission (mole/room/year)	Open Panel Emission (mole/panel/year)	VOC Emission Rate per Open Panel (g/panel/year)	VOC Emission Rate per Open Panel (tons/panel/year)	Closed Panel Emission Rate (moles/panel/year)	Closed Panel Emission Rate (tons/panel/year)	Maximum Repository Emission Rate (tons/year)
			BASE CASE--WEIGHTED AVERAGE HEADSPACE CONCENTRATION																	
Carbon Tetrachloride	153.82	921.5209517	0.00092	0.07838	0.75808	1/2 X	1.90E-06	1.96E-07	1.81E-10	6,050	1.095E-06	3.454E+01	0.5	2.79E+00	5.127E+01	7886	0.009	19.513	##################	3.84E-02
Carbon Tetrachloride	153.82	921.5209517	0.00092	0.07838	0.75808	1 X	3.70E-06	3.83E-07	3.53E-10	6,050	2.133E-06	6.726E+01	0.5	2.79E+00	8.399E+01	12919	0.014	19.513	##################	4.40E-02
Carbon Tetrachloride	153.82	921.5209517	0.00092	0.07838	0.75808	2X	7.40E-06	7.65E-07	7.05E-10	6,050	4.266E-06	1.345E+02	0.5	2.79E+00	1.512E+02	23265	0.026	19.513	##################	5.54E-02
Carbon Tetrachloride	153.82	921.5209517	0.00092	0.07838	0.75808	5X	1.85E-05	1.91E-06	1.76E-09	6,050	1.066E-05	3.363E+02	0.5	2.79E+00	3.530E+02	54304	0.060	19.513	##################	8.96E-02
Carbon Tetrachloride	153.82	375.5	0.00038	0.07838	0.75808	APPLICATION	1.17E-05	1.21E-06	4.54E-10	6,050	2.748E-06	8.667E+01	0.5	1.14E+00	9.348E+01	14380	0.016	7.951	##################	2.80E-02
Carbon Tetrachloride	153.82	921.52	0.00092	0.07838	0.75808	N/A	1.2458E-05	1.29E-06	1.19E-09	6,050	7.181E-06	2.265E+02	0.5	2.79E+00	2.432E+02	37409	0.041	19.513	##################	7.09E-02
Methylene Chloride	84.90	36.01012462	0.00004	0.09573	0.75808	1/2 X	1.90E-06	2.40E-07	8.64E-12	6,050	5.227E-08	1.648E+00	0.5	1.09E-01	2.302E+00	195	0.000	0.763	##################	8.57E-04
Methylene Chloride	84.90	36.01012462	0.00004	0.09573	0.75808	1 X	3.70E-06	4.67E-07	1.68E-11	6,050	1.018E-07	3.210E+00	0.5	1.09E-01	3.864E+00	328	0.000	0.763	##################	1.00E-03
Methylene Chloride	84.90	36.01012462	0.00004	0.09573	0.75808	2X	7.40E-06	9.34E-07	3.37E-11	6,050	2.036E-07	6.420E+00	0.5	1.09E-01	7.074E+00	601	0.001	0.763	##################	1.30E-03
Methylene Chloride	84.90	36.01012462	0.00004	0.09573	0.75808	5X	1.85E-05	2.34E-06	8.41E-11	6,050	5.090E-07	1.605E+01	0.5	1.09E-01	1.670E+01	1418	0.002	0.763	##################	2.20E-03
Methylene Chloride	84.90	369	0.00037	0.09573	0.75808	APPLICATION	1.17E-05	1.48E-06	5.45E-10	6,050	3.298E-06	1.040E+02	0.5	1.12E+00	1.107E+02	9400	0.010	7.814	##################	1.69E-02
Methylene Chloride	84.90	36.01012462	0.00004	0.09573	0.75808	N/A	1.2458E-05	1.57E-06	5.67E-11	6,050	3.427E-07	1.081E+01	0.5	1.09E-01	1.146E+01	973	0.001	0.763	##################	1.71E-03
Chlorobenzene	112.56	2.667728853	0.00000	0.07540	0.75808	1/2 X	1.90E-06	1.89E-07	5.04E-13	6,050	3.050E-09	9.619E-02	0.5	8.07E-03	1.446E-01	16	0.000	0.056	##################	0.0
Chlorobenzene	112.56	2.667728853	0.00000	0.07540	0.75808	1 X	3.70E-06	3.68E-07	9.82E-13	6,050	5.940E-09	1.873E-01	0.5	8.07E-03	2.357E-01	27	0.000	0.056	##################	0.0
Chlorobenzene	112.56	2.667728853	0.00000	0.07540	0.75808	2X	7.40E-06	7.36E-07	1.96E-12	6,050	1.188E-08	3.746E-01	0.5	8.07E-03	4.230E-01	48	0.000	0.056	##################	0.0
Chlorobenzene	112.56	2.667728853	0.00000	0.07540	0.75808	5X	1.85E-05	1.84E-06	4.91E-12	6,050	2.970E-08	9.366E-01	0.5	8.07E-03	9.850E-01	111	0.000	0.056	##################	0.0
Chlorobenzene	112.56	12.5	0.00001	0.07540	0.75808	APPLICATION	1.17E-05	1.16E-06	1.45E-11	6,050	8.801E-08	2.775E+00	0.5	3.78E-02	3.002E+00	338	0.000	0.265	##################	0.0
Chlorobenzene	112.56	2.667728853	0.00000	0.07540	0.75808	N/A	1.2458E-05	1.24E-06	3.31E-12	6,050	2.000E-08	6.307E-01	0.5	8.07E-03	6.791E-01	76	0.000	0.056	##################	1.47E-04
Chloroform	119.39	16.11566606	0.00002	0.08675	0.75808	1/2 X	1.90E-06	2.17E-07	3.50E-12	6,050	2.120E-08	6.685E-01	0.5	4.87E-02	9.610E-01	115	0.000	0.341	##################	0.0
Chloroform	119.39	16.11566606	0.00002	0.08675	0.75808	1 X	3.70E-06	4.23E-07	6.82E-12	6,050	4.128E-08	1.302E+00	0.5	4.87E-02	1.594E+00	190	0.000	0.341	##################	0.0
Chloroform	119.39	16.11566606	0.00002	0.08675	0.75808	2X	7.40E-06	8.47E-07	1.36E-11	6,050	8.256E-08	2.604E+00	0.5	4.87E-02	2.896E+00	346	0.000	0.341	##################	0.0
Chloroform	119.39	16.11566606	0.00002	0.08675	0.75808	5X	1.85E-05	2.12E-06	3.41E-11	6,050	2.064E-07	6.509E+00	0.5	4.87E-02	6.802E+00	812	0.001	0.341	##################	0.0
Chloroform	119.39	25.3	0.00003	0.08675	0.75808	APPLICATION	1.17E-05	1.34E-06	3.39E-11	6,050	2.049E-07	6.463E+00	0.5	7.65E-02	6.922E+00	826	0.001	0.536	##################	0.0
Chloroform	119.39	16.11566606	0.00002	0.08675	0.75808	N/A	1.2458E-05	1.43E-06	2.30E-11	6,050	1.390E-07	4.383E+00	0.5	4.87E-02	4.676E+00	558	0.001	0.341	##################	1.02E-03
1,1-Dichloroethylene	96.95	12.90707145	0.00001	0.09076	0.75808	1/2 X	1.90E-06	2.27E-07	2.94E-12	6,050	1.776E-08	5.602E-01	0.5	3.90E-02	7.944E-01	77	0.000	0.273	##################	0.0
1,1-Dichloroethylene	96.95	12.90707145	0.00001	0.09076	0.75808	1 X	3.70E-06	4.43E-07	5.72E-12	6,050	3.459E-08	1.091E+00	0.5	3.90E-02	1.325E+00	128	0.000	0.273	##################	0.0
1,1-Dichloroethylene	96.95	12.90707145	0.00001	0.09076	0.75808	2X	7.40E-06	8.86E-07	1.14E-11	6,050	6.918E-08	2.182E+00	0.5	3.90E-02	2.416E+00	234	0.000	0.273	##################	0.0
1,1-Dichloroethylene	96.95	12.90707145	0.00001	0.09076	0.75808	5X	1.85E-05	2.21E-06	2.86E-11	6,050	1.730E-07	5.454E+00	0.5	3.90E-02	5.688E+00	551	0.001	0.273	##################	0.0
1,1-Dichloroethylene	96.95	11.5	0.00001	0.09076	0.75808	APPLICATION	1.17E-05	1.40E-06	1.61E-11	6,050	9.746E-08	3.073E+00	0.5	3.48E-02	3.282E+00	318	0.000	0.244	##################	0.0
1,1-Dichloroethylene	96.95	12.90707145	0.00001	0.09076	0.75808	N/A	1.2458E-05	1.49E-06	1.93E-11	6,050	1.165E-07	3.673E+00	0.5	3.90E-02	3.907E+00	379	0.000	0.273	##################	6.80E-04
1,2-Dichloroethane	98.97	3.771454853	0.00000	0.08594	0.75808	1/2 X	1.90E-06	2.15E-07	8.12E-13	6,050	4.915E-09	1.550E-01	0.5	1.14E-02	2.234E-01	22	0.000	0.080	##################	0.0
1,2-Dichloroethane	98.97	3.771454853	0.00000	0.08594	0.75808	1 X	3.70E-06	4.19E-07	1.58E-12	6,050	9.571E-09	3.018E-01	0.5	1.14E-02	3.703E-01	37	0.000	0.080	##################	0.0
1,2-Dichloroethane	98.97	3.771454853	0.00000	0.08594	0.75808	2X	7.40E-06	8.39E-07	3.16E-12	6,050	1.914E-08	6.037E-01	0.5	1.14E-02	6.721E-01	67	0.000	0.080	##################	0.0
1,2-Dichloroethane	98.97	3.771454853	0.00000	0.08594	0.75808	5X	1.85E-05	2.10E-06	7.91E-12	6,050	4.785E-08	1.509E+00	0.5	1.14E-02	1.578E+00	156	0.000	0.080	##################	0.0
1,2-Dichloroethane	98.97	9.1	0.00001	0.08594	0.75808	APPLICATION	1.17E-05	1.33E-06	1.21E-11	6,050	7.303E-08	2.303E+00	0.5	2.75E-02	2.468E+00	244	0.000	0.193	##################	0.0
1,2-Dichloroethane	98.97	3.771454853	0.00000	0.08594	0.75808	N/A	1.2458E-05	1.41E-06	5.33E-12	6,050	3.223E-08	1.016E+00	0.5	1.14E-02	1.085E+00	107	0.000	0.080	##################	1.97E-04
1,1,2,2-Tetrachloroethane	167.86	2.748672093	0.00000	0.07855	0.75808	1/2 X	1.90E-06	1.97E-07	5.41E-13	6,050	3.274E-09	1.032E-01	0.5	8.31E-03	1.531E-01	26	0.000	0.058	##################	0.0
1,1,2,2-Tetrachloroethane	167.86	2.748672093	0.00000	0.07855	0.75808	1 X	3.70E-06	3.83E-07	1.05E-12	6,050	6.375E-09	2.010E-01	0.5	8.31E-03	2.509E-01	42	0.000	0.058	##################	0.0
1,1,2,2-Tetrachloroethane	167.86	2.748672093	0.00000	0.07855	0.75808	2X	7.40E-06	7.67E-07	2.11E-12	6,050	1.275E-08	4.021E-01	0.5	8.31E-03	4.520E-01	76	0.000	0.058	##################	0.0
1,1,2,2-Tetrachloroethane	167.86	2.748672093	0.00000	0.07855	0.75808	5X	1.85E-05	1.92E-06	5.27E-12	6,050	3.188E-08	1.005E+00	0.5	8.31E-03	1.055E+00	177	0.000	0.058	##################	0.0
1,1,2,2-Tetrachloroethane	167.86	9.4	0.00001	0.07855	0.75808	APPLICATION	1.17E-05	1.21E-06	1.14E-11	6,050	6.894E-08	2.174E+00	0.5	2.84E-02	2.345E+00	394	0.000	0.199	##################	0.0
1,1,2,2-Tetrachloroethane	167.86	2.748672093	0.00000	0.07855	0.75808	N/A	1.2458E-05	1.29E-06	3.55E-12	6,050	2.147E-08	6.769E-01	0.5	8.31E-03	7.268E-01	122	0.000	0.058	##################	2.31E-04
Toluene	92.13	12.23011667	0.00001	0.07724	0.75808	1/2 X	1.90E-06	1.94E-07	2.37E-12	6,050	1.432E-08	4.518E-01	0.5	3.70E-02	6.737E-01	62	0.000	0.259	##################	0.0
Toluene	92.13	12.23011667	0.00001	0.07724	0.75808	1 X	3.70E-06	3.77E-07	4.61E-12	6,050	2.790E-08	8.797E-01	0.5	3.70E-02	1.102E+00	102	0.000	0.259	##################	0.0
Toluene	92.13	12.23011667	0.00001	0.07724	0.75808	2X	7.40E-06	7.54E-07	9.22E-12	6,050	5.579E-08	1.759E+00	0.5	3.70E-02	1.981E+00	183	0.000	0.259	##################	0.0
Toluene	92.13	12.23011667	0.00001	0.07724	0.75808	5X	1.85E-05	1.89E-06	2.31E-11	6,050	1.395E-07	4.399E+00	0.5	3.70E-02	4.621E+00	426	0.000	0.259	##################	0.0
Toluene	92.13	19.4	0.00002	0.07724	0.75808	APPLICATION	1.17E-05	1.19E-06	2.31E-11	6,050	1.399E-07	4.413E+00	0.5	5.87E-02	4.765E+00	439	0.000	0.411	##################	0.0
Toluene	92.13	12.23011667	0.00001	0.07724	0.75808	N/A	1.2458E-05	1.27E-06	1.55E-11	6,050	9.393E-08	2.962E+00	0.5	3.70E-02	3.184E+00	293	0.000	0.259	##################	5.60E-04
1,1,1-Trichloroethane	133.42	739.815	0.00074	0.07858	0.75808	1/2 X	1.90E-06	1.97E-07	1.46E-10	6,050	8.815E-07	2.780E+01	0.5	2.24E+00	4.123E+01	5500	0.006	15.666	##################	0.0
1,1,1-Trichloroethane	133.42	739.815	0.00074	0.07858	0.75808	1 X	3.70E-06	3.84E-07	2.84E-10	6,050	1.717E-06	5.413E+01	0.5	2.24E+00	6.756E+01	9014	0.010	15.666	##################	0.0
1,1,1-Trichloroethane	133.42	739.815	0.00074	0.07858	0.75808	2X	7.40E-06	7.67E-07	5.67E-10	6,050	3.433E-06	1.083E+02	0.5	2.24E+00	1.217E+02	16236	0.018	15.666	##################	0.0
1,1,1-Trichloroethane	133.42	739.815	0.00074	0.07858	0.75808	5X	1.85E-05	1.92E-06	1.42E-09	6,050	8.583E-06	2.707E+02	0.5	2.24E+00	2.841E+02	37903	0.042	15.666	##################	0.1
1,1,1-Trichloroethane	133.42	317	0.00032	0.07858	0.75808	APPLICATION	1.17E-05	1.21E-06	3.84E-10	6,050	2.326E-06	7.335E+01	0.5	9.59E-01	7.910E+01	10553	0.012	6.712	##################	0.0
1,1,1-Trichloroethane	133.42	739.815	0.00074	0.07858	0.75808	N/A	1.2458E-05	1.29E-06	9.55E-10	6,050	5.780E-06	1.823E+02	0.5	2.24E+00	1.957E+02	26109	0.029	15.666	##################	4.95E-02
Acetone	58.08	53.1	0.00005	0.09372	0.75808	1/2 X	1.90E-06	2.35E-07	1.25E-11	6,050	7.546E-08	2.380E+00	0.5	1.61E-01	3.344E+00	194	0.000	1.124	##################	0.0
Acetone	58.08	53.1	0.00005	0.09372	0.75808	1 X	3.70E-06	4.57E-07	2.43E-11	6,050	1.470E-07	4.634E+00	0.5	1.61E-01	5.598E+00	325	0.000	1.124	##################	0.0
Acetone	58.08	53.1	0.00005	0.09372	0.75808	2X	7.40E-06	9.15E-07	4.86E-11	6,050	2.939E-07	9.269E+00	0.5	1.61E-01	1.023E+01	594	0.001	1.124	##################	0.0
Acetone	58.08	53.1	0.00005	0.09372	0.75808	5X	1.85E-05	2.29E-06	1.21E-10	6,050	7.348E-07	2.317E+01	0.5	1.61E-01	2.414E+01	1402	0.002	1.124	##################	0.0

VOC	Mol Wt (g/mole)	Drum Headspace Concentration (ppmv)	Drum Headspace Concentration (mole fraction)	Diffusivity VOC-air (298.15 K, 1 atm Slattery & Bird)	Diffusivity H2-air (298.15 K, 1 atm Slattery & Bird)	Filter Model on Container	Filter Diffusivity for Hydrogen	VOC Filter Diffusivity Coefficient (mole/sec/mf)	VOC Emission Rate per Drum (mole/sec)	Drums per Room	VOC Emission Rate per Room (mole/sec)	Open Room Emission (mole/room/year)	Effective Gas Generation Rate (mole/drum/year)	Closed Room Emission (mole/room/year)	Open Panel Emission (mole/panel/year)	VOC Emission Rate per Open Panel (g/panel/year)	VOC Emission Rate per Open Panel (tons/panel/year)	Closed Panel Emission Rate (moles/panel/year)	Closed Panel Emission Rate (tons/panel/year)	Maximum Repository Emission Rate (tons/year)
Acetone	58.08	79.8	0.00008	0.09372	0.75808	APPLICATION	1.17E-05	1.45E-06	1.15E-10	6,050	6.983E-07	2.202E+01	0.5	2.41E-01	2.347E+01	1363	0.002	1.690	##################	0.0
Acetone	58.08	53.1	0.00005	0.09372	0.75808	N/A	1.2458E-05	1.54E-06	8.18E-11	6,050	4.948E-07	1.560E+01	0.5	1.61E-01	1.657E+01	962	0.001	1.124	##################	1.71E-03
Benzene	78.11	4.30	0.00000	0.08486	0.75808	1/2 X	1.90E-06	2.13E-07	9.15E-13	6,050	5.533E-09	1.745E-01	0.5	1.30E-02	2.525E-01	20	0.000	0.091	##################	0.0
Benzene	78.11	4.3	0.00000	0.08486	0.75808	1 X	3.70E-06	4.14E-07	1.78E-12	6,050	1.077E-08	3.398E-01	0.5	1.30E-02	4.178E-01	33	0.000	0.091	##################	0.0
Benzene	78.11	4.3	0.00000	0.08486	0.75808	2X	7.40E-06	8.28E-07	3.56E-12	6,050	2.155E-08	6.796E-01	0.5	1.30E-02	7.576E-01	59	0.000	0.091	##################	0.0
Benzene	78.11	4.3	0.00000	0.08486	0.75808	5X	1.85E-05	2.07E-06	8.90E-12	6,050	5.387E-08	1.699E+00	0.5	1.30E-02	1.777E+00	139	0.000	0.091	##################	0.0
Benzene	78.11	9.3	0.00001	0.08486	0.75808	APPLICATION	1.17E-05	1.31E-06	1.22E-11	6,050	7.369E-08	2.324E+00	0.5	2.81E-02	2.493E+00	195	0.000	0.197	##################	0.0
Benzene	78.11	4.3	0.00000	0.08486	0.75808	N/A	1.2458E-05	1.39E-06	6.00E-12	6,050	3.628E-08	1.144E+00	0.5	1.30E-02	1.222E+00	95	0.000	0.091	##################	1.76E-04
Bromoform	252.73	1.8	0.00000	0.06687	0.75808	1/2 X	1.90E-06	1.68E-07	3.02E-13	6,050	1.825E-09	5.756E-02	0.5	5.45E-03	9.023E-02	23	0.000	0.038	##################	0.0
Bromoform	252.73	1.8	0.00000	0.06687	0.75808	1 X	3.70E-06	3.26E-07	5.87E-13	6,050	3.554E-09	1.121E-01	0.5	5.45E-03	1.448E-01	37	0.000	0.038	##################	0.0
Bromoform	252.73	1.8	0.00000	0.06687	0.75808	2X	7.40E-06	6.53E-07	1.17E-12	6,050	7.108E-09	2.242E-01	0.5	5.45E-03	2.568E-01	65	0.000	0.038	##################	0.0
Bromoform	252.73	1.8	0.00000	0.06687	0.75808	5X	1.85E-05	1.63E-06	2.94E-12	6,050	1.777E-08	5.604E-01	0.5	5.45E-03	5.931E-01	150	0.000	0.038	##################	0.0
Bromoform	252.73	9.4	0.00001	0.06687	0.75808	APPLICATION	1.17E-05	1.03E-06	9.70E-12	6,050	5.869E-08	1.851E+00	0.5	2.84E-02	2.022E+00	511	0.001	0.199	##################	0.0
Bromoform	252.73	1.8	0.00000	0.06687	0.75808	N/A	1.2458E-05	1.10E-06	1.98E-12	6,050	1.197E-08	3.774E-01	0.5	5.45E-03	4.101E-01	104	0.000	0.038	##################	2.10E-04
Butanol	74.12	13.8	0.00001	0.08401	0.75808	1/2 X	1.90E-06	2.11E-07	2.91E-12	6,050	1.758E-08	5.544E-01	0.5	4.17E-02	8.048E-01	60	0.000	0.292	##################	0.0
Butanol	74.12	13.8	0.00001	0.08401	0.75808	1 X	3.70E-06	4.10E-07	5.66E-12	6,050	3.423E-08	1.080E+00	0.5	4.17E-02	1.330E+00	99	0.000	0.292	##################	0.0
Butanol	74.12	13.8	0.00001	0.08401	0.75808	2X	7.40E-06	8.20E-07	1.13E-11	6,050	6.846E-08	2.159E+00	0.5	4.17E-02	2.410E+00	179	0.000	0.292	##################	0.0
Butanol	74.12	13.8	0.00001	0.08401	0.75808	5X	1.85E-05	2.05E-06	2.83E-11	6,050	1.712E-07	5.398E+00	0.5	4.17E-02	5.648E+00	419	0.000	0.292	##################	0.0
Butanol	74.12	78.1	0.00008	0.08401	0.75808	APPLICATION	1.17E-05	1.30E-06	1.01E-10	6,050	6.126E-07	1.932E+01	0.5	2.36E-01	2.074E+01	1537	0.002	1.654	##################	0.0
Butanol	74.12	13.8	0.00001	0.08401	0.75808	N/A	1.2458E-05	1.38E-06	1.91E-11	6,050	1.153E-07	3.635E+00	0.5	4.17E-02	3.885E+00	288	0.000	0.292	##################	5.32E-04
Carbon Disulfide	76.13	10.5	0.00001	0.10187	0.75808	1/2 X	1.90E-06	2.55E-07	2.68E-12	6,050	1.622E-08	5.115E-01	0.5	3.18E-02	7.021E-01	53	0.000	0.222	##################	0.0
Carbon Disulfide	76.13	10.5	0.00001	0.10187	0.75808	1 X	3.70E-06	4.97E-07	5.22E-12	6,050	3.159E-08	9.961E-01	0.5	3.18E-02	1.187E+00	90	0.000	0.222	##################	0.0
Carbon Disulfide	76.13	10.5	0.00001	0.10187	0.75808	2X	7.40E-06	9.94E-07	1.04E-11	6,050	6.317E-08	1.992E+00	0.5	3.18E-02	2.183E+00	166	0.000	0.222	##################	0.0
Carbon Disulfide	76.13	10.5	0.00001	0.10187	0.75808	5X	1.85E-05	2.49E-06	2.61E-11	6,050	1.579E-07	4.981E+00	0.5	3.18E-02	5.171E+00	394	0.000	0.222	##################	0.0
Carbon Disulfide	76.13	0	0.00000	0.10187	0.75808	APPLICATION	1.17E-05	1.57E-06	0.00E+00	6,050	0.000E+00	0.000E+00	0.5	0.00E+00	0.000E+00	0	0.000	0.000	##################	0.0
Carbon Disulfide	76.13	10.5	0.00001	0.10187	0.75808	N/A	1.2458E-05	1.67E-06	1.76E-11	6,050	1.064E-07	3.354E+00	0.5	3.18E-02	3.545E+00	270	0.000	0.222	##################	4.65E-04
Cyclohexane	84.16	10.8	0.00001	0.08044	0.75808	1/2 X	1.90E-06	2.02E-07	2.18E-12	6,050	1.317E-08	4.154E-01	0.5	3.27E-02	6.115E-01	51	0.000	0.229	##################	0.0
Cyclohexane	84.16	10.8	0.00001	0.08044	0.75808	1 X	3.70E-06	3.93E-07	4.24E-12	6,050	2.565E-08	8.090E-01	0.5	3.27E-02	1.005E+00	85	0.000	0.229	##################	0.0
Cyclohexane	84.16	10.8	0.00001	0.08044	0.75808	2X	7.40E-06	7.85E-07	8.48E-12	6,050	5.131E-08	1.618E+00	0.5	3.27E-02	1.814E+00	153	0.000	0.229	##################	0.0
Cyclohexane	84.16	10.8	0.00001	0.08044	0.75808	5X	1.85E-05	1.96E-06	2.12E-11	6,050	1.283E-07	4.045E+00	0.5	3.27E-02	4.241E+00	357	0.000	0.229	##################	0.0
Cyclohexane	84.16	27.5	0.00003	0.08044	0.75808	APPLICATION	1.17E-05	1.24E-06	3.41E-11	6,050	2.066E-07	6.514E+00	0.5	8.32E-02	7.013E+00	590	0.001	0.582	##################	0.0
Cyclohexane	84.16	10.8	0.00001	0.08044	0.75808	N/A	1.2458E-05	1.32E-06	1.43E-11	6,050	8.638E-08	2.724E+00	0.5	3.27E-02	2.920E+00	246	0.000	0.229	##################	4.61E-04
1,1-Dichloroethane	98.96	9.9	0.00001	0.08863	0.75808	1/2 X	1.90E-06	2.22E-07	2.20E-12	6,050	1.331E-08	4.196E-01	0.5	2.99E-02	5.993E-01	59	0.000	0.210	##################	0.0
1,1-Dichloroethane	98.96	9.9	0.00001	0.08863	0.75808	1 X	3.70E-06	4.33E-07	4.28E-12	6,050	2.591E-08	8.171E-01	0.5	2.99E-02	9.968E-01	99	0.000	0.210	##################	0.0
1,1-Dichloroethane	98.96	9.9	0.00001	0.08863	0.75808	2X	7.40E-06	8.65E-07	8.57E-12	6,050	5.182E-08	1.634E+00	0.5	2.99E-02	1.814E+00	180	0.000	0.210	##################	0.0
1,1-Dichloroethane	98.96	9.9	0.00001	0.08863	0.75808	5X	1.85E-05	2.16E-06	2.14E-11	6,050	1.296E-07	4.086E+00	0.5	2.99E-02	4.265E+00	422	0.000	0.210	##################	0.0
1,1-Dichloroethane	98.96	10.2	0.00001	0.08863	0.75808	APPLICATION	1.17E-05	1.37E-06	1.40E-11	6,050	8.442E-08	2.662E+00	0.5	3.09E-02	2.847E+00	282	0.000	0.216	##################	0.0
1,1-Dichloroethane	98.96	9.9	0.00001	0.08863	0.75808	N/A	1.2458E-05	1.46E-06	1.44E-11	6,050	8.724E-08	2.751E+00	0.5	2.99E-02	2.931E+00	290	0.000	0.210	##################	5.25E-04
cis-1,2-Dichloroethylene	96.94	3.9	0.00000	0.09088	0.75808	1/2 X	1.90E-06	2.28E-07	8.88E-13	6,050	5.375E-09	1.695E-01	0.5	1.18E-02	2.403E-01	23	0.000	0.083	##################	0.0
cis-1,2-Dichloroethylene	96.94	3.9	0.00000	0.09088	0.75808	1 X	3.70E-06	4.44E-07	1.73E-12	6,050	1.047E-08	3.301E-01	0.5	1.18E-02	4.008E-01	39	0.000	0.083	##################	0.0
cis-1,2-Dichloroethylene	96.94	3.9	0.00000	0.09088	0.75808	2X	7.40E-06	8.87E-07	3.46E-12	6,050	2.093E-08	6.601E-01	0.5	1.18E-02	7.309E-01	71	0.000	0.083	##################	0.0
cis-1,2-Dichloroethylene	96.94	3.9	0.00000	0.09088	0.75808	5X	1.85E-05	2.22E-06	8.65E-12	6,050	5.233E-08	1.650E+00	0.5	1.18E-02	1.721E+00	167	0.000	0.083	##################	0.0
cis-1,2-Dichloroethylene	96.94	9	0.00001	0.09088	0.75808	APPLICATION	1.17E-05	1.40E-06	1.26E-11	6,050	7.637E-08	2.409E+00	0.5	2.72E-02	2.572E+00	249	0.000	0.191	##################	0.0
cis-1,2-Dichloroethylene	96.94	3.9	0.00000	0.09088	0.75808	N/A	1.2458E-05	1.49E-06	5.82E-12	6,050	3.524E-08	1.111E+00	0.5	1.18E-02	1.182E+00	115	0.000	0.083	##################	2.06E-04
rans-1,2-Dichloroethylen	96.94	4.1	0.00000	0.09088	0.75808	1/2 X	1.90E-06	2.28E-07	9.34E-13	6,050	5.650E-09	1.782E-01	0.5	1.24E-02	2.526E-01	24	0.000	0.087	##################	0.0
rans-1,2-Dichloroethylen	96.94	4.1	0.00000	0.09088	0.75808	1 X	3.70E-06	4.44E-07	1.82E-12	6,050	1.100E-08	3.470E-01	0.5	1.24E-02	4.214E-01	41	0.000	0.087	##################	0.0
rans-1,2-Dichloroethylen	96.94	4.1	0.00000	0.09088	0.75808	2X	7.40E-06	8.87E-07	3.64E-12	6,050	2.201E-08	6.940E-01	0.5	1.24E-02	7.684E-01	74	0.000	0.087	##################	0.0
rans-1,2-Dichloroethylen	96.94	4.1	0.00000	0.09088	0.75808	5X	1.85E-05	2.22E-06	9.09E-12	6,050	5.501E-08	1.735E+00	0.5	1.24E-02	1.809E+00	175	0.000	0.087	##################	0.0
rans-1,2-Dichloroethylen	96.94	0	0.00000	0.09088	0.75808	APPLICATION	1.17E-05	1.40E-06	0.00E+00	6,050	0.000E+00	0.000E+00	0.5	0.00E+00	0.000E+00	0	0.000	0.000	##################	0.0
rans-1,2-Dichloroethylen	96.94	4.1	4.10E-06	0.09088	0.75808	N/A	1.2458E-05	1.49E-06	6.12E-12	6,050	3.705E-08	1.168E+00	0.5	1.24E-02	1.243E+00	120	0.000	0.087	##################	2.16E-04
Ethyl Benzene	106.17	3.6	0.00000	0.07191	0.75808	1/2 X	1.90E-06	1.80E-07	6.49E-13	6,050	3.925E-09	1.238E-01	0.5	1.09E-02	1.891E-01	20	0.000	0.076	##################	0.0
Ethyl Benzene	106.17	3.6	0.00000	0.07191	0.75808	1 X	3.70E-06	3.51E-07	1.26E-12	6,050	7.644E-09	2.411E-01	0.5	1.09E-02	3.064E-01	33	0.000	0.076	##################	0.0

VOC	Mol Wt (g/mole)	Drum Headspace Concentration (ppmv)	Drum Headspace Concentration (mole fraction)	Diffusivity VOC-air (298.15 K, 1 atm Slattery & Bird)	Diffusivity H2-air (298.15 K, 1 atm Slattery & Bird)	Filter Model on Container	Filter Diffusivity for Hydrogen	VOC Filter Diffusivity Coefficient (mole/sec/mf)	VOC Emission Rate per Drum (mole/sec)	Drums per Room	VOC Emission Rate per Room (mole/sec)	Open Room Emission (mole/room/year)	Effective Gas Generation Rate (mole/drum/year)	Closed Room Emission (mole/room/year)	Open Panel Emission (mole/panel/year)	VOC Emission Rate per Open Panel (g/panel/year)	VOC Emission Rate per Open Panel (tons/panel/year)	Closed Panel Emission Rate (moles/panel/year)	Closed Panel Emission Rate (tons/panel/year)	Maximum Repository Emission Rate (tons/year)
Ethyl Benzene	106.17	3.6	0.00000	0.07191	0.75808	2X	7.40E-06	7.02E-07	2.53E-12	6,050	1.529E-08	4.821E-01	0.5	1.09E-02	5.475E-01	58	0.000	0.076	##################	0.0
Ethyl Benzene	106.17	3.6	0.00000	0.07191	0.75808	5X	1.85E-05	1.75E-06	6.32E-12	6,050	3.822E-08	1.205E+00	0.5	1.09E-02	1.271E+00	135	0.000	0.076	##################	0.0
Ethyl Benzene	106.17	11.6	0.00001	0.07191	0.75808	APPLICATION	1.17E-05	1.11E-06	1.29E-11	6,050	7.789E-08	2.456E+00	0.5	3.51E-02	2.667E+00	283	0.000	0.246	##################	0.0
Ethyl Benzene	106.17	3.6	0.00000	0.07191	0.75808	N/A	1.2458E-05	1.18E-06	4.25E-12	6,050	2.574E-08	8.117E-01	0.5	1.09E-02	8.770E-01	93	0.000	0.076	##################	1.83E-04
Ethyl Ether	74.12	4.8	0.00000	0.08555	0.75808	1/2 X	1.90E-06	2.14E-07	1.03E-12	6,050	6.227E-09	1.964E-01	0.5	1.45E-02	2.835E-01	21	0.000	0.102	##################	0.0
Ethyl Ether	74.12	4.8	0.00000	0.08555	0.75808	1 X	3.70E-06	4.18E-07	2.00E-12	6,050	1.213E-08	3.824E-01	0.5	1.45E-02	4.695E-01	35	0.000	0.102	##################	0.0
Ethyl Ether	74.12	4.8	0.00000	0.08555	0.75808	2X	7.40E-06	8.35E-07	4.01E-12	6,050	2.425E-08	7.648E-01	0.5	1.45E-02	8.519E-01	63	0.000	0.102	##################	0.0
Ethyl Ether	74.12	4.8	0.00000	0.08555	0.75808	5X	1.85E-05	2.09E-06	1.00E-11	6,050	6.063E-08	1.912E+00	0.5	1.45E-02	1.999E+00	148	0.000	0.102	##################	0.0
Ethyl Ether	74.12	13.3	0.00001	0.08555	0.75808	APPLICATION	1.17E-05	1.32E-06	1.76E-11	6,050	1.062E-07	3.350E+00	0.5	4.02E-02	3.592E+00	266	0.000	0.282	##################	0.0
Ethyl Ether	74.12	4.8	0.00000	0.08555	0.75808	N/A	1.2458E-05	1.41E-06	6.75E-12	6,050	4.083E-08	1.288E+00	0.5	1.45E-02	1.375E+00	102	0.000	0.102	##################	1.87E-04
Methanol	32.04	71.3	0.00007	0.12386	0.75808	1/2 X	1.90E-06	3.10E-07	2.21E-11	6,050	1.339E-07	4.223E+00	0.5	2.16E-01	5.517E+00	177	0.000	1.510	##################	0.0
Methanol	32.04	71.3	0.00007	0.12386	0.75808	1 X	3.70E-06	6.05E-07	4.31E-11	6,050	2.608E-07	8.224E+00	0.5	2.16E-01	9.518E+00	305	0.000	1.510	##################	0.0
Methanol	32.04	71.3	0.00007	0.12386	0.75808	2X	7.40E-06	1.21E-06	8.62E-11	6,050	5.216E-07	1.645E+01	0.5	2.16E-01	1.774E+01	568	0.001	1.510	##################	0.0
Methanol	32.04	71.3	0.00007	0.12386	0.75808	5X	1.85E-05	3.02E-06	2.16E-10	6,050	1.304E-06	4.112E+01	0.5	2.16E-01	4.241E+01	1359	0.001	1.510	##################	0.0
Methanol	32.04	213	0.00021	0.12386	0.75808	APPLICATION	1.17E-05	1.91E-06	4.07E-10	6,050	2.463E-06	7.769E+01	0.5	6.44E-01	8.155E+01	2613	0.003	4.510	##################	0.0
Methanol	32.04	71.3	0.00007	0.12386	0.75808	N/A	1.2458E-05	2.04E-06	1.45E-10	6,050	8.780E-07	2.769E+01	0.5	2.16E-01	2.898E+01	929	0.001	1.510	##################	1.50E-03
Methyl Chloride	50.49	15.6	0.00002	0.10382	0.75808	1/2 X	1.90E-06	2.60E-07	4.06E-12	6,050	2.456E-08	7.745E-01	0.5	4.72E-02	1.058E+00	53	0.000	0.330	##################	0.0
Methyl Chloride	50.49	15.6	0.00002	0.10382	0.75808	1 X	3.70E-06	5.07E-07	7.90E-12	6,050	4.783E-08	1.508E+00	0.5	4.72E-02	1.791E+00	90	0.000	0.330	##################	0.0
Methyl Chloride	50.49	15.6	0.00002	0.10382	0.75808	2X	7.40E-06	1.01E-06	1.58E-11	6,050	9.565E-08	3.016E+00	0.5	4.72E-02	3.300E+00	167	0.000	0.330	##################	0.0
Methyl Chloride	50.49	15.6	0.00002	0.10382	0.75808	5X	1.85E-05	2.53E-06	3.95E-11	6,050	2.391E-07	7.541E+00	0.5	4.72E-02	7.824E+00	395	0.000	0.330	##################	0.0
Methyl Chloride	50.49	0	0.00000	0.10382	0.75808	APPLICATION	1.17E-05	1.60E-06	0.00E+00	6,050	0.000E+00	0.000E+00	0.5	0.00E+00	0.000E+00	0	0.000	0.000	##################	0.0
Methyl Chloride	50.49	15.6	0.00002	0.10382	0.75808	N/A	1.2458E-05	1.71E-06	2.66E-11	6,050	1.610E-07	5.078E+00	0.5	4.72E-02	5.361E+00	271	0.000	0.330	##################	4.63E-04
Methyl Ethyl Ketone	72.11	13.8	0.00001	0.08530	0.75808	1/2 X	1.90E-06	2.14E-07	2.95E-12	6,050	1.785E-08	5.629E-01	0.5	4.17E-02	8.133E-01	59	0.000	0.292	##################	0.0
Methyl Ethyl Ketone	72.11	13.8	0.00001	0.08530	0.75808	1 X	3.70E-06	4.16E-07	5.75E-12	6,050	3.476E-08	1.096E+00	0.5	4.17E-02	1.347E+00	97	0.000	0.292	##################	0.0
Methyl Ethyl Ketone	72.11	13.8	0.00001	0.08530	0.75808	2X	7.40E-06	8.33E-07	1.15E-11	6,050	6.952E-08	2.192E+00	0.5	4.17E-02	2.443E+00	176	0.000	0.292	##################	0.0
Methyl Ethyl Ketone	72.11	13.8	0.00001	0.08530	0.75808	5X	1.85E-05	2.08E-06	2.87E-11	6,050	1.738E-07	5.481E+00	0.5	4.17E-02	5.731E+00	413	0.000	0.292	##################	0.0
Methyl Ethyl Ketone	72.11	63.7	0.00006	0.08530	0.75808	APPLICATION	1.17E-05	1.32E-06	8.39E-11	6,050	5.073E-07	1.600E+01	0.5	1.93E-01	1.716E+01	1237	0.001	1.349	##################	0.0
Methyl Ethyl Ketone	72.11	13.8	0.00001	0.08530	0.75808	N/A	1.2458E-05	1.40E-06	1.93E-11	6,050	1.170E-07	3.691E+00	0.5	4.17E-02	3.941E+00	284	0.000	0.292	##################	5.22E-04
Methyl Isobutyl Ketone	100.16	12.4	0.00001	0.07162	0.75808	1/2 X	1.90E-06	1.80E-07	2.23E-12	6,050	1.347E-08	4.247E-01	0.5	3.75E-02	6.497E-01	65	0.000	0.263	##################	0.0
Methyl Isobutyl Ketone	100.16	12.4	0.00001	0.07162	0.75808	1 X	3.70E-06	3.50E-07	4.33E-12	6,050	2.622E-08	8.270E-01	0.5	3.75E-02	1.052E+00	105	0.000	0.263	##################	0.0
Methyl Isobutyl Ketone	100.16	12.4	0.00001	0.07162	0.75808	2X	7.40E-06	6.99E-07	8.67E-12	6,050	5.245E-08	1.654E+00	0.5	3.75E-02	1.879E+00	188	0.000	0.263	##################	0.0
Methyl Isobutyl Ketone	100.16	12.4	0.00001	0.07162	0.75808	5X	1.85E-05	1.75E-06	2.17E-11	6,050	1.311E-07	4.135E+00	0.5	3.75E-02	4.360E+00	437	0.000	0.263	##################	0.0
Methyl Isobutyl Ketone	100.16	79	0.00008	0.07162	0.75808	APPLICATION	1.17E-05	1.11E-06	8.73E-11	6,050	5.283E-07	1.666E+01	0.5	2.39E-01	1.809E+01	1812	0.002	1.673	##################	0.0
Methyl Isobutyl Ketone	100.16	12.4	0.00001	0.07162	0.75808	N/A	1.2458E-05	1.18E-06	1.46E-11	6,050	8.830E-08	2.784E+00	0.5	3.75E-02	3.010E+00	301	0.000	0.263	##################	5.93E-04
Tetrachloroethylene	165.83	5.1	0.00001	0.09507	0.75808	1/2 X	1.90E-06	2.38E-07	1.22E-12	6,050	7.352E-09	2.319E-01	0.5	1.54E-02	3.244E-01	54	0.000	0.108	##################	0.0
Tetrachloroethylene	165.83	5.1	0.00001	0.09507	0.75808	1 X	3.70E-06	4.64E-07	2.37E-12	6,050	1.432E-08	4.515E-01	0.5	1.54E-02	5.441E-01	90	0.000	0.108	##################	0.0
Tetrachloroethylene	165.83	5.1	0.00001	0.09507	0.75808	2X	7.40E-06	9.28E-07	4.73E-12	6,050	2.864E-08	9.031E-01	0.5	1.54E-02	9.956E-01	165	0.000	0.108	##################	0.0
Tetrachloroethylene	165.83	5.1	0.00001	0.09507	0.75808	5X	1.85E-05	2.32E-06	1.18E-11	6,050	7.159E-08	2.258E+00	0.5	1.54E-02	2.350E+00	390	0.000	0.108	##################	0.0
Tetrachloroethylene	165.83	9.4	0.00001	0.09507	0.75808	APPLICATION	1.17E-05	1.47E-06	1.38E-11	6,050	8.345E-08	2.632E+00	0.5	2.84E-02	2.802E+00	465	0.001	0.199	##################	0.0
Tetrachloroethylene	165.83	5.1	0.00001	0.09507	0.75808	N/A	1.2458E-05	1.56E-06	7.97E-12	6,050	4.821E-08	1.520E+00	0.5	1.54E-02	1.613E+00	267	0.000	0.108	##################	4.72E-04
Trichloroethylene	131.39	51.2	0.00005	0.08066	0.75808	1/2 X	1.90E-06	2.02E-07	1.04E-11	6,050	6.262E-08	1.975E+00	0.5	1.55E-01	2.904E+00	382	0.000	1.084	##################	0.0
Trichloroethylene	131.39	51.2	0.00005	0.08066	0.75808	1 X	3.70E-06	3.94E-07	2.02E-11	6,050	1.220E-07	3.846E+00	0.5	1.55E-01	4.775E+00	627	0.001	1.084	##################	0.0
Trichloroethylene	131.39	51.2	0.00005	0.08066	0.75808	2X	7.40E-06	7.87E-07	4.03E-11	6,050	2.439E-07	7.692E+00	0.5	1.55E-01	8.621E+00	1133	0.001	1.084	##################	0.0
Trichloroethylene	131.39	51.2	0.00005	0.08066	0.75808	5X	1.85E-05	1.97E-06	1.01E-10	6,050	6.098E-07	1.923E+01	0.5	1.55E-01	2.016E+01	2649	0.003	1.084	##################	0.0
Trichloroethylene	131.39	25.1	0.00003	0.08066	0.75808	APPLICATION	1.17E-05	1.24E-06	3.12E-11	6,050	1.890E-07	5.962E+00	0.5	7.59E-02	6.417E+00	843	0.001	0.531	##################	0.0
Trichloroethylene	131.39	51.2	0.00005	0.08066	0.75808	N/A	1.2458E-05	1.33E-06	6.79E-11	6,050	4.106E-07	1.295E+01	0.5	1.55E-01	1.388E+01	1823	0.002	1.084	##################	3.42E-03
Trichloro-1,2,2-Trifluoroe	102	208.9	0.00021	0.08734	0.75808	1/2 X	1.90E-06	2.19E-07	4.57E-11	6,050	2.767E-07	8.725E+00	0.5	6.32E-01	1.252E+01	1277	0.001	4.423	##################	0.0
Trichloro-1,2,2-Trifluoroe	102	208.9	0.00021	0.08734	0.75808	1 X	3.70E-06	4.26E-07	8.91E-11	6,050	5.388E-07	1.699E+01	0.5	6.32E-01	2.078E+01	2120	0.002	4.423	##################	0.0
Trichloro-1,2,2-Trifluoroe	102	208.9	0.00021	0.08734	0.75808	2X	7.40E-06	8.53E-07	1.78E-10	6,050	1.078E-06	3.398E+01	0.5	6.32E-01	3.777E+01	3853	0.004	4.423	##################	0.0
Trichloro-1,2,2-Trifluoroe	102	208.9	0.00021	0.08734	0.75808	5X	1.85E-05	2.13E-06	4.45E-10	6,050	2.694E-06	8.496E+01	0.5	6.32E-01	8.875E+01	9052	0.010	4.423	##################	0.0
Trichloro-1,2,2-Trifluoroe	102	33	0.00003	0.08734	0.75808	APPLICATION	1.17E-05	1.35E-06	4.45E-11	6,050	2.691E-07	8.488E+00	0.5	9.98E-02	9.086E+00	927	0.001	0.699	##################	0.0
Trichloro-1,2,2-Trifluoroe	102	208.9	0.00021	0.08734	0.75808	N/A	1.2458E-05	1.44E-06	3.00E-10	6,050	1.814E-06	5.721E+01	0.5	6.32E-01	6.100E+01	6222	0.007	4.423	##################	1.13E-02

VOC	Mol Wt (g/mole)	Drum Headspace Concentration (ppmv)	Drum Headspace Concentration (mole fraction)	Diffusivity VOC-air (298.15 K, 1 atm Slattery & Bird)	Diffusivity H2-air (298.15 K, 1 atm Slattery & Bird)	Filter Model on Container	Filter Diffusivity for Hydrogen	VOC Filter Diffusivity Coefficient (mole/sec/mf)	VOC Emission Rate per Drum (mole/sec)	Drums per Room	VOC Emission Rate per Room (mole/sec)	Open Room Emission (mole/room/year)	Effective Gas Generation Rate (mole/drum/year)	Closed Room Emission (mole/room/year)	Open Panel Emission (mole/panel/year)	VOC Emission Rate per Open Panel (g/panel/year)	VOC Emission Rate per Open Panel (tons/panel/year)	Closed Panel Emission Rate (moles/panel/year)	Closed Panel Emission Rate (tons/panel/year)	Maximum Repository Emission Rate (tons/year)
1,2,4-Trimethlybenzene	120.2	2.6	0.00000	0.06679	0.75808	1/2 X	1.90E-06	1.67E-07	4.35E-13	6,050	2.633E-09	8.304E-02	0.5	7.87E-03	1.302E-01	16	0.000	0.055	###################	0.0
1,2,4-Trimethlybenzene	120.2	2.6	0.00000	0.06679	0.75808	1 X	3.70E-06	3.26E-07	8.48E-13	6,050	5.128E-09	1.617E-01	0.5	7.87E-03	2.089E-01	25	0.000	0.055	###################	0.0
1,2,4-Trimethlybenzene	120.2	2.6	0.00000	0.06679	0.75808	2X	7.40E-06	6.52E-07	1.70E-12	6,050	1.026E-08	3.234E-01	0.5	7.87E-03	3.706E-01	45	0.000	0.055	###################	0.0
1,2,4-Trimethlybenzene	120.2	2.6	0.00000	0.06679	0.75808	5X	1.85E-05	1.63E-06	4.24E-12	6,050	2.564E-08	8.085E-01	0.5	7.87E-03	8.557E-01	103	0.000	0.055	###################	0.0
1,2,4-Trimethlybenzene	120.2	12.2	0.00001	0.06679	0.75808	APPLICATION	1.17E-05	1.03E-06	1.26E-11	6,050	7.608E-08	2.399E+00	0.5	3.69E-02	2.621E+00	315	0.000	0.258	###################	0.0
1,2,4-Trimethlybenzene	120.2	2.6	0.00000	0.06679	0.75808	N/A	1.2458E-05	1.10E-06	2.85E-12	6,050	1.726E-08	5.445E-01	0.5	7.87E-03	5.917E-01	71	0.000	0.055	###################	1.44E-04
1,3,5-Trimethylbenzene	120.2	3.2	0.00000	0.06679	0.75808	1/2 X	1.90E-06	1.67E-07	5.36E-13	6,050	3.241E-09	1.022E-01	0.5	9.68E-03	1.603E-01	19	0.000	0.068	###################	0.0
1,3,5-Trimethylbenzene	120.2	3.2	0.00000	0.06679	0.75808	1 X	3.70E-06	3.26E-07	1.04E-12	6,050	6.311E-09	1.990E-01	0.5	9.68E-03	2.571E-01	31	0.000	0.068	###################	0.0
1,3,5-Trimethylbenzene	120.2	3.2	0.00000	0.06679	0.75808	2X	7.40E-06	6.52E-07	2.09E-12	6,050	1.262E-08	3.980E-01	0.5	9.68E-03	4.561E-01	55	0.000	0.068	###################	0.0
1,3,5-Trimethylbenzene	120.2	3.2	0.00000	0.06679	0.75808	5X	1.85E-05	1.63E-06	5.22E-12	6,050	3.155E-08	9.951E-01	0.5	9.68E-03	1.053E+00	127	0.000	0.068	###################	0.0
1,3,5-Trimethylbenzene	120.2	8.6	0.00001	0.06679	0.75808	APPLICATION	1.17E-05	1.03E-06	8.86E-12	6,050	5.363E-08	1.691E+00	0.5	2.60E-02	1.847E+00	222	0.000	0.182	###################	0.0
1,3,5-Trimethylbenzene	120.2	3.2	0.00000	0.06679	0.75808	N/A	1.2458E-05	1.10E-06	3.51E-12	6,050	2.125E-08	6.701E-01	0.5	9.68E-03	7.282E-01	88	0.000	0.068	###################	1.77E-04
m,p-Xylene	106.17	6.5	0.00001	0.07053	0.75808	1/2 X	1.90E-06	1.77E-07	1.15E-12	6,050	6.952E-09	2.192E-01	0.5	1.97E-02	3.372E-01	36	0.000	0.138	###################	0.0
m,p-Xylene	106.17	6.5	0.00001	0.07053	0.75808	1 X	3.70E-06	3.44E-07	2.24E-12	6,050	1.354E-08	4.269E-01	0.5	1.97E-02	5.449E-01	58	0.000	0.138	###################	0.0
m,p-Xylene	106.17	6.5	0.00001	0.07053	0.75808	2X	7.40E-06	6.89E-07	4.48E-12	6,050	2.708E-08	8.539E-01	0.5	1.97E-02	9.718E-01	103	0.000	0.138	###################	0.0
m,p-Xylene	106.17	6.5	0.00001	0.07053	0.75808	5X	1.85E-05	1.72E-06	1.12E-11	6,050	6.769E-08	2.135E+00	0.5	1.97E-02	2.253E+00	239	0.000	0.138	###################	0.0
m,p-Xylene	106.17	19.3	0.00002	0.07053	0.75808	APPLICATION	1.17E-05	1.09E-06	2.10E-11	6,050	1.271E-07	4.009E+00	0.5	5.84E-02	4.359E+00	463	0.001	0.409	###################	0.0
m,p-Xylene	106.17	6.5	0.00001	0.07053	0.75808	N/A	1.2458E-05	1.16E-06	7.53E-12	6,050	4.558E-08	1.437E+00	0.5	1.97E-02	1.555E+00	165	0.000	0.138	###################	3.27E-04
o-Xylene	106.17	3.8	0.00000	0.07053	0.75808	1/2 X	1.90E-06	1.77E-07	6.72E-13	6,050	4.064E-09	1.282E-01	0.5	1.15E-02	1.971E-01	21	0.000	0.080	###################	0.0
o-Xylene	106.17	3.8	0.00000	0.07053	0.75808	1 X	3.70E-06	3.44E-07	1.31E-12	6,050	7.914E-09	2.496E-01	0.5	1.15E-02	3.186E-01	34	0.000	0.080	###################	0.0
o-Xylene	106.17	3.8	0.00000	0.07053	0.75808	2X	7.40E-06	6.89E-07	2.62E-12	6,050	1.583E-08	4.992E-01	0.5	1.15E-02	5.682E-01	60	0.000	0.080	###################	0.0
o-Xylene	106.17	3.8	0.00000	0.07053	0.75808	5X	1.85E-05	1.72E-06	6.54E-12	6,050	3.957E-08	1.248E+00	0.5	1.15E-02	1.317E+00	140	0.000	0.080	###################	0.0
o-Xylene	16.00	79.8	0.00008	0.07053	0.75808	APPLICATION	1.17E-05	1.09E-06	8.69E-11	6,050	5.256E-07	1.657E+01	0.5	2.41E-01	1.802E+01	288	0.000	1.690	###################	0.0
o-Xylene	106.17	3.8	0.00000	0.07053	0.75808	N/A	1.2458E-05	1.16E-06	4.40E-12	6,050	2.665E-08	8.404E-01	0.5	1.15E-02	9.094E-01	97	0.000	0.080	###################	1.91E-04

ATMOSPHERIC DISPERSION This section presents the results of air dispersion modeling performed inside and outside the WIPP site boundary. The modeling was performed to evaluate four specific scenarios: the Boundary Public, Livingston Ridge Rancher (grazing allotment on the north side of the WIPP site), Antelope Ridge Rancher (grazing allotment on the south side of the WIPP site), and Surface Worker. The Long-Term Version of the Industrial Source Complex (ISCLT3) model, (U.S. Environmental Protection Agency, 1995), was used for the original air dispersion modeling. Concentrations were modeled in accordance with (U.S. Environmental Protection Agency, 1992) EPA (1992). Details of the modeling are described in Appendix D10 of the 1996 Permit Application. The modeling produced the air dispersion factors (ADFs) listed in the center column of Table 6. In 2010 the modeling was updated in order to use newer EPA analytical tools (AERMOD) and updated physical conditions (new buildings, three exhaust stacks) (URS Corporation, 2010).

Area	Original Air Dispersion Factor (ADF)	Revised Air Dispersion Factor (ADF)
Training Building	1.23E-02	1.14E-02
Livingston Ridge Allotment	9.80E-05	1.76E-04
Antelope Ridge Allotment	6.70E-05	6.72E-04
WIPP Site Boundary	1.20E-04	8.78E-05

LOCATION OF PUBLIC AND WORKERS Three classes of exposed individuals (receptors) were presented in Appendix D9 of the 1996 Permit Application (U. S. Department of Energy, 1996 a); a surface worker, an underground worker, and a member of the public. The compliance point for the surface worker is the Training Building. The compliance point for the underground worker is downwind from the waste during initial emplacement in a room. The compliance point for the member of the public is the nearest point outside the controlled area where ranch hands may be working.

HEALTH BASED LEVELS The environmental performance standard proposed for the workers was the Occupational Safety and Health Administration (OSHA) 8-hour time weighted average (TWA) for each compound. The environmental performance standards proposed for the public were 10^{-6} for Class A and B2 carcinogens and 10^{-5} for Class C carcinogens and a Hazard Quotient of 1 for non-carcinogens. These are summarized in Table 7. These risk levels were not used by the New Mexico Environment Department (NMED) to develop the standards that eventually were included in the Hazardous Waste Facility Permit (Permit) that was issued in 1999. The NMED reduced the standards to only two receptors: the Underground Worker and the Surface Worker. These standards which are reflected in the VOC limits in the Permit are listed in Table 8. The NMED translated these risk levels into specific concentrations of concern (Cs of C) for each VOC and published them as repository limits and room-based limits. Action levels associated with these limits were also established in the Permit. The NMED modeled cumulative risk and hazard due to exposure to all compounds simultaneously. This required them to develop a process for translating the total risk into a specific risk associated with each VOC involved. The rationale used is documented in a memorandum to file issued by the NMED in 1998 (Zappe, 1998) and in written testimony submitted at the 1999 Permit Hearing (New Mexico Environment Department, 1999). The NMED accepted the Permittees limited list of analytes (which constituted 99 percent of the risk or hazard) and apportioned risk among the nine compounds. This risk apportionment has been modified over time. The most recent apportionment is shown in Table 8, along with the percentage of the total risk assigned to the compound. Table 9 focuses on repository limits since room-based limits are now monitored separately using a Disposal Room VOC Monitoring System. In the design of the current Panel Closure, performance criteria were established in the form of health based levels (HBLs) that could be applied at any appropriate point of compliance (the Land Withdrawal boundary was used in the Panel Closure design document titled Conceptual Design for Operational Phase Panel Closure Systems, Appendix I1 of the 1996 Permit Application (U. S. Department of Energy, 1996 a)). This approach was driven by the no-migration standard found in 40 CFR 268 which applied at the time. The methodology for calculating HBLs that was used was described in the proposed ruling on Subpart S, Corrective Action for Solid Waste Management Units at Hazardous Waste Management Facilities (Federal Register, 1990). In the proposed 40 CFR 264 Subpart S, the action levels, or HBLs, are calculated given the exposure assumptions for the media of interest and the toxic or carcinogenic effects for each hazardous constituent. The proposed Subpart S recommended that continuous lifetime exposure duration of 70 years be assumed; however, because the operational/closure phase of the facility is 35 years, a 35-year exposure is assumed in determining HBLs for the assessment. The assumed risk levels for carcinogens are 10^{-6} for Class A or B2 carcinogens and 10^{-5} for Class C carcinogens. In determining HBLs for non-carcinogens, the chemical-specific reference concentrations are used, which estimate the daily exposure an individual can experience without appreciable risk of adverse effects during a lifetime. Because the guidelines refer to excess health risks, the calculated HBLs are applied only to potential migration of hazardous constituents from the disposed waste. The methodology for determining HBLs is derived from the EPA's Risk Assessment Guidance for Superfund (U. S. Environmental Protection Agency, 1989). Although the EPA provides alternate "standard default exposure factors," exposure assumptions outlined in the proposed Subpart S were used. To calculate the HBLs in air for carcinogens with an absorption factor conservatively assumed to be equal to 1, the following equation is used:

and reference concentrations (RfCs)) used in the
ble 10. The main source of these data is the EPA
tem (IRIS); the data in the IRIS system are updated
approved by the EPA. Values not in the IRIS system are
urces. This list has been updated from the original study

$$HBL = \frac{TRL \times AT}{EF \times ED \times IUR}$$

where:

HBL = HBL for carcinogen, $\mu g/m^3$
TRL = target risk level (TRL), 10^{-5} (Class C) or 10^{-6} (Class A and B2)
AT = averaging time, 25,550 days for carcinogens (70 years × 365 days/year)
EF = exposure frequency, 365 days/year
ED = exposure duration, 35 years
IUR = inhalation unit risk factor (IUR) for carcinogen, $(\mu g/m^3)^{-1}$

For non-carcinogens, the HBLs in air are calculated as follows:

$$HBL = \frac{THQ \times RfC \times AT_{p\,or\,w} \times (1{,}000\,\frac{\mu g}{mg})}{EF_{p\,or\,w} \times ED_{p\,or\,w}}$$

where:

HBL = HBL for non-carcinogen, $\mu g/m^3$
THQ = target hazard quotient (THQ), assumed to be 1
RfC = reference concentration for the non-carcinogen, mg/m^3
AT_p = averaging time, 12,775 days for non-carcinogenic exposure for public (ED × 365 days/year)
AT_w = averaging time, 87,600 for non-carcinogenic exposure for non-waste surface workers based on exposure duration)
EF_p = exposure frequency for public, 365 days/year
EF_w = exposure frequency for non-waste surface worker, 1,920 hours/year
ED_p = exposure duration for public, 35 years
ED_w = exposure duration, non-waste surface worker, 10 years.

cinogens and non-carcinogens; exposure duration of 35 years
years for the non-waste surface worker. For non-carcinogens,
the exposure duration, therefore, this assumption has no effect
This assumption is reasonable, because waste emplacement is
-year closure period follows. For the non-waste surface
n an employment period of 10 years in the training building.
tor VOC in air is listed in Table 11. Values are shown for two
d the surface worker risk is 10^{-5}. The original Panel Closure

IUR = Inhalation unit risk factor (IUR) for carcinogen, $(\mu g/m^3)^{-1}$

For non-carcinogens, the HBLs in air are calculated as follows:

$$HBL = \frac{THQ \times RfC \times AT_{p\,or\,w} \times (1{,}000\ \frac{\mu g}{mg})}{EF_{p\,or\,w} \times ED_{p\,or\,w}}$$

where:

HBL = HBL for non-carcinogen, $\mu g/m^3$
THQ = target hazard quotient (THQ), assumed to be 1
RfC = reference concentration for the non-carcinogen, mg/m^3
AT_p = averaging time, 12,775 days for non-carcinogenic exposure for public (ED x 365 days/year)
AT_w = averaging time, 87,600 for non-carcinogenic exposure for non-waste surface workers based on exposure duration)
EF_p = exposure frequency for public, 365 days/year
EF_w = exposure frequency for non-waste surface worker, 1,920 hours/year
ED_p = exposure duration for public, 35 years
ED_w = exposure duration, non-waste surface worker, 10 years.

The toxicity measures (i.e., IURs calculations are presented in Ta Integrated Risk Information Sysi monthly and are reviewed and i based on EPA recommended so in the Permit Application.

In calculating the HBLs for both car was assumed for the public and 10 the averaging time is equivalent to on the calculated value of the HBL. expected to last 25 years, and a ter worker, the assumption is based o The calculated HBL for each indicat risk levels. The public risk is 10^{-6} an design uses the public risk values.

	VOLATILE ORGANIC COMPOUND	MOLECULAR WEIGHT (g/mole)	Exhaust Shaft Concentration ug/m^3	Inhalation Unit Risk (IUR) $(ug/m^3)^{-1}$	Reference concentration (RfC) mg/m^3	Health Based Levels for Reduced Exposure ug/cubic meter: 10^{-6} RISK LEVEL	10^{-5} RISK LEVEL	NON-CARCINOGENIC	RECEPTOR CONCENTRATION: conc times old ADF	conc times new ADF
RISK AT THE TRAINING BUILDING	Acetone	58.08	0.40	---	3.10E+01	---	---	141,438	4.93E-03	4.57E-03
	Benzene	78.11	0.04	7.80E-06	3.00E-02	4.094551282	41	137	5.07E-04	4.70E-04
	Bromoform	252.73	0.05	1.10E-06	---	29.03409091	290	---	6.06E-04	5.61E-04
	Butanol	74.12	0.12	---	6.00E-02	---	---	274	1.54E-03	1.42E-03
	Carbon Disulfide	76.13	0.08	---	7.00E-01	---	---	3,194	9.41E-04	8.72E-04
	Carbon Tetrachloride	153.84	16.67	6.00E-06	1.00E-01	5.322916667	53	456	2.05E-01	1.90E-01
	Chlorobenzene	112.56	0.03	---	5.00E-02	---	---	228	4.25E-04	3.94E-04
	Chloroform	119.39	0.24	2.30E-05	9.80E-02	1.388586957	14	447	2.94E-03	2.73E-03
	Cyclohexane	84.16	0.11	---	6	---	---	27,375	1.33E-03	1.24E-03
	1,1-Dichloroethane	98.96	0.12	1.60E-06	---	19.9609375	200	---	1.52E-03	1.41E-03
	1,2-Dichloroethane	98.97	0.05	2.60E-05	7.00E-03	1.228365385	12	32	5.68E-04	5.26E-04
	1,1-Dichloroethylene	96.95	0.16	---	2.00E-01	---	---	913	1.96E-03	1.82E-03
	cis-1,2-Dichloroethylene	96.94	0.05	---	---	---	---	---	5.94E-04	5.50E-04
	trans-1,2-Dichloroethylene	96.94	0.05	---	6.00E-02	---	---	274	6.24E-04	5.79E-04
	Ethyl Benzene	106.17	0.04	2.50E-06	1	12.775	128	4,563	5.07E-04	4.70E-04
	Ethyl Ether	74.12	0.04	---	---	---	---	---	5.40E-04	5.00E-04
	Methanol	32.04	0.35	---	4	---	---	18,250	4.34E-03	4.02E-03
	Methyl Chloride	50.49	0.11	---	9.00E-02	---	---	411	1.34E-03	1.24E-03
	Methylene Chloride	84.94	0.40	1.00E-08	6.00E-01	3193.75	31,938	2,738	4.95E-03	4.59E-03
	Methyl Ethyl Ketone	72.11	0.12	---	5	---	---	22,813	1.51E-03	1.40E-03
	Methyl Isobutyl Ketone	100.16	0.14	---	3	---	---	13,688	1.71E-03	1.59E-03
	1,1,2,2-Tetrachloroethane	167.86	0.05	5.80E-05	---	0.550646552	6	---	6.68E-04	6.19E-04
	Tetrachloroethylene	165.83	0.11	2.60E-07	4.00E-02	122.8365385	1,228	183	1.36E-03	1.26E-03
	Toluene	92.13	0.13	---	5	---	---	22,813	1.62E-03	1.50E-03
	1,1,1-Trichloroethane	133.42	11.62	---	5	---	---	22,813	1.43E-01	1.32E-01
	Trichloroethylene	131.39	0.80	4.10E-06	2.00E-03	7.789634146	78	9	9.88E-03	9.16E-03
	1,1,2-Trichloro-1,2,2-Trifluoroethane	252.73	6.59	---	3.00E+01	---	---	136,875	8.11E-02	7.51E-02
	1,2,4-Trimethylbenzene	120.2	0.03	---	7.00E-03	---	---	32	4.16E-04	3.85E-04
	1,3,5-Trimethylbenzene	120.2	0.04	---	---	---	---	---	5.12E-04	4.74E-04
	m,p-Xylene	106.17	6.50	---	1.00E-01	---	---	456	8.00E-02	7.41E-02
	o-Xylene	106.17	0.04	---	1.00E-01	---	---	456	5.52E-04	5.11E-04

These HBLs are based on 10 years exposure in Training Building (87,600 hours)

Concentration as percent of Health Based Level

	1 in 1000000: conc times old ADF	conc times new ADF	1 in 100000: conc times old ADF	conc times new ADF	HI: conc times old ADF	conc times new ADF	RISK = (FULL REPOSITORY CONCENTRATION X ADF X EF X IUR X ED)/(AT)	RISK = FULL REPOSITORY CONCENTRATION X ADF X EF X ED)/(AT X RfC X 1000)
Acetone	---	---	---	---	0.00%	0.00%	---	3.23177E-08
Benzene	0.01%	0.01%	0.00%	0.00%	0.00%	0.00%	1.14858E-10	3.43593E-06
Bromoform	0.00%	0.00%	0.00%	0.00%	---	---	1.93338E-11	---
Butanol	---	---	---	---	0.00%	0.00%	---	5.20243E-06
Carbon Disulfide	---	---	---	---	0.00%	0.00%	---	2.7319E-07
Carbon Tetrachloride	3.85%	3.57%	0.39%	0.36%	0.04%	0.04%	3.56932E-08	0.00041642
Chlorobenzene	---	---	---	---	0.00%	0.00%	---	1.72804E-06
Chloroform	0.21%	0.20%	0.02%	0.02%	0.00%	0.00%	1.96435E-09	6.10046E-06
Cyclohexane	---	---	---	---	0.00%	0.00%	---	4.51355E-08
1,1-Dichloroethane	0.01%	0.01%	0.00%	0.00%	---	---	7.04361E-11	---
1,2-Dichloroethane	0.05%	0.04%	0.00%	0.00%	0.00%	0.00%	4.28522E-10	1.64816E-05
1,1-Dichloroethylene	---	---	---	---	0.00%	0.00%	---	1.99492E-06
cis-1,2-Dichloroethylene	---	---	---	---	---	---	---	---
trans-1,2-Dichloroethylene	---	---	---	---	0.00%	0.00%	---	2.11379E-06
Ethyl Benzene	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	3.68136E-11	1.03078E-07
Ethyl Ether	---	---	---	---	---	---	---	---
Methanol	---	---	---	---	0.00%	0.00%	---	2.20395E-07
Methyl Chloride	---	---	---	---	0.00%	0.00%	---	3.02202E-06
Methylene Chloride	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	1.43725E-12	1.6768E-06
Methyl Ethyl Ketone	---	---	---	---	0.00%	0.00%	---	6.12563E-08
Methyl Isobutyl Ketone	---	---	---	---	0.00%	0.00%	---	1.15949E-07
1,1,2,2-Tetrachloroethane	0.12%	0.11%	0.01%	0.01%	---	---	1.12436E-09	---
Tetrachloroethylene	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	1.02906E-11	6.92635E-06
Toluene	---	---	---	---	0.00%	0.00%	---	6.56838E-08
1,1,1-Trichloroethane	---	---	---	---	0.00%	0.00%	---	5.80722E-06
Trichloroethylene	0.13%	0.12%	0.01%	0.01%	0.11%	0.10%	1.17574E-09	0.001003681
1,1,2-Trichloro-1,2,2-Trifluoroethane	---	---	---	---	0.00%	0.00%	---	5.48949E-07
1,2,4-Trimethylbenzene	---	---	---	---	0.00%	0.00%	---	1.20673E-05
1,3,5-Trimethylbenzene	---	---	---	---	---	---	---	---
m,p-Xylene	---	---	---	---	0.02%	0.02%	---	0.000162411
o-Xylene	---	---	---	---	0.00%	0.00%	---	1.12108E-06
	4.38%	4.06%	0.44%	0.41%	0.18%	0.17%	4.06393E-08	0.001651656

		MOLECULAR WEIGHT (g/mole)	Exhaust Shaft Concentration ug/m^3	Inhalation Unit Risk (IUR) $(ug/m^3)^{-1}$	Reference concentration (RfC) mg/m^3		10^{-6} RISK LEVEL	10^{-5} RISK LEVEL	NON-CARCINOGENIC	conc times old ADF	conc times new ADF
	Acetone	58.08	0.40	---	3.10E+01		---	---	31000	3.93E-05	7.06E-05
	Benzene	78.11	0.04	7.80E-06	3.00E-02		0.26	2.56	30	4.04E-06	7.26E-06
	Bromoform	252.73	0.05	1.10E-06	---		1.82	18.18	---	4.83E-06	8.67E-06
	Butanol	74.12	0.12	---	6.00E-02		---	---	60	1.22E-05	2.20E-05

Concentration as percent of Health Based Level

	1 in 1000000: conc times old ADF	conc times new ADF	1 in 100000: conc times old ADF	conc times new ADF	HI: conc times old ADF	conc times new ADF	RISK = (FULL REPOSITORY CONCENTRATION X ADF X EF X IUR X ED)/(AT)	RISK = FULL REPOSITORY CONCENTRATION X ADF X EF X ED)/(AT X RfC X 1000)
Acetone	---	---	---	---	0.00%	0.00%	---	2.27642E-09
Benzene	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	2.8362E-11	2.42022E-07
Bromoform	0.00%	0.00%	0.00%	0.00%	---	---	4.76695E-12	---
Butanol	---	---	---	---	0.00%	0.00%	---	3.66452E-07

RISK AT LIVINGSTON RIDGE WORKER	Carbon Disulfide	76.13	0.08	---	7.00E-01		---	---	700	7.50E-06	1.35E-05	---	---	---	---	0.00%	0.00%	---		1.92431E-08
	Carbon Tetrachloride	153.84	16.67	6.00E-06	1.00E-01		0.33	3.33	100	1.63E-03	2.93E-03	0.49%	0.89%	0.05%	0.09%	0.00%	0.00%		8.80843E-09	2.93321E-05
	Chlorobenzene	112.56	0.03	---	5.00E-02		---	---	50	3.39E-06	6.09E-06	---	---	---	---	0.00%	0.00%	---		1.2172E-07
	Chloroform	119.39	0.24	2.30E-05	9.80E-02		0.09	0.87	98	2.34E-05	4.21E-05	0.03%	0.05%	0.00%	0.00%	0.00%	0.00%		4.84039E-10	4.29708E-07
	Cyclohexane	84.16	0.11	---	6		---	---	6000	1.06E-05	1.91E-05	---	---	---	---	0.00%	0.00%	---		3.17928E-09
	1,1-Dichloroethane	98.96	0.12	1.60E-06	---		1.25	12.5	---	1.21E-05	2.17E-05	0.00%	0.00%	0.00%	0.00%	---	---		1.7365E-11	---
	1,2-Dichloroethane	98.97	0.05	2.60E-05	7.00E-03		0.08	0.77	7	4.53E-06	8.13E-06	0.01%	0.01%	0.00%	0.00%	0.00%	0.00%		1.0554E-10	1.16094E-06
	1,1-Dichloroethylene	96.95	0.16	---	2.00E-01		---	---	200	1.56E-05	2.81E-05	---	---	---	---	0.00%	0.00%	---		1.40519E-07
	cis-1,2-Dichloroethylene	96.94	0.05	---	---		---	---	---	4.73E-06	8.50E-06	---	---	---	---	---	---	---		---
	trans-1,2-Dichloroethylene	96.94	0.05	---	6.00E-02		---	---	60	4.97E-06	8.93E-06	---	---	---	---	0.00%	0.00%	---		1.48892E-07
	Ethyl Benzene	106.17	0.04	2.50E-06	1		0.8	8	1000	4.04E-06	7.26E-06	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%		9.07584E-12	7.26067E-09
	Ethyl Ether	74.12	0.04	---	---		---	---	---	4.30E-06	7.73E-06	---	---	---	---	---	---	---		---
	Methanol	32.04	0.35	---	4		---	---	4000	3.46E-05	6.21E-05	---	---	---	---	0.00%	0.00%	---		1.55243E-08
	Methyl Chloride	50.49	0.11	---	9.00E-02		---	---	90	1.07E-05	1.92E-05	---	---	---	---	0.00%	0.00%	---		2.12867E-07
	Methylene Chloride	84.94	0.40	1.00E-08	6.00E-01		200	2000	600	3.95E-05	7.09E-05	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%		3.54333E-13	1.18111E-07
	Methyl Ethyl Ketone	72.11	0.12	---	5		---	---	5000	1.20E-05	2.16E-05	---	---	---	---	0.00%	0.00%	---		4.31481E-09
	Methyl Isobutyl Ketone	100.16	0.14	---	3		---	---	3000	1.36E-05	2.45E-05	---	---	---	---	0.00%	0.00%	---		8.16732E-09
	1,1,2,2-Tetrachloroethane	167.86	0.05	5.80E-05	---		0.03	0.34	---	5.32E-06	9.56E-06	0.02%	0.03%	0.00%	0.00%	---	---		2.8113E-10	---
	Tetrachloroethylene	165.83	0.11	2.60E-07	4.00E-02		7.69	76.92	40	1.09E-05	1.95E-05	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%		2.53709E-12	4.87882E-07
	Toluene	92.13	0.13	---	5		---	---	5000	1.29E-05	2.31E-05	---	---	---	---	0.00%	0.00%	---		4.62668E-09
	1,1,1-Trichloroethane	133.42	11.62	---	5		---	---	5000	1.14E-03	2.05E-03	---	---	---	---	0.00%	0.00%	---		4.09052E-07
	Trichloroethylene	131.39	0.80	4.10E-06	2.00E-03		0.49	4.88	2	7.87E-05	1.41E-04	0.02%	0.03%	0.00%	0.00%	0.00%	0.01%		2.89745E-10	7.06979E-05
	1,1,2-Trichloro-1,2,2-Trifluoroethane	252.73	6.59	---	3.00E+01		---	---	30000	6.46E-04	1.16E-03	---	---	---	---	0.00%	0.00%	---		3.86672E-08
	1,2,4-Trimethylbenzene	120.2	0.03	---	7.00E-03		---	---	7	3.31E-06	5.95E-06	---	---	---	---	0.00%	0.00%	---		8.50003E-07
	1,3,5-Trimethylbenzene	120.2	0.04	---	---		---	---	---	4.08E-06	7.32E-06	---	---	---	---	---	---	---		---
	m,p-Xylene	106.17	6.50	---	1.00E-01		---	---	100	6.37E-04	1.14E-03	---	---	---	---	0.00%	0.00%	---		0.00001144
	o-Xylene	106.17	0.04	---	1.00E-01		---	---	100	4.40E-06	7.90E-06	---	---	---	---	0.00%	0.00%	---		7.89675E-08
												0.56%	1.01%	0.06%	0.10%	0.01%	0.01%		1.00313E-08	0.00011634

		MOLECULAR WEIGHT (g/mole)	Exhaust Shaft Concentration ug/m^3	Inhalation Unit Risk (IUR) (ug/m^3)$^{-1}$	Reference concentration (RfC) mg/m^3		10^{-6} RISK LEVEL	10^{-5} RISK LEVEL	NON-CARCINOGENIC	conc times old ADF	conc times new ADF	Concentration as percent of Health Based Level: 1 in 1000000 conc times old ADF	1 in 1000000 conc times new ADF	1 in 100000 conc times old ADF	1 in 100000 conc times new ADF	HI conc times old ADF	HI conc times new ADF	RISK = (FULL REPOSITORY CONCENTRATION X ADF X EF X IUR X ED)/(AT)	RISK = (FULL REPOSITORY CONCENTRATION X ADF X EF X ED)/(AT X RfC X 1000)
RISK AT ANTELOPE RIDGE WORKER	Acetone	58.08	0.40	---	3.10E+01		---	---	31000	2.69E-05	2.69E-04	---	---	---	---	0.00%	0.00%	---	8.69177E-09
	Benzene	78.11	0.04	7.80E-06	3.00E-02		0.26	2.56	30	2.76E-06	2.77E-05	0.00%	0.01%	0.00%	0.00%	0.00%	0.00%	1.08291E-10	9.24085E-07
	Bromoform	252.73	0.05	1.10E-06	---		1.82	18.18	---	3.30E-06	3.31E-05	0.00%	0.00%	0.00%	0.00%	---	---	1.82011E-11	---
	Butanol	74.12	0.12	---	6.00E-02		---	---	60	8.37E-06	8.40E-05	---	---	---	---	0.00%	0.00%	---	1.39918E-06
	Carbon Disulfide	76.13	0.08	---	7.00E-01		---	---	700	5.13E-06	5.14E-05	---	---	---	---	0.00%	0.00%	---	7.34736E-08
	Carbon Tetrachloride	153.84	16.67	6.00E-06	1.00E-01		0.33	3.33	100	1.12E-03	1.12E-02	0.34%	3.39%	0.03%	0.34%	0.00%	0.01%	3.36322E-08	0.000111995
	Chlorobenzene	112.56	0.03	---	5.00E-02		---	---	50	2.32E-06	2.32E-05	---	---	---	---	0.00%	0.00%	---	4.64751E-07
	Chloroform	119.39	0.24	2.30E-05	9.80E-02		0.09	0.87	98	1.60E-05	1.61E-04	0.02%	0.18%	0.00%	0.02%	0.00%	0.00%	1.84815E-09	1.6407E-06
	Cyclohexane	84.16	0.11	---	6		---	---	6000	7.26E-06	7.28E-05	---	---	---	---	0.00%	0.00%	---	1.21391E-08
	1,1-Dichloroethane	98.96	0.12	1.60E-06	---		1.25	12.5	---	8.26E-06	8.29E-05	0.00%	0.01%	0.00%	0.00%	---	---	6.63026E-11	---
	1,2-Dichloroethane	98.97	0.05	2.60E-05	7.00E-03		0.08	0.77	7	3.09E-06	3.10E-05	0.00%	0.04%	0.00%	0.00%	0.00%	0.00%	4.02971E-10	4.43269E-06
	1,1-Dichloroethylene	96.95	0.16	---	2.00E-01		---	---	200	1.07E-05	1.07E-04	---	---	---	---	0.00%	0.00%	---	5.36527E-07
	cis-1,2-Dichloroethylene	96.94	0.05	---	---		---	---	---	3.23E-06	3.24E-05	---	---	---	---	---	---	---	---
	trans-1,2-Dichloroethylene	96.94	0.05	---	6.00E-02		---	---	60	3.40E-06	3.41E-05	---	---	---	---	0.00%	0.00%	---	5.68497E-07
	Ethyl Benzene	106.17	0.04	2.50E-06	1		0.8	8	1000	2.76E-06	2.77E-05	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	3.46532E-11	2.77226E-08
	Ethyl Ether	74.12	0.04	---	---		---	---	---	2.94E-06	2.95E-05	---	---	---	---	---	---	---	---
	Methanol	32.04	0.35	---	4		---	---	4000	2.36E-05	2.37E-04	---	---	---	---	0.00%	0.00%	---	5.92748E-08
	Methyl Chloride	50.49	0.11	---	9.00E-02		---	---	90	7.29E-06	7.31E-05	---	---	---	---	0.00%	0.00%	---	8.12763E-07
	Methylene Chloride	84.94	0.40	1.00E-08	6.00E-01		200	2000	600	2.70E-05	2.71E-04	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	1.35291E-12	4.5097E-07
	Methyl Ethyl Ketone	72.11	0.12	---	5		---	---	5000	8.21E-06	8.24E-05	---	---	---	---	0.00%	0.00%	---	1.64747E-08
	Methyl Isobutyl Ketone	100.16	0.14	---	3		---	---	3000	9.33E-06	9.36E-05	---	---	---	---	0.00%	0.00%	---	3.11843E-08
	1,1,2,2-Tetrachloroethane	167.86	0.05	5.80E-05	---		0.03	0.34	---	3.64E-06	3.65E-05	0.01%	0.12%	0.00%	0.01%	---	---	1.0734E-09	---

	Tetrachloroethylene	165.83	0.11	2.60E-07	4.00E-02		7.69	76.92	40	7.43E-06	7.45E-05	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%		9.68707E-12	1.86282E-06
	Toluene	92.13	0.13	---	5		---	---	5000	8.81E-06	8.83E-05	---	---	---	---	0.00%	0.00%	---		1.76655E-08
	1,1,1-Trichloroethane	133.42	11.62	---	5		---	---	5000	7.79E-04	7.81E-03	---	---	---	---	0.00%	0.00%	---		1.56184E-06
	Trichloroethylene	131.39	0.80	4.10E-06	2.00E-03		0.49	4.88	2	5.38E-05	5.40E-04	0.01%	0.11%	0.00%	0.01%	0.00%	0.03%		1.1063E-09	0.000269937
	1,1,2-Trichloro-1,2,2-Trifluoroethane	252.73	6.59	---	3.00E+01		---	---	30000	4.42E-04	4.43E-03	---	---	---	---	0.00%	0.00%	---		1.47638E-07
	1,2,4-Trimethylbenzene	120.2	0.03	---	7.00E-03		---	---	7	2.27E-06	2.27E-05	---	---	---	---	0.00%	0.00%	---		3.24547E-06
	1,3,5-Trimethylbenzene	120.2	0.04	---	---		---	---	---	2.79E-06	2.80E-05	---	---	---	---	---	---	---	---	
	m,p-Xylene	106.17	6.50	---	1.00E-01		---	---	100	4.36E-04	4.37E-03	---	---	---	---	0.00%	0.00%	---		0.00004368
	o-Xylene	106.17	0.04	---	1.00E-01		---	---	100	3.01E-06	3.02E-05	---	---	---	---	0.00%	0.00%	---		3.01512E-07
												0.39%	3.87%	0.04%	0.38%	0.00%	0.04%		3.83015E-08	0.000444209

		MOLECULAR WEIGHT (g/mole)	Exhaust Shaft Concentration ug/m^3	Inhalation Unit Risk (IUR) (ug/m^3)$^{-1}$	Reference concentration (RfC) mg/m^3		10^{-6} RISK LEVEL	10^{-5} RISK LEVEL	NON-CARCINOGENIC	conc times old ADF	conc times new ADF	Concentration as percent of Health Based Level: 1 in 1000000 conc times old ADF	1 in 1000000 conc times new ADF	1 in 100000 conc times old ADF	1 in 100000 conc times new ADF	HI conc times old ADF	HI conc times new ADF	RISK = (FULL REPOSITORY CONCENTRATION X ADF X EF X IUR X ED)/(AT)	RISK = FULL REPOSITORY CONCENTRATION X ADF X EF X ED)/(AT X RfC X 1000)
RISK AT WIPP SITE BOUNDARY	Acetone	58.08	0.40	---	3.10E+01		---	---	31000	4.81E-05	3.52E-05	---	---	---	---	0.00%	0.00%	---	1.13562E-09
	Benzene	78.11	0.04	7.80E-06	3.00E-02		0.26	2.56	30	4.95E-06	3.62E-06	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	1.41488E-11	1.20736E-07
	Bromoform	252.73	0.05	1.10E-06	---		1.82	18.18	---	5.91E-06	4.32E-06	0.00%	0.00%	0.00%	0.00%	---	---	2.37806E-12	---
	Butanol	74.12	0.12	---	6.00E-02		---	---	60	1.50E-05	1.10E-05	---	---	---	---	0.00%	0.00%	---	1.8281E-07
	Carbon Disulfide	76.13	0.08	---	7.00E-01		---	---	700	9.18E-06	6.72E-06	---	---	---	---	0.00%	0.00%	---	9.59968E-09
	Carbon Tetrachloride	153.84	16.67	6.00E-06	1.00E-01		0.33	3.33	100	2.00E-03	1.46E-03	0.61%	0.44%	0.06%	0.04%	0.00%	0.00%	4.39421E-09	1.46327E-05
	Chlorobenzene	112.56	0.03	---	5.00E-02		---	---	50	4.15E-06	3.04E-06	---	---	---	---	0.00%	0.00%	---	6.07219E-08
	Chloroform	119.39	0.24	2.30E-05	9.80E-02		0.09	0.87	98	2.87E-05	2.10E-05	0.03%	0.02%	0.00%	0.00%	0.00%	0.00%	2.41469E-10	2.14366E-07
	Cyclohexane	84.16	0.11	---	6		---	---	6000	1.30E-05	9.52E-06	---	---	---	---	0.00%	0.00%	---	1.58603E-09
	1,1-Dichloroethane	98.96	0.12	1.60E-06	---		1.25	12.5	---	1.48E-05	1.08E-05	0.00%	0.00%	0.00%	0.00%	---	---	8.66276E-12	---
	1,2-Dichloroethane	98.97	0.05	2.60E-05	7.00E-03		0.08	0.77	7	5.54E-06	4.05E-06	0.01%	0.01%	0.00%	0.00%	0.00%	0.00%	5.26501E-11	5.79151E-07
	1,1-Dichloroethylene	96.95	0.16	---	2.00E-01		---	---	200	1.92E-05	1.40E-05	---	---	---	---	0.00%	0.00%	---	7.00998E-08
	cis-1,2-Dichloroethylene	96.94	0.05	---	---		---	---	---	5.79E-06	4.24E-06	---	---	---	---	---	---	---	---
	trans-1,2-Dichloroethylene	96.94	0.05	---	6.00E-02		---	---	60	6.09E-06	4.46E-06	---	---	---	---	0.00%	0.00%	---	7.42769E-08
	Ethyl Benzene	106.17	0.04	2.50E-06	1		0.8	8	1000	4.95E-06	3.62E-06	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	4.52761E-12	3.62209E-09
	Ethyl Ether	74.12	0.04	---	---		---	---	---	5.27E-06	3.85E-06	---	---	---	---	---	---	---	---
	Methanol	32.04	0.35	---	4		---	---	4000	4.23E-05	3.10E-05	---	---	---	---	0.00%	0.00%	---	7.74453E-09
	Methyl Chloride	50.49	0.11	---	9.00E-02		---	---	90	1.31E-05	9.56E-06	---	---	---	---	0.00%	0.00%	---	1.06191E-07
	Methylene Chloride	84.94	0.40	1.00E-08	6.00E-01		200	2000	600	4.83E-05	3.54E-05	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	1.76764E-13	5.89213E-08
	Methyl Ethyl Ketone	72.11	0.12	---	5		---	---	5000	1.47E-05	1.08E-05	---	---	---	---	0.00%	0.00%	---	2.1525E-09
	Methyl Isobutyl Ketone	100.16	0.14	---	3		---	---	3000	1.67E-05	1.22E-05	---	---	---	---	0.00%	0.00%	---	4.07438E-09
	1,1,2,2-Tetrachloroethane	167.86	0.05	5.80E-05	---		0.03	0.34	---	6.52E-06	4.77E-06	0.02%	0.02%	0.00%	0.00%	---	---	1.40245E-10	---
	Tetrachloroethylene	165.83	0.11	2.60E-07	4.00E-02		7.69	76.92	40	1.33E-05	9.74E-06	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	1.26566E-12	2.43387E-07
	Toluene	92.13	0.13	---	5		---	---	5000	1.58E-05	1.15E-05	---	---	---	---	0.00%	0.00%	---	2.30808E-09
	1,1,1-Trichloroethane	133.42	11.62	---	5		---	---	5000	1.39E-03	1.02E-03	---	---	---	---	0.00%	0.00%	---	2.04061E-07
	Trichloroethylene	131.39	0.80	4.10E-06	2.00E-03		0.49	4.88	2	9.64E-05	7.05E-05	0.02%	0.01%	0.00%	0.00%	0.00%	0.00%	1.44543E-10	3.52686E-05
	1,1,2-Trichloro-1,2,2-Trifluoroethane	252.73	6.59	---	3.00E+01		---	---	30000	7.91E-04	5.79E-04	---	---	---	---	0.00%	0.00%	---	1.92897E-08
	1,2,4-Trimethylbenzene	120.2	0.03	---	7.00E-03		---	---	7	4.06E-06	2.97E-06	---	---	---	---	0.00%	0.00%	---	4.24036E-07
	1,3,5-Trimethylbenzene	120.2	0.04	---	---		---	---	---	4.99E-06	3.65E-06	---	---	---	---	---	---	---	---
	m,p-Xylene	106.17	6.50	---	1.00E-01		---	---	100	7.80E-04	5.71E-04	---	---	---	---	0.00%	0.00%	---	0.000005707
	o-Xylene	106.17	0.04	---	1.00E-01		---	---	100	5.38E-06	3.94E-06	---	---	---	---	0.00%	0.00%	---	3.9394E-08
												0.69%	0.51%	0.07%	0.05%	0.01%	0.01%		5.00427E-09	5.8038E-05

TABLE 1 TRU Waste VOC Source Term

Constituent	Original Weighted Average (ppmv)	Revised Weighted Average (ppmv)
ACETONE	79.8	53.1
BENZENE	9.3	4.3
BROMOFORM	9.4	1.8
BUTANOL	78.1	13.8
CARBON DISULFIDE	---	10.5
CARBON TETRACHLORIDE	375.5	921.5
CHLOROBENZENE	12.5	2.7
CHLOROFORM	25.3	16.1
CYCLOHEXANE	27.5	10.8
1,1-DICHLOROETHANE	10.2	9.9
1,2-DICHLOROETHANE	9.1	3.8
1,1-DICHLOROETHYLENE	11.5	12.9
CIS-1,2-DICHLOROETHYLENE	9.0	3.9
TRANS-1,2-DICHLOROETHYLENE	---	4.1
ETHYL BENZENE	11.6	3.6
ETHYL ETHER	13.3	4.8
METHANOL	213.0	71.3
METHYL CHLORIDE	---	15.6
METHYLENE CHLORIDE	368.5	36.0
METHYL ETHYL KETONE	63.7	13.8
METHYL ISOBUTYL KETONE	79.0	12.4
1,1,2,2-TETRACHLOROETHANE	9.4	4.8
TETRACHLOROETHYLENE	9.4	5.1
TOLUENE	19.4	12.2
1,1,1-TRICHLOROETHANE	317.1	739.8
TRICHLOROETHYLENE	25.1	51.2
1,1,2-TRICHLORO-1,2,2-TRIFLUOROETHANE	33.0	208.9
1,2,4-TRIMETHYLBENZENE	12.2	2.6
1,3,5-TRIMETHYLBENZENE	8.6	3.2
M,P-XYLENE	19.3	6.5
O-XYLENE	16.0	3.8

Table 1 is derived from the Weighted HS Conc sheet

This Table is manufactured from the Permit and the VOC Carbon Tetrachloride Modification

TABLE 9 Repository Limits for Specific Compounds and their Related Risk Portions

VOC OF INTEREST	TYPE	LIMIT IN PERMIT (ppbv)	ASSOCIATED RISK	ASSOCIATED HAZARD	PERCENT OF TOTAL RISK	PERCENT OF TOTAL HAZARD
Carbon Tetrachloride	C	960	4.30E-06		44.6	
Chlorobenzene	N	220		2.40E-03		88.5
Chloroform	C	180	2.40E-06		24.9	
1,1-Dichloroethene	N	100		2.30E-04		8.7
1,2-Dichloroethane	C	45	5.60E-07		5.8	
Methylene Chloride	C	1,930	1.90E-08		0.2	
1,1,2,2-Tetrachloroethane	C	50	2.30E-06		24.5	
Toluene	N	190		1.20E-04		4.4
1,1,1-Trichloroethane	N	590		7.60E-05		2.8
		TOTAL	9.60E-06	2.70E-03	100%	100%

C = Carcinogen

N = Non-carcinogen

TABLE 3 Compilation of Filter H_2 Diffusivity for Disposed Waste (Panels 1 through 5) (mole/sec/mole fraction)

Panel	Room	Inner Container Count	Outer Container Count	Outer Container Filter Count	Summation of Filter Diffusivity	Diffusivity/Filter	Diffusivity/Outer Container
1	7	9953	9953	10187	3.12E-02	3.06E-06	3.14E-06
1	6	2392	2393	2441	7.72E-03	3.16E-06	3.23E-06
1	5	2403	2404	2427	7.09E-03	2.92E-06	2.95E-06
1	4	2484	2484	2523	7.97E-03	3.16E-06	3.21E-06
1	3	10691	10691	10911	3.31E-02	3.03E-06	3.09E-06
1	2	8368	8368	9115	2.61E-02	2.86E-06	3.12E-06
PANEL TOTAL		**3737**	**3121**	**3975**	**1.47E-02**	**3.70E-06**	**4.71E-06**
2	7	7111	5158	7455	2.85E-02	3.82E-06	5.53E-06
2	5	6965	4219	7115	3.18E-02	4.47E-06	7.55E-06
2	3	6610	5061	7102	3.26E-02	4.58E-06	6.43E-06
2	2	6727	4981	6967	3.93E-02	5.64E-06	7.88E-06
2	1	2179	1785	2214	3.18E-02	1.43E-05	1.78E-05
PANEL TOTAL		**42831**	**29770**	**44596**	**2.29E-01**	**5.13E-06**	**7.69E-06**
3	7	6022	1599	5657	4.91E-02	8.67E-06	3.07E-05
3	6	6678	2399	3713	4.37E-02	1.18E-05	1.82E-05
3	4	6693	3336	4548	5.33E-02	1.17E-05	1.60E-05
3	3	6476	2857	4501	5.06E-02	1.12E-05	1.77E-05
3	2	6588	2734	4300	5.23E-02	1.22E-05	1.91E-05
3	1	4112	2260	3256	3.82E-02	1.17E-05	1.69E-05
PANEL TOTAL		**42000**	**17760**	**28932**	**3.31E-01**	**1.14E-05**	**1.86E-05**
4	7	6063	2890	4574	5.09E-02	1.11E-05	1.76E-05
4	6	6073	3604	4802	6.40E-02	1.33E-05	1.78E-05
4	5	6621	4137	5728	7.21E-02	1.26E-05	1.74E-05
4	4	5870	3945	4928	7.61E-02	1.54E-05	1.93E-05
4	3	5673	4264	4784	8.16E-02	1.70E-05	1.91E-05
4	2	5535	4687	5236	8.93E-02	1.71E-05	1.91E-05
4	1	3545	3035	3280	5.72E-02	1.74E-05	1.89E-05
PANEL TOTAL		**39380**	**26562**	**33332**	**4.91E-01**	**1.47E-05**	**1.85E-05**
5	7	6512	5576	6169	1.07E-01	1.74E-05	1.92E-05
5	6	6568	5945	6442	1.19E-01	1.85E-05	2.00E-05
5	5	6332	5442	6023	1.03E-01	1.71E-05	1.89E-05
5	4	6524	3972	4423	6.85E-02	1.55E-05	1.73E-05
5	3	7223	4331	5120	8.31E-02	1.62E-05	1.92E-05
5	2	7088	5195	6370	1.05E-01	1.66E-05	2.03E-05
5	1	5007	3997	4449	7.81E-02	1.76E-05	1.96E-05
PANEL TOTAL		**45254**	**34458**	**38996**	**6.65E-01**	**1.70E-05**	**1.93E-05**

Table based on data provided by Eric D'Amico (WDS data)

TABLE 5: Number of Containers Disposed in Each Panel

Container Type	Panel 1	Panel 2	Panel 3	Panel 4	Panel 5	Panel 6	Container Total
55-Gallon Drum	38,139	23,865	8,394	12,858	21,255	6,339	110,850
Standard Waste Boxes	1,239	3,176	1,730	1,405	2,200	741	10,491
10-Drum Overpack	35	1,451	2,227	1,048	788	131	5,680
85-Gallon Drum	2	-	-	3	-	-	5
100-Gallon Drum	-	1,278	5,409	11,050	9,951	1,218	28,906
Standard Large Box 2	-	-	-	-	-	5	5
Panel Total	39,415	29,770	17,760	26,364	34,194	5,376	152,879
Rooms per Panel	5	7	7	7	7	1	32
Containers per Room	8,211	4,580	2,691	3,995	5,181	5,376	4,777

This information was taken from a compilation provided by Don Hancock as of January 14, 2012

TABLE 6: Air Dispersion Factors for WIPP Site Areas

Area	Original Air Dispersion Factor (ADF)	Revised Air Dispersion Factor (ADF)
WIPP Site Boundary	1.2E-04	8.8E-05
Livingston Ridge Allotment	9.8E-05	1.8E-04
Antelope Ridge Allotment	6.7E-05	6.7E-04
Training Building	1.2E-02	1.1E-02

Calculated by URS Austin

TABLE 2: TRU Waste Container Gas Generation Rates Due to Microbial Degradation

	High	Low	Expected
Gas-Generation Rate moles/drum/year	0.4	0	0.1

From Permit Application and NMVP

TABLE 4: Effective Gas Generation Rate

Gas-Generation Rate	moles/drum/year
Microbial Degradation	0.1
Creep Closure	0.4
Total Effective Gas Generation Rate	0.5

From Permit Application and NMVP

TABLE 10: EPA Risk Factor for Volatile Organic Compounds (as of 4/2/2012)

VOLATILE ORGANIC COMPOUND	Inhalation Unit Risk (IUR) (ug/m3)-1	Reference concentration (RfC) mg/m3
Acetone	---	3.10E+01
Benzene	7.80E-06	3.00E-02
Bromoform	1.10E-06	---
Butanol	---	6.00E-02
Carbon Disulfide	---	7.00E-01
Carbon Tetrachloride	6.00E-06	1.00E-01
Chlorobenzene	---	5.00E-02
Chloroform	2.30E-05	9.80E-02
Cyclohexane	---	6.00E+00
1,1-Dichloroethane	1.60E-06	---
1,2-Dichloroethane	2.60E-05	7.00E-03
1,1-Dichloroethylene	---	2.00E-01
cis-1,2-Dichloroethylene	---	---
trans-1,2-Dichloroethylene	---	6.00E-02
Ethyl Benzene	2.50E-06	1.00E+00
Ethyl Ether	---	---
Methanol	---	4.00E+00
Methyl Chloride	---	9.00E-02
Methylene Chloride	1.00E-08	6.00E-01
Methyl Ethyl Ketone	---	5.00E+00
Methyl Isobutyl Ketone	---	3.00E+00
1,1,2,2-Tetrachloroethane	5.80E-05	---
Tetrachloroethylene	2.60E-07	4.00E-02
Toluene	---	5.00E+00
1,1,1-Trichloroethane	---	5.00E+00
Trichloroethylene	4.10E-06	2.00E-03
1,1,2-Trichloro-1,2,2-Trifluoroethane	---	3.00E+01
1,2,4-Trimethlybenzene	---	7.00E-03
1,3,5-Trimethylbenzene	---	---
m,p-Xylene	---	1.00E-01
o-Xylene	---	1.00E-01

Updated by URS comment--IRIS and related databases

TABLE 7 Risk Levels Proposed in the WIPP RCRA Part B Permit Application in 1996 (Appendix D9, Tables D9-5, -6, -8, and -9)

EXPOSED CLASS	COMPLIANCE POINT	CARCINOGENS		NON-CARCINOGENS
		CLASS A and B2 CARCINOGENS	CLASS C	
Surface Worker	Training Building	OSHA 8-HOUR TWA		
Underground Worker	Exhaust drift adjacent to filled room	OSHA 8-HOUR TWA		
Public	Controlled area fence line	1.00E-06	1.00E-05	1

From Permit Application and NMVP

TABLE 8 Risk Levels Imposed by the NMED in the Permit in 1999

EXPOSED CLASS	COMPLIANCE POINT	CLASS B2 CARCINOGENS	CLASS C CARCINOGENS	NON-CARCINOGENS
Surface Worker	Training Building	1.00E-05	1.00E-05	1
Underground Worker	Exhaust drift adjacent to filled room	OSHA IDLH or LFL	OSHA IDLH or LFL	OSHA IDLH or LFL
Public	Controlled area fence line	Bounded by Surface Worker Limit		

IDLH = Concentration that is immediately dangerous to life and health

LFL = Lower flammability limit

From Zappe Memo

Table 13: Risk as a Fraction of the Health-Based Levels for Four Exposure Scenarios

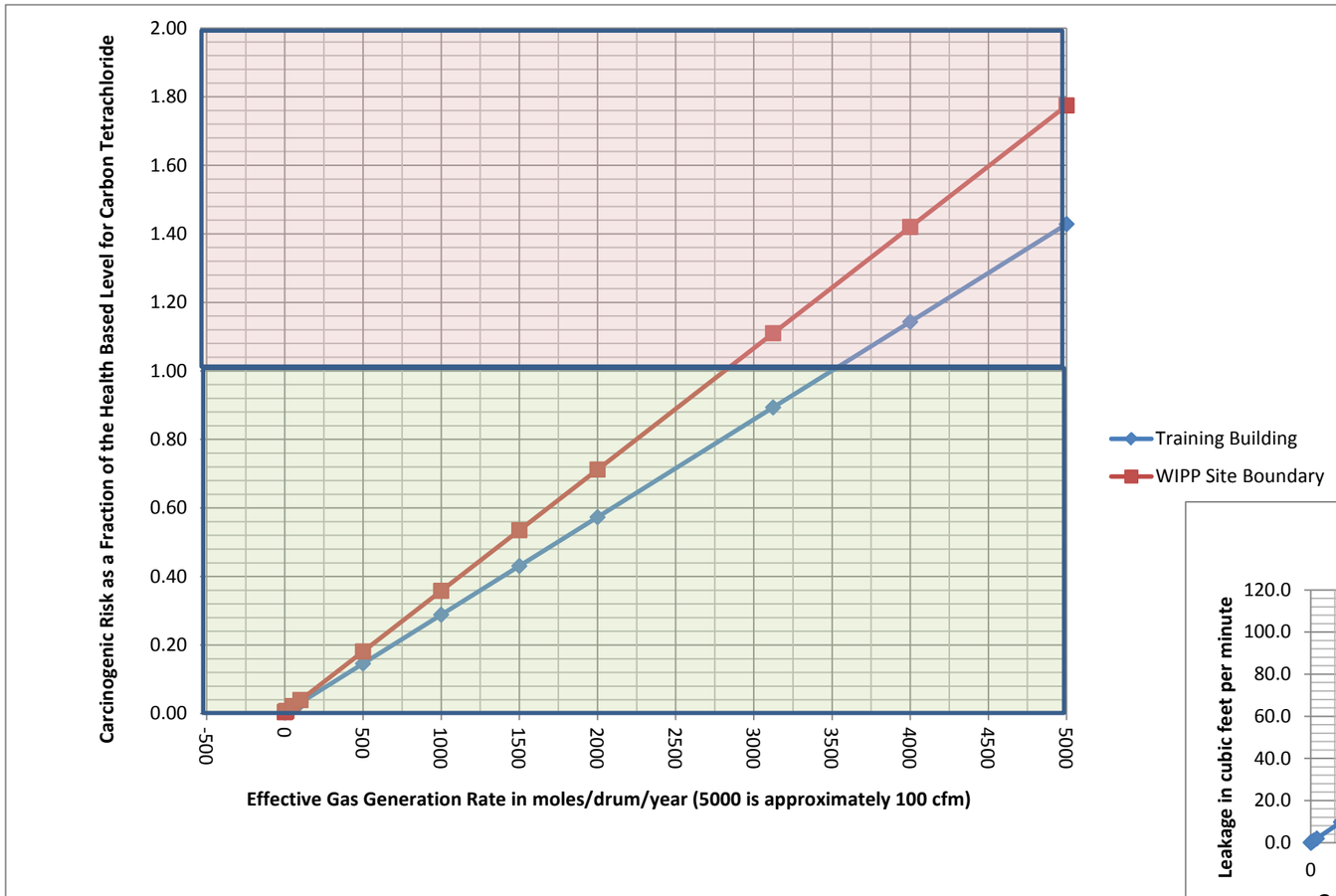
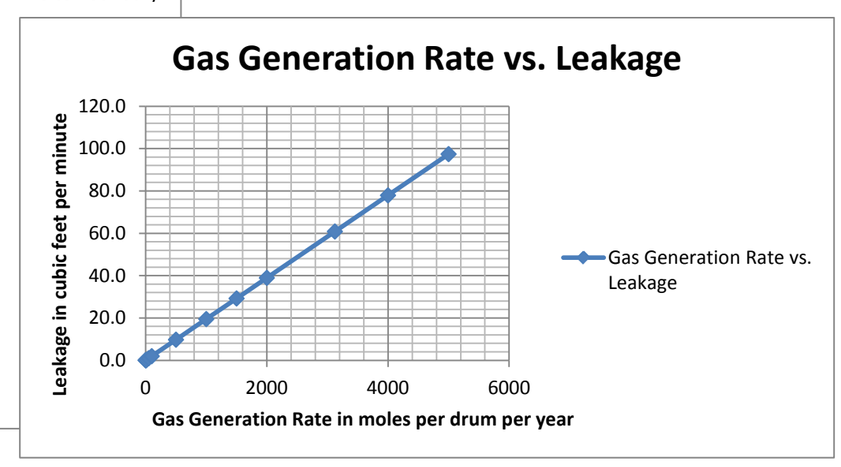
COMPOUND	RISK AS A FRACTION OF THE HEALTH BASED LEVEL							
	WORKER		PUBLIC		PUBLIC		PUBLIC	
	TRAINING BUILDING		LIVINGSTON RIDGE		ANTELOPE RIDGE		WIPP SITE BOUNDARY	
	CARCINOGENIC	NON-CARCINOGENIC	CARCINOGENIC	NON-CARCINOGENIC	CARCINOGENIC	NON-CARCINOGENIC	CARCINOGENIC	NON-CARCINOGENIC
Acetone	---	3.23E-08	---	2.28E-09	---	8.69E-09	---	1.14E-09
Benzene	1.15E-05	3.44E-06	2.79E-05	2.42E-07	1.07E-04	9.24E-07	1.39E-05	1.21E-07
Bromoform	1.93E-06	---	4.76E-06	---	1.82E-05	---	2.38E-06	---
Butanol	---	5.20E-06	---	3.66E-07	---	1.40E-06	---	1.83E-07
Carbon Disulfide	---	2.73E-07	---	1.92E-08	---	7.35E-08	---	9.60E-09
Carbon Tetrachloride	3.57E-03	4.16E-04	8.89E-03	2.93E-05	3.39E-02	1.12E-04	4.43E-03	1.46E-05
Chlorobenzene	---	1.73E-06	---	1.22E-07	---	4.65E-07	---	6.07E-08
Chloroform	1.96E-04	6.10E-06	4.68E-04	4.30E-07	1.79E-03	1.64E-06	2.33E-04	2.14E-07
Cyclohexane	---	4.51E-08	---	3.18E-09	---	1.21E-08	---	1.59E-09
1,1-Dichloroethane	7.04E-06	---	1.74E-05	---	6.63E-05	---	8.66E-06	---
1,2-Dichloroethane	4.29E-05	1.65E-05	1.02E-04	1.16E-06	3.88E-04	4.43E-06	5.07E-05	5.79E-07
1,1-Dichloroethylene	---	1.99E-06	---	1.41E-07	---	5.37E-07	---	7.01E-08
cis-1,2-Dichloroethylene	---	---	---	---	---	---	---	---
trans-1,2-Dichloroethylene	---	2.11E-06	---	1.49E-07	---	5.68E-07	---	7.43E-08
Ethyl Benzene	3.68E-06	1.03E-07	9.08E-06	7.26E-09	3.47E-05	2.77E-08	4.53E-06	3.62E-09
Ethyl Ether	---	---	---	---	---	---	---	---
Methanol	---	2.20E-07	---	1.55E-08	---	5.93E-08	---	7.74E-09
Methyl Chloride	---	3.02E-06	---	2.13E-07	---	8.13E-07	---	1.06E-07
Methylene Chloride	1.44E-07	1.68E-06	3.54E-07	1.18E-07	1.35E-06	4.51E-07	1.77E-07	5.89E-08
Methyl Ethyl Ketone	---	6.13E-08	---	4.31E-09	---	1.65E-08	---	2.15E-09
Methyl Isobutyl Ketone	---	1.16E-07	---	8.17E-09	---	3.12E-08	---	4.07E-09
1,1,2,2-Tetrachloroethane	1.12E-04	---	3.19E-04	---	1.22E-03	---	1.59E-04	---
Tetrachloroethylene	1.03E-06	6.93E-06	2.54E-06	4.88E-07	9.69E-06	1.86E-06	1.27E-06	2.43E-07
Toluene	---	6.57E-08	---	4.63E-09	---	1.77E-08	---	2.31E-09
1,1,1-Trichloroethane	---	5.81E-06	---	4.09E-07	---	1.56E-06	---	2.04E-07
Trichloroethylene	1.18E-04	1.00E-03	2.89E-04	7.07E-05	1.10E-03	2.70E-04	1.44E-04	3.53E-05
1,1,2-Trichloro-1,2,2-Trifluoroethane	---	5.49E-07	---	3.87E-08	---	1.48E-07	---	1.93E-08
1,2,4-Trimethlybenzene	---	1.21E-05	---	8.50E-07	---	3.25E-06	---	4.24E-07
1,3,5-Trimethylbenzene	---	---	---	---	---	---	---	---
m,p-Xylene	---	1.62E-04	---	1.14E-05	---	4.37E-05	---	5.71E-06
o-Xylene	---	1.12E-06	---	7.90E-08	---	3.02E-07	---	3.94E-08
Total	4.06E-03	1.65E-03	1.01E-02	1.16E-04	3.87E-02	4.44E-04	5.05E-03	5.80E-05

TABLE 11: Health Based Levels for various Risk Scenarios

VOLATILE ORGANIC COMPOUND	HEALTH BASED LEVELS (ug/m³)			
	10^{-6} RISK LEVEL	10^{-5} RISK LEVEL	NON-CARCINOGENIC	
	Public	Surface Worker	Public	Surface Worker
Acetone	---	---	31,000	141,438
Benzene	0.26	41	30	137
Bromoform	1.82	290	---	---
Butanol	---	---	60	274
Carbon Disulfide	---	---	700	3,194
Carbon Tetrachloride	0.33	53	100	456
Chlorobenzene	---	---	50	228
Chloroform	0.09	14	98	447
Cyclohexane	---	---	6,000	27,375
1,1-Dichloroethane	1.25	200	---	---
1,2-Dichloroethane	0.08	12	7	32
1,1-Dichloroethylene	---	---	200	913
cis-1,2-Dichloroethylene	---	---	---	---
trans-1,2-Dichloroethylene	---	---	60	274
Ethyl Benzene	0.80	128	1,000	4,563
Ethyl Ether	---	---	---	---
Methanol	---	---	4,000	18,250
Methyl Chloride	---	---	90	411
Methylene Chloride	200	31,938	600	2,738
Methyl Ethyl Ketone	---	---	5,000	22,813
Methyl Isobutyl Ketone	---	---	3,000	13,688
1,1,2,2-Tetrachloroethane	0.03	6	---	---
Tetrachloroethylene	7.69	1,228	40	183
Toluene	---	---	5,000	22,813
1,1,1-Trichloroethane	---	---	5,000	22,813
Trichloroethylene	0.49	78	2	9
1,1,2-Trichloro-1,2,2-Trifluoroethane	---	---	30,000	136,875
1,2,4-Trimethlybenzene	---	---	7	32
1,3,5-Trimethylbenzene	---	---	---	---
m,p-Xylene	---	---	100	456
o-Xylene	---	---	100	456

TABLE 12: Annual Emission Rates for Drums, Rooms, Panels, and the Repository

COMPOUND	AVERAGE DRUM EMISSION RATE (mole/drum/year)	AVERAGE OPEN ROOM EMISSION RATE (mole/room/year)	AVERAGE CLOSED ROOM EMISSION RATE (mole/room/year)	AVERAGE OPEN PANEL EMISSION RATE (mole/panel/year)	AVERAGE CLOSED PANEL EMISSION RATE (mole/panel/year)	MAXIMUM REPOSITORY EMISSION RATE (moles/year)	FULL REPOSITORY CONCENTRATION AT THE EXHAUST SHAFT (ug/m³)
Acetone	2.58E-03	15.60	0.16	16.57	1.12	26.69	0.40
Benzene	1.89E-04	1.14	0.01	1.22	0.09	2.04	0.04
Bromoform	6.24E-05	0.38	0.01	0.41	0.04	0.75	0.05
Butanol	6.01E-04	3.63	0.04	3.89	0.29	6.52	0.12
Carbon Disulfide	5.54E-04	3.35	0.03	3.54	0.04	3.89	0.08
Carbon Tetrachloride	3.74E-02	226.47	2.79	243.20	19.51	418.82	16.67
Chlorobenzene	1.04E-04	0.63	0.01	0.68	0.06	1.19	0.03
Chloroform	7.25E-04	4.38	0.05	4.68	0.34	7.75	0.24
Cyclohexane	4.50E-04	2.72	0.03	2.92	0.23	4.98	0.11
1,1-Dichloroethane	4.55E-04	2.75	0.03	2.93	0.21	4.82	0.12
1,2-Dichloroethane	1.68E-04	1.02	0.01	1.08	0.08	1.80	0.05
1,1-Dichloroethylene	6.07E-04	3.67	0.04	3.91	0.27	6.37	0.16
cis-1,2-Dichloroethylene	1.84E-04	1.11	0.01	1.18	0.08	1.93	0.05
trans-1,2-Dichloroethylene	1.93E-04	1.17	0.01	1.24	0.09	2.02	0.05
Ethyl Benzene	1.34E-04	0.81	0.01	0.88	0.08	1.56	0.04
Ethyl Ether	2.13E-04	1.29	0.01	1.37	0.10	2.29	0.04
Methanol	4.58E-03	27.69	0.22	28.98	1.51	42.57	0.35
Methyl Chloride	8.39E-04	5.08	0.05	5.36	0.33	8.33	0.11
Methylene Chloride	1.79E-03	10.81	0.11	11.46	0.76	18.33	0.40
Methyl Ethyl Ketone	6.10E-04	3.69	0.04	3.94	0.29	6.57	0.12
Methyl Isobutyl Ketone	4.60E-04	2.78	0.04	3.01	0.26	5.37	0.14
1,1,2,2-Tetrachloroethane	1.12E-04	0.68	0.01	0.73	0.06	1.25	0.05
Tetrachloroethylene	2.51E-04	1.52	0.02	1.61	0.11	2.58	0.11
Toluene	4.90E-04	2.96	0.04	3.18	0.26	5.51	0.13
1,1,1-Trichloroethane	3.01E-02	182.27	2.24	195.69	15.67	336.68	11.62
Trichloroethylene	2.14E-03	12.95	0.15	13.88	1.08	23.64	0.80
1,1,2-Trichloro-1,2,2-Trifluoroethane	9.46E-03	57.21	0.63	61.00	4.42	100.81	6.59
1,2,4-Trimethlybenzene	9.00E-05	0.54	0.01	0.59	0.06	1.09	0.03
1,3,5-Trimethylbenzene	1.11E-04	0.67	0.01	0.73	0.07	1.34	0.04
o-Xylene	1.39E-04	0.84	0.01	0.91	0.08	1.63	0.04
m,p-Xylene	2.38E-04	1.44	0.02	1.56	0.14	2.79	0.08

GAS GENERATION RATE	WIPP TRAINING BUILDING		LIVINGSTON RIDGE WORKER		ANTELOPE RIDGE WORKER		WIPP SITE BOUNDARY RESIDENT		Equivalent flow rate in cfm
	Carcinogenic	Non Carcinogenic	Carcinogenic	Non Carcinogenic	Carcinogenic	Non Carcinogenic	Carcinogenic	Non Carcinogenic	
	FRACTION OF THE HEALTH BASED LIMIT (CCl4)								
0.5	3.57E-03	4.16E-04	8.89E-03	2.93E-05	3.39E-02	1.12E-04	4.43E-03	1.46E-05	0.00974
1	3.71E-03	4.33E-04	9.25E-03	3.05E-05	3.53E-02	1.17E-04	4.61E-03	1.52E-05	0.01948
5	4.85E-03	5.66E-04	1.21E-02	3.99E-05	4.61E-02	1.52E-04	6.03E-03	1.99E-05	0.0974
10	6.28E-03	7.32E-04	1.56E-02	5.16E-05	5.97E-02	1.97E-04	7.80E-03	2.57E-05	0.1948
50	1.77E-02	2.06E-03	4.40E-02	1.45E-04	1.68E-01	5.55E-04	2.20E-02	7.25E-05	0.974
100	3.19E-02	3.73E-03	7.95E-02	2.62E-04	3.04E-01	1.00E-03	3.97E-02	1.31E-04	1.948
500	1.46E-01	1.70E-02	3.63E-01	1.20E-03	1.39E+00	4.58E-03	1.81E-01	5.98E-04	9.74
1000	2.88E-01	3.37E-02	7.18E-01	2.37E-03	2.74E+00	9.05E-03	3.58E-01	1.18E-03	19.48
1500	4.31E-01	5.03E-02	1.07E+00	3.54E-03	4.10E+00	1.35E-02	5.35E-01	1.77E-03	29.22
2000	5.73E-01	6.69E-02	1.43E+00	4.71E-03	5.45E+00	1.80E-02	7.12E-01	2.35E-03	38.96
3123	8.94E-01	1.04E-01	2.23E+00	7.34E-03	8.50E+00	2.80E-02	1.11E+00	3.66E-03	60.83604
4000	1.14E+00	1.33E-01	2.85E+00	9.39E-03	1.09E+01	3.59E-02	1.42E+00	4.69E-03	77.92
5000	1.43E+00	1.67E-01	3.56E+00	1.17E-02	1.36E+01	4.48E-02	1.77E+00	5.86E-03	97.4

These calculations are performed by changing the gas generation rate in Sheet "Inputs and Outputs" and pasting the values into the correct line in the table.