

## Risk Assessment for Hazardous Waste Comminglers at Various Universities

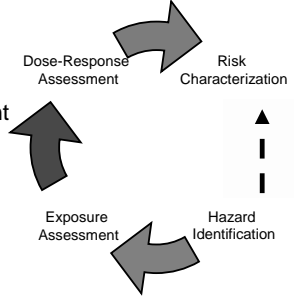
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## Risk Assessment Process

- Hazard identification
- Dose-response assessment
- Exposure assessment
- Risk characterization



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## Hazard Identification

- The determination of whether a particular substance or chemical is or is not causally linked to particular health effects at environmentally relevant concentrations
  - Select Chemicals of Potential Concern
  - Establish relationship w/adverse health effects
  - Determine critical health effect
  - Evaluate scientific weight of evidence

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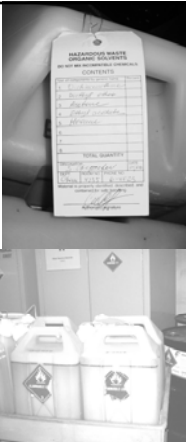
## Hazard Identification

- Review a range of data
  - Structure/Activity Relationships
  - In vitro assays
  - Animal studies
  - Human studies (epidemiological studies)
- IRIS website  
<http://www.epa.gov/iris/>



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## Laboratory Solvents



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## Solvent Commingling



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## Solvent Commingling/Bulking



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## Hazard Identification

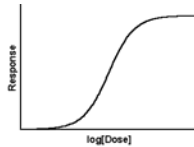
Table 1: Information related to COCs in air at a hazardous waste bulking facility

Chemical of Concern (COC)	95 UCLM Conc. In Air (mg/m <sup>3</sup> ) with ventilation	95 UCLM Conc. In Air (mg/m <sup>3</sup> ) without ventilation	Target Organ
benzene	78.22	3.66	Blood
carbon tetrachloride	5.83	75.23	Liver, kidneys and central nervous system.
chlorobenzene	1.87	0.06	Liver, kidneys, and brain.
chloroform	185.76	317.21	Liver and kidneys
ethylbenzene	39.08	39.29	Nervous system, liver, kidneys, eyes
methylene chloride	402.70	1195.07	Central nervous system
toluene	127.56	112.75	Nervous system
1,1,1-trichloro-ethane	67.70	75.27	
trichloro-monofluoro-methane	4.43	3.80	
M-xylene, P-xylene	92.68	104.51	Skin, lungs

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## Dose-Response (Toxicity) Assessment

- The determination of the relationship between the magnitude of the administered, applied, or absorbed dose and the probability of occurrence and magnitude of health effects
- NOAEL/LOAEL/RfD
- Uncertainty factor (UF)
- Modification factor (MF)



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## Toxicity Assessment - Chronic

Table 2: Summary of derivation of reference doses

Chemical of Concern	Source	Critical effect	Point of Departure	UF	MF	RIC-inh (mg/m <sup>3</sup> )	RfD-inh (mg/kg-day)
benzene	I	Decreased lymphocyte count	BMCL: 8.2 mg/m <sup>3</sup>	300	1	0.03	8.6E-03
carbon tetrachloride	M	Hepatic	MRL: 0.3 ppm	30			5.00E-02
chlorobenzene	P						1.4E-02
chloroform	E						1.4E-02
ethylbenzene	I	Developmental toxicity	NOAEL: 434 mg/m <sup>3</sup>	300	1	1	2.90E-01
methylene chloride	M	Hepatic	MRL: 0.3 ppm	30		0.3	3.00E-01
toluene	I	Neurological effects in occupationally-exposed workers	NOAEL: 46 mg/m <sup>3</sup>	10	1	5	1.40E+00
1,1,1-trichloro-ethane		Not assessed					
trichloro-monofluoro-methane	A						2.00E-01
M-xylene, P-xylene	I	Impaired motor coordination	NOAEL: 39 mg/m <sup>3</sup>	300	1	0.1	3.00E-02

Sources: I = IRIS H = HEAST A = HEAST Alternate M = ATSDR MRL (chronic)  
E = EPA/NCES provisional value O = other P = EPA provisional peer-reviewed value

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## Toxicity Assessment - Cancer

Table 3: Summary of derivation of Cancer Slope Factor (CSF)

Chemical of Concern	CSF-inh (mg/kg-day) <sup>-1</sup>	Air Unit Risk per ug/m <sup>3</sup>	Tumor Type and Test Species
benzene	2.7E-02	.0000022-.0000078	Leukemia in human
carbon tetrachloride	5.30E-02	0.000015	Hepatocellular carcinomas/hepatomas in hamster, mouse and rat
chloroform	8.10E-02	0.000023	Hepatocellular carcinoma in mouse
methylene chloride	1.65E-03	4.7E-07	Combined adenomas and carcinomas in mouse

Source: IRIS

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## Exposure Assessment

- The determination or valuation of exposure to each chemical by exposure medium, receptor of concern, and exposure route:
  - Environmental media
  - Receptors
  - Routes
  - Cumulative exposure

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## Exposure Assessment

$$ADD = \frac{C \times IR \times EF \times ED \times AF \times CF}{BW \times AT} \quad (1)$$

ADD = average daily dose (mg/kg-day)  
 C = concentration in a specific medium (mg/l or mg/kg)  
 IR = ingestion or intake rate (mg/day) = 1.6 m<sup>3</sup>/hr  
 EF = exposure frequency (day/yr)  
 ED = exposure duration (yr)  
 AF = absorption factor (unitless)  
 CF = conversion factor (where needed)  
 BW = average body weight (kg) = 70 kg  
 AT = averaging time (days)

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## Exposure Assessment

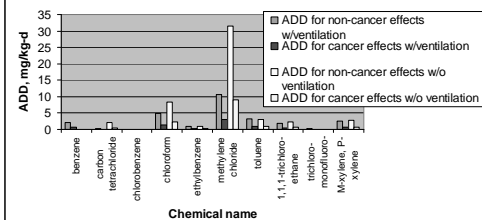
Table 4: Reported exposure frequency (EF) and duration (ED) by university

University	hr/wk	wk/yr	EF hr/yr	EDmin yr	EDmax yr
A	4	18	72	5	15
B			100	15	20
C	10	42	420	15	15
D	2	48	96	1	6
E	8	48	384	1	8
F	3	45	135	2	4
G	8	48	384	1	4
H	2	35	69	1	5
I	0.5	48	24	5	15
J	1.5	40	60	7	25

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## ADD for high exposure

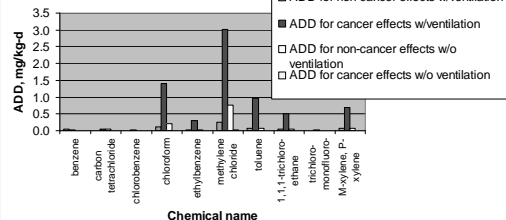
Figure 1: ADD (mg/kg-d) for each chemical for high end exposure



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## ADD for low exposure

Figure 2: ADD (mg/kg-day) for each chemical for low end exposure



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## Risk Characterization

- The likelihood of injury, disease, or death resulting from human exposure to a potential environmental hazard
- Includes discussion of uncertainty and variability

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## Carcinogenic Risk

$$\text{Risk} = L(\text{ADD}) \times \text{CSF}$$

Where:

Risk = a unitless probability of an individual developing excess cancer

L(ADD) = chronic lifetime daily dose average over 70 years (mg/kg-d)

CSF = cancer slope (or potency) factor (mg/kg-d)<sup>-1</sup>

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## Non-carcinogenic risk

$$\text{Hazard Quotient (HQ)} = \text{ADD}/\text{RfD}$$

where RfD = reference dose (mg/kg-day)

Hazard Index (HI) = Sum of HQs for specific chemical or specific target organ

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## Risk Characterization - Chronic

Table 6: The HQ estimates for individual chemicals

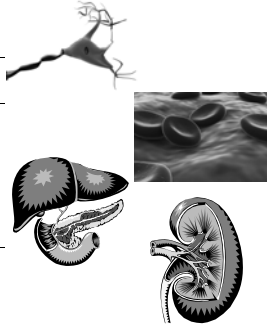
Ventilation?	Yes			No		
	High exposure HQ	Low exposure HQ	Percent attributable to each chemical	High exposure HQ	Low exposure HQ	Percent attributable to each chemical
Chemical of Concern (COC)						
benzene	239.23	5.70	33.3	11.21	0.04	1.3
carbon tetrachloride	3.07	0.07	0.4	39.57	0.14	4.7
chlorobenzene	3.51	0.08	0.5	0.11	0.00	0.0
chloroform	348.97	8.31	48.6	595.92	2.13	70.2
ethylbenzene	3.54	0.08	0.5	3.56	0.01	0.4
methylene chloride	35.30	0.84	4.9	104.77	0.37	12.3
toluene	2.40	0.06	0.3	2.12	0.01	0.2
trichloro-monofluoro-methane	0.58	0.01	0.1	0.50	0.00	0.1
M-xylene, P-xylene	81.25	1.93	11.3	91.63	0.33	10.8
HI	717.86	17.09		849.40	3.03	

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## Risk Assessment - Chronic

Table 8: Cumulative HIs for target organs

Target Organ	HI w/ventilation	HI w/o ventilation
High exposure scenario		
CNS	44.3	150.0
Liver, kidneys	359.1	639.2
Blood	239.2	11.2
Skin, lungs	81.3	91.6
Low exposure scenario		
CNS	1.1	0.5
Liver, kidneys	8.5	2.3
Blood	5.7	0.0
Skin, lungs	1.9	0.3



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## Risk Characterization - Cancer

Table 7: ECR estimates for individual chemicals

Ventilation?	Yes			No		
	High exposure ECR	Low exposure ECR	Percent attributable to each chemical	High exposure ECR	Low exposure ECR	Percent attributable to each chemical
Chemical of Concern (COC)						
benzene	1.6E-02	5.7E-05	11.6	7.4E-04	2.7E-06	0.3
carbon tetrachloride	2.3E-03	8.3E-06	1.7	3.0E-02	1.1E-04	12.6
chloroform	1.1E-01	4.0E-04	83.0	1.9E-01	6.9E-04	80.9
methylene chloride	5.0E-03	1.8E-05	3.7	1.5E-02	5.3E-05	6.2
Total	1.4E-01	4.9E-04		2.4E-01	8.5E-04	

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## Uncertainties

- Variability in the types of facilities and the ventilation
- Variability of the solvents that are bulked
- Only examined the top ten most prevalent chemicals
- Assumption of cumulative combined health effects of these chemicals

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## Risk Management: Engineering Controls



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## Personal Protective Equipment



## Acknowledgements

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