

## 6 TOXICITY ASSESSMENT

The toxicity assessment weighs the available evidence regarding the potential for particular chemicals to cause adverse effects in an exposed individual. The assessment also considers the relationship between the extent of an exposure to a chemical and the increased likelihood and/or severity of effects. Information pertaining to doses and effects is typically reported in literature as the results of a combination of human epidemiological studies, animal experimentation data, and other bioassays. Two broad categories of chemically induced disease states were evaluated in this toxicity assessment: cancer and noncancer health effects. The exposure assessment estimates the chronic dosage of chemicals received by an individual in a given exposure scenario, and the toxicity assessment links adverse effects associated with exposure to the particular chemical. The dose received determines the magnitude of anticipated adverse effects.

### 6.1 TOXICITY VALUES FOR CHRONIC EXPOSURES

Toxicity values are used in risk characterization to quantify the probability of observing cancer and noncancer effects in a potentially exposed human receptor. Two types of toxicity values are used to express a chemical's dose-response-effect relationship for chronic exposures:

- a cancer slope factor (CSF) for estimating the likelihood of carcinogenic effects (based on evidence that a chemical is a known or probable human carcinogen)
- a reference dose (RfD) for estimating possible noncarcinogenic effects (based on an estimate of the daily exposure to a human population, including sensitive subpopulations, that is unlikely to cause an increased incidence of deleterious health effects during a lifetime of exposure)

In general, CSF values (expressed in units of  $(\text{mg COPC}/\text{kg of body weight}\cdot\text{day})^{-1}$ ) and RfD values (expressed in units of  $\text{mg COPC}/\text{kg of body weight}\cdot\text{day}$ ) are derived from long-term animal studies and incorporate uncertainty factors (UFs) to compensate for extrapolation of observed adverse effects in laboratory animals to estimate possible adverse effects of chemicals in humans. If adequate human data from epidemiological studies are available, these data are used to reduce uncertainty in deriving toxicity values.

RfDs and CSFs were obtained from information sources based on the hierarchy of human health toxicity values described in Office of Solid Waste and Emergency Response (OSWER) Directive 9285.7-53 (USEPA, 2003) and consistent with CDPHE's Policy on Use of Human Health Toxicity Values in Environmental Risk Assessment and Remediation Management (2004). The recommended toxicity value hierarchy is as follows:

- Tier 1 - USEPA's Integrated Risk Information System (IRIS)
- Tier 2 - USEPA's provisional peer reviewed toxicity values
- Tier 3 - Other toxicity values, including:
  - The California EPA - Office of Environmental Health Hazard Assessment (OEHHA) Toxicity Criteria Database
  - The ATSDR minimal risk levels (MRLs)
  - USEPA Region IX preliminary remediation goal (PRG) tables (USEPA, 2002c)

These information sources provide lists of available, verifiable toxicity values for various chemicals. These information sources do not, however, provide toxicity values for mustard

agent. Mustard toxicity was evaluated using RfDs and CSFs published by the Army and reported by the Agency for Toxic Substance and Disease Registry (ATSDR, 2003).

Twenty-four COPCs that may potentially be present in PCAPP emissions do not have verifiable toxicity values available from the sources listed in the hierarchy above, and therefore cannot be included in the quantifiable risk assessment. In an attempt to identify toxicity data from possible sources outside this hierarchy, the BPT submitted a data request to the Chemical, Biological, Radiological, & Nuclear Defense Information Analysis Center (CBRNIAC) for any available human toxicity data for the 24 COPCs with no available toxicity values. The CBRNIAC could only find published human health effects information for the following COPCs:

- 1,2,3-trichlorobenzene
- 1,2-dichlorobutane
- 1-hexene
- 2-hexanone
- ethane
- ethene
- methane
- octane
- pentane
- tert-butyl alcohol
- thiirane
- thiodiglycol

Although the available data indicate various levels of adverse health effects associated with exposure to each of these 12 COPCs, no toxicity values have been developed from the available study data. A discussion of the impact of this data gap is included in the uncertainty assessment in Section 8, and the impact has been evaluated qualitatively. In addition, USEPA has recommended the use of age-dependent adjustment factors for carcinogens acting through a mutagenic mode of action. Specifically, the added risk from early-life exposure to vinyl chloride should be accounted for in quantitative risk estimates by a two-fold UF (USEPA, 2005c). The impact of this UF is also included in the uncertainty assessment in Section 8.

Table 6-1 presents the RfDs and CSFs obtained from various sources based on the hierarchy presented above.

## 6.2 TOXICITY VALUES FOR SHORT-TERM EXPOSURES

Acute inhalation exposure criteria (AIEC) were selected for each COPC using the hierarchical approach recommended in the HHRAP (USEPA, 2005a) and presented below in order of preference:

- Cal/EPA acute Reference Exposure Levels (RELs)
- Acute Inhalation Exposure Guidelines (AEGL-1)
- Level 1 Emergency Response Planning Guidelines (ERPG-1)
- Temporary Emergency Exposure Limits (TEEL-1)
- AEGL-2 values

Table 6-1. Toxicity Values for Chronic Exposures

COPC	Cancer Slope Factor				Reference Dose			
	Inhalation		Oral		Inhalation		Oral	
	(mg COPC/kg body weight-day) <sup>-1</sup>	Reference	(mg COPC/kg body weight-day) <sup>-1</sup>	Reference	(mg COPC/kg body weight-day)	Reference	(mg COPC/kg body weight-day)	Reference
1,1,2,2-tetrachloroethane	0.2	IRIS	0.2	IRIS	0.06	Reg. 9 PRG	0.06	Reg. 9 PRG
1,1-dichloroethane	0.0057	Cal/EPA	0.0057	Cal/EPA	1.40E-01	Reg. 9 PRG	0.1	Reg. 9 PRG
1,2,4-trichlorobenzene	n/a		3.60E-03	Cal/EPA	0.001	Reg. 9 PRG	0.01	IRIS
1,2,4-trimethyl benzene	n/a		n/a		1.70E-03	Reg. 9 PRG	5.00E-02	Reg. 9 PRG
1,2-dichloroethane	0.091	IRIS	0.091	IRIS	6.90E-01	ATSDR MRL	0.02	Reg. 9 PRG
1,2-dichloropropane	0.068	Reg. 9 PRG	0.068	Reg. 9 PRG	0.0011	IRIS	0.09	ATSDR MRL
1,4-dioxane	0.011	Reg. 9 PRG	0.011	IRIS	1.03	ATSDR MRL	0.1	ATSDR MRL
1,4-dithiane	n/a		n/a		1.00E-02	Reg. 9 PRG	1.00E-02	IRIS
1-chlorobutane	n/a		n/a		4.00E-01	Reg. 9 PRG	4.00E-01	Reg. 9 PRG
2-butanone (MEK)	n/a		n/a		1.4	IRIS	6.00E-01	IRIS
3-methyl phenol	n/a		n/a		5.00E-02	Reg. 9 PRG	5.00E-02	IRIS
4-methyl phenol	n/a		n/a		5.00E-03	Reg. 9 PRG	5.00E-03	Reg. 9 PRG
4-methyl-2-pentanone (MIBK)	n/a		n/a		8.60E-01	IRIS	8.00E-02	Reg. 9 PRG
Acetaldehyde	7.70E-03	IRIS	no data		0.0026	IRIS	no data	
Acetone	n/a		n/a		8.80E+00	ATSDR MRL	9.00E-01	IRIS
Acrolein	n/a		n/a		5.71E-06	IRIS	5.00E-04	IRIS
alpha-methylstyrene	n/a		n/a		7.00E-02	Reg. 9 PRG	7.00E-02	Reg. 9 PRG
Ammonia	Na		n/a		2.86E-02	IRIS	no data	
Benzene	2.70E-02	IRIS	5.50E-02	IRIS	8.60E-03	IRIS	4.00E-03	IRIS
carbon disulfide	n/a		n/a		2.00E-01	IRIS	1.00E-01	IRIS
Chloroethane	2.90E-03	Reg. 9 PRG	2.90E-03	Reg. 9 PRG	2.86E+00	IRIS	4.00E-01	Reg. 9 PRG
Chloroform	8.10E-02	IRIS	3.10E-02	Cal/EPA	1.40E-02	Reg. 9 PRG	1.00E-02	IRIS
Chloromethane	n/a		n/a		2.60E-02	IRIS	2.60E-02	Reg. 9 PRG
diethyl ether	n/a		n/a		2.00E-01	Reg. 9 PRG	2.00E-01	IRIS
Ethylbenzene	n/a		n/a		2.90E-01	IRIS	1.00E-01	IRIS
HD	2.98E+02	USEPA	7.70E+00	USACHPPM	6.00E-06	USACHPPM	7.00E-06	USACHPPM
Hexachlorobutadiene	7.70E-02	IRIS	7.80E-02	IRIS	0.0003	Reg. 9 PRG	0.0003	Reg. 9 PRG
Hexachloroethane	1.40E-02	IRIS	1.40E-02	IRIS	0.001	Reg. 9 PRG	0.001	IRIS
Hexane	n/a		n/a		2.00E-01	IRIS	1.10E+01	Reg. 9 PRG
methyl tert-butyl ether	9.10E-04	Reg. 9 PRG	1.80E-03	Reg. 9 PRG	8.60E-01	IRIS	8.60E-01	Reg. 9 PRG
methylene chloride	1.60E-03	IRIS	7.50E-03	IRIS	8.60E-01	Reg. 9 PRG	6.00E-02	IRIS
Naphthalene	1.20E-01	Cal/EPA	no data		8.60E-04	IRIS	2.00E-02	IRIS
Propene	n/a		n/a		0.86	Cal/EPA	no data	
Tetrachloroethene	2.10E-02	Reg. 9 PRG	5.40E-01	Reg. 9 PRG	1.00E-02	Reg. 9 PRG	1.00E-02	IRIS
Toluene	n/a		n/a		1.4	IRIS	8.00E-02	IRIS
Trichloroethene	4.00E-01	Reg. 9 PRG	4.00E-01	Reg. 9 PRG	1.00E-02	Reg. 9 PRG	3.00E-04	Reg. 9 PRG
vinyl chloride	3.08E-02	IRIS	1.50E+00	IRIS	2.90E-02	IRIS	3.00E-03	IRIS
Xylenes	n/a		n/a		2.90E-02	IRIS	2.00E-01	IRIS

Notes:

n/a - not applicable. This chemical is not a known carcinogen.

Cal/EPA - California EPA, Office of Environmental Health Hazard Assessment (OEHA) Toxicity Criteria Database.

Reg. 9 PRG - USEPA Region IX PRG tables.

USEPA - Koppikar, A., R. McGaughey, AND L. Rhomberg. "Upper-Bound Quantitative Cancer Risk Estimates for Population Adjacent to Sulfur Mustard Incineration Facilities." U.S. Environmental Protection Agency, Washington, D.C., EPA/600/8-91/053 (NTIS PB92137207).

USACHPPM - "Derivation of Health-Based Environmental Screening Levels for Chemical Warfare Agents - A Technical Evaluation." March 1999, US Army Center for Health Promotion and Preventive Medicine.

ASTDR MRL - The Agency of Toxic Substances and Disease Registry (ASTDR) Minimal Risk Levels (MRLs).

As directed by the HHRAP (USEPA, 2005a), if an instance occurred when an AEGL-1 value was not available but an AEGL-2 value was available, the AEGL-2 value was selected as the AIEC only when it was a more protective value (i.e., lower in concentration) than an ERPG-2 or TEEL-1 value, if either of these values was available.

Table 6-2 presents the acute toxicity data obtained from all hierarchical sources, as well as the AIEC used to estimate potential acute hazards for each COPC evaluated in this MPHRA.

Table 6-2. Toxicity Values for Acute Exposures<sup>a</sup>

COPC	Cal/EPA Acute REL	AEGL-1	AIHA ERPG-1	TEEL-1	AEGL-2	Selected Acute Inhalation Exposure Criteria	
	(mg/m <sup>3</sup> )	(mg/m <sup>3</sup> )	(mg/m <sup>3</sup> )	(mg/m <sup>3</sup> )	(mg/m <sup>3</sup> )	(mg/m <sup>3</sup> )	Averaging Time
1,1,1,2-tetrachloroethane				20		20	15-minute
1,1-dichloroethane				1,250		1,250	15-minute
1,2,3-trichlorobenzene				15		15	15-minute
1,2,4-trimethyl benzene		688		150	1,769	688	1-hour
1,2-dichloroethane			202	202		202	1-hour
1,2-dichloropropane				500		500	15-minute
1,4-dioxane	3	61		35	1,152	3	1-hour
1,4-oxathiane				50		50	15-minute
1-chlorobutane				75		75	15-minute
1-hexene				100		100	15-minute
2-butanone (MEK)	13	589		590	7,958	13	1 hour
2-hexanone				40		40	15-minute
3-methyl phenol				20		20	15-minute
4-methyl phenol				20		20	15-minute
4-methyl-2-pentanone (MIBK)				300		300	15-minute
acetaldehyde		81	18	18	487	81	1-hour
acetone		475		475	7,597	475	1-hour
acrolein	0.00019	0.069	0.11	0.069	0.2	0.00019	1-hour
alpha-methylstyrene				500		500	15-minute
ammonia	3	21	17	21	111	3	1-hour
benzene	1	166	160	156	2,554	1	6-hour
carbon disulfide	6	40	3	13	498	6	6-hour
chloroethane				2,500		2,500	15-minute
chloroform	0.15	NR	n/a	10	312	0.15	7-hour
chloromethane		NR	n/a	200	1,878	200	15-minute
diethyl ether				1,500		1,500	15-minute
ethane				3,500		3,500	15-minute
ethene				600		600	15-minute
ethylbenzene				500		500	15-minute
HD (bis (2-chloroethyl) sulfide)		0.065		0.065	0.13	0.065	1-hour
hexachlorobutadiene			11	11		11	1-hour
hexachloroethane				30		30	15-minute
hexane		NR		500	11,627	500	15-minute
methyl tert-butyl ether		180		500	2,055	180	1-hour
methylene chloride	14	694		696	1,944	14	1-hour
naphthalene				75		75	15-minute
octane				1,250		1,250	15-minute
pentane				1,500		1,500	15-minute
propene				2,500		2,500	15-minute
tert-butyl alcohol				400		400	15-minute
tetrachloroethene	20	237	678	689	1,559	20	1-hour
thiodiglycol				75		75	15-minute
toluene	37	753	188	753	1,921	37	1-hour
trichloroethene		698	537	698	2,417	698	1-hour
vinyl chloride	180	639	1,277	1,300	3,066	180	1-hour
xylenes	22	564		564	3,992	22	1-hour

a. Only the 46 COPCs with acute toxicity values are listed in the table.

Notes:

Cal/EPA Acute REL – California EPA Acute Reference Exposure Level.

AEGL-1 – Acute Exposure Guideline Level 1.

AIHA ERPG-1 – American Industrial Hygiene Association Level 1 Emergency Response Planning Guidelines (ERPG).

TEEL-1 – United States Department of Energy (DOE) Temporary Emergency Exposure Limits.

AEGL-2 – Acute Exposure Guideline Level 2.

AEGL-1 and AEGL-2 values for acetaldehyde, acetone, and vinyl chloride are interim values.

AEGL-1 and AEGL-2 values for 1, 2, 4-trimethyl benzene and methyl tert-butyl ether are proposed values.

All AEGL-1, AEGL-2, and AIHA ERPG-1 data were provided in parts per million. Conversion to mg/m<sup>3</sup> was completed using a temperature and pressure of 25°C and 1 atmosphere, respectively.

NR – not recommended due to insufficient data.

n/a – not appropriate.

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