



# **Health Effects Assessment Summary Tables**

**Second Quarter  
FY 1989**

## DISCLAIMER

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3/89 UPDATE OF HEA SUMMARY TABLES:  
CHANGES FROM 12/88 ECAO-CIN VERSION

GENERIC ISSUES:

There were no changes in format or the groundrules for compiling the HEA Summary Tables from the 12/88 update.

CHEMICAL-SPECIFIC CHANGES TO TABLE A: OTHER THAN CARCINOGENICITY

Arsenic

The oral RfD value that was verified on 5/25/88 ( $1E-3$ ) is currently under review for issues such as variability of exposure data and application of uncertainty factors. Therefore both the chronic and subchronic RfD values have been deleted from the table.

DDT

The U.S. EPA (1987) citation in the Reference column has been changed to U.S. EPA (1988) to reflect the date of the updated Health Assessment Document, and this latter reference has been added to the References Section.

1,2-Dichlorobenzene

The subchronic oral reference dose of  $4E-1$  was a typographical error and has been corrected to  $9E-1$ . A new chronic oral reference dose of  $9E-2$  has been recently verified by the U.S. EPA (1989). The new oral RfD has been incorporated into Table A, as well as appropriate revisions in all relevant columns. The U.S. EPA (1985b) citation has been deleted.

CHEMICAL-SPECIFIC CHANGES TO TABLE B: CARCINOGENICITY

Arsenic

The footnote indicator K has been added to the oral potency slope column to reflect the fact that an oral unit risk of  $5E-5(\mu/l)^{-1}$  has been proposed by the Risk Assessment Forum. This recommendation has been scheduled for SAB review and the HEA summary table will be updated when the review is completed.

Asbestos

The slope factor has been changed to  $2.4E-1$  (fibers/ml) $^{-1}$  to reflect the new value recently verified by the Crave Work Group (11/30/88), but not yet available on IRIS. The Monthly CRAVE Status Report (2/28/89) indicates that the Work Group still needs to clarify the use of 10% of risk of lung tumors as the risk of GI tumors. The U.S. EPA (1987) citation was deleted.

Hexachlorobenzene

A new oral slope factor of  $1.7E+0$  based on the Cabral et al. (1977) study has been verified. This revised oral slope factor has also been verified for inhalation exposure. Pertinent changes were made in all columns of Table B. The Lambrecht et al. references have been deleted from the list of References, whereas the Cabral et al. (1977) has been added.

Methylene chloride

The synonym "dichloromethane", which is also used for methylene chloride, has been added to the Compound Identification column in Table B.

PCBs

The name "polychlorinated biphenyls" has been added under the acronym PCB in the Compound Identification column in Table B.

2,3,7,8-TCDD

The oral slope factor of  $1.56 \times 5$  has now been verified by the CRAVE Work Group and has also been adopted as slope factor for inhalation exposure. Pertinent changes were made in all relevant columns.

## INTRODUCTION: USER'S GUIDE

The Health Effects Assessment Summary Tables A & B summarize reference doses (RfDs) for toxicity due to subchronic and chronic inhalation and oral exposure (Table A) and  $q_1^*$  and unit risk slope values for carcinogenicity due to lifetime inhalation and oral exposure (Table B). The chemicals included in the tables are the subjects of Health Effects Assessment documents (HEAs) and Health and Environmental Effects Documents (HEEDs). The information in HEA Summary Tables A and B is excerpted from the HEAs and HEEDs and expanded and updated quarterly to include chemicals addressed in HEAs and HEEDs that have been finalized since the last update and to bring existing values into conformity with more recent EPA assessments, especially RfD or CRAVE Work Group verifications. The references listed for each chemical in the Reference column and References section represent not only the study or studies that are the basis for the RfD,  $q_1^*$  or unit risk slope, but also the U.S. EPA reference that is the source of the Agency analysis or risk assessment values and the IRIS citation for values verified by the RfD or CRAVE work group. Verified values are indicated in the tables by a footnote.

The RfD is an estimate (with uncertainty spanning perhaps an order of magnitude) of the daily exposure to the human population that is likely to be without an appreciable risk of deleterious effect during a portion of the lifetime, in the case of a subchronic RfD (designated "RfD<sub>s</sub>" in Table A and formerly called AIS), or during the lifetime, in the case of a chronic RfD (designated "RfD" in Table A and formerly called AIC). The RfD values are listed in Table A in the column under "Reference Dose". The RfD is

derived by dividing the NOAEL (or LOAEL if a suitable NOAEL is not available) for subchronic or chronic exposure by an uncertainty factor (UF) times a modifying factor (MF):

$$RfD = \frac{\text{NOAEL or LOAEL}}{UF \times MF}$$

In Table A, the NOAEL or LOAEL that is the basis for the RfD value is listed under "Exposure". When a NOAEL or LOAEL is reported in terms of exposure concentration and schedule, the calculated mg/kg/day dose is given in parentheses. The species in which the NOAEL or LOAEL was determined and the effect of concern are also described, and the reference for the study is presented. In the "Exposure", "Effect of Concern" and "Reference" columns, information for the inhalation route is given first, separated from information for the oral route by a semicolon or slash.

The uncertainty factor used in calculating the RfD reflects scientific judgment regarding the various types of data used to estimate RfD values. An uncertainty factor of 10 is usually used to account for variations in human sensitivity when extrapolating from valid human studies involving subchronic (for RfD<sub>s</sub>) or long-term (for RfD) exposure of average, healthy subjects. An additional 10-fold factor is usually used for each of the following extrapolations: from long-term animal studies to the case of humans, from a LOAEL to a NOAEL, and from subchronic studies to a chronic RfD. In order to reflect professional assessment of the uncertainties of the study and data base not explicitly addressed by the above uncertainty factors (e.g., completeness of the overall data base), an additional

uncertainty factor or modifying factor ranging from >1 to 10 is applied. The default value for this modifying factor is 1.

Table A lists the uncertainty factor and modifying factor, multiplied together to form a single factor, under the heading "Uncertainty Factor". For example, the uncertainty factor of 500 listed for the chronic oral RfD for cyanide reflects an uncertainty factor of 100 and a modifying factor of 5; the uncertainty factor of 100 listed for the subchronic inhalation RfD for bromomethane reflects an uncertainty factor of 100 and a modifying factor of 1.

RfD values are specific for the route of exposure for which they are listed on Table A. In the few instances where an oral RfD has been extrapolated from inhalation data, the extrapolation is indicated by footnoting the value.

RfD values for inhalation exposure are reported both as a concentration in air (in  $\text{mg}/\text{m}^3$  for continuous, 24 hours/day exposure) and as a corresponding inhaled dose (in  $\text{mg}/\text{kg}/\text{day}$ ). RfD values for oral exposure are reported as  $\text{mg}/\text{kg}/\text{day}$ . An oral RfD value can be converted to a corresponding concentration in drinking water, assuming human body weight of 70 kg and water consumption of 2  $\text{l}/\text{day}$ , as follows:

$$\text{mg/l in water} = \frac{\text{oral RfD (in mg/kg/day)} \times 70 \text{ kg}}{2 \text{ l/day}}$$

The RfD is used as a reference point for gauging the potential effects of other doses. Usually, doses that are less than the RfD are not likely to be associated with health risks. As the frequency of exposures exceeding the RfD increases, and as the size of the excess increases, the probability increases that adverse health effects may be observed in a human population.



Nonetheless, a clear distinction that would categorize all doses below the RfD as "acceptable" (risk-free) and all doses in excess of the RfD as "unacceptable" (causing adverse effects) cannot be made. In addition, RfD values, and particularly those with limitations in the quality or quantity of supporting data, are subject to change as additional information becomes available.

When RfD values are listed for chemicals that are carcinogens, the entry under "Effect of Concern" in Table A will list cancer and will refer to Table B if additional information concerning carcinogenicity is available in that table. RfD values that have been derived for carcinogens are based on noncancer endpoints and should not be assumed to be protective against carcinogenicity.

In assessing the carcinogenic potential of a chemical, the Carcinogen Assessment Group (CAG) of the U.S. EPA classifies the chemical into one of the following groups, according to the weight of evidence from epidemiological studies and animal studies:

- Group A - Human Carcinogen (sufficient evidence of carcinogenicity in humans)
- Group B - Probable Human Carcinogen (B1 - limited evidence of carcinogenicity in humans; B2 - sufficient evidence of carcinogenicity in animals with inadequate evidence in humans)
- Group C - Possible Human Carcinogen (limited evidence of carcinogenicity in animals, in the absence of human data)
- Group D - Not Classifiable as to Human Carcinogenicity (inadequate or no evidence)
- Group E - Evidence of Noncarcinogenicity for Humans (no evidence of carcinogenicity in adequate studies).

These classifications are shown under "EPA Group" on Table B.

Quantitative carcinogenic risk assessments are performed for chemicals in Groups A and B, and on a case-by-case basis for chemicals in Group C. Cancer risk and slope (potency) factors are estimated through the use of mathematical extrapolation models, most commonly the linearized multistage model, for estimating the largest possible linear slope (within the 95% confidence limit) at low extrapolated doses that is consistent with the data. The cancer potency or risk is characterized as an upper-bound estimate: i.e., the true risk to humans, while not identifiable, is not likely to exceed the upper-bound estimate and in fact may be lower.

Cancer potency factors listed in Table B include the following:

slope factor or  $q_1^*$  = risk per unit dose = risk per mg/kg/day

unit risk or unit risk slope = risk per concentration unit in  
air or drinking water = risk per  $\mu\text{g}/\text{m}^3$  (air) or risk per  
 $\mu\text{g}/\text{l}$  (water)

The unit risk estimates can be calculated by dividing the  $q_1^*$  by 70 kg and multiplying by the inhalation rate ( $20 \text{ m}^3/\text{day}$ ) or the water consumption rate ( $2 \text{ l}/\text{day}$ ), respectively, for risk associated with unit concentration in air or water. Hence,

$$\text{risk per } \mu\text{g}/\text{m}^3 \text{ (air)} = q_1^* \times \frac{1}{70 \text{ kg}} \times 20 \text{ m}^3/\text{day} \times 10^{-3}$$

$$\text{risk per } \mu\text{g}/\text{l} \text{ (water)} = q_1^* \times \frac{1}{70 \text{ kg}} \times 2 \text{ l}/\text{day} \times 10^{-3}$$

Quantitative estimates of carcinogenic risk are listed under " $q_1^*$  or Unit Risk Slope" in Table B. Information on the study and data set used for estimation of the cancer potency factor is given in the other columns of

Table B. In the "Exposure" and "Reference" columns, information for the inhalation route is given first, separated from information for the oral route by a semicolon or slash.

Cancer potency factors are specific for the route of exposure for which they are listed on Table B. Footnotes are used in Table B to indicate those instances in which the values for inhalation or oral exposure are based on extrapolation from another route of exposure.

To estimate risk-specific concentrations in air from the unit risk slope in air as presented in Table B, the specified level of risk is divided by the unit risk slope for air. Hence the air concentration (in  $\mu\text{g}/\text{m}^3$ ) corresponding to an upper-bound increased lifetime cancer risk of  $1 \times 10^{-5}$  is calculated as follows:

$$\mu\text{g}/\text{m}^3 \text{ in air} = \frac{1 \times 10^{-5}}{\text{unit risk slope in } (\mu\text{g}/\text{m}^3)^{-1}}$$

To estimate risk-specific concentrations in drinking water from the oral  $q_1^*$  values presented in Table B, the specified level of risk is multiplied by 70 kg and divided by the  $q_1^*$  and by 2  $\text{L}/\text{day}$ . Hence, the water concentration corresponding to an upper-bound increased lifetime cancer risk of  $1 \times 10^{-5}$  is calculated as:

$$\text{mg}/\text{L} \text{ in water} = \frac{1 \times 10^{-5} \times 70 \text{ kg}}{q_1^* \text{ in } (\text{mg}/\text{kg}/\text{day})^{-1} \times 2 \text{ L}/\text{day}}$$

**HEALTH EFFECTS ASSESSMENTS SUMMARY TABLE A: SUBCHRONIC AND CHRONIC TOXICITY (OTHER THAN CARCINOGENICITY)**  
Update: March, 1989

Compound	Exposure Inhalation; Oral	Species		Effect of Concern Inhalation; Oral	Reference Dose		Uncertainty Factor		Reference Inhalation/Oral
		Inhalation	Oral		Inhalation [mg/m <sup>3</sup> (mg/kg/day)]	Oral (mg/kg/day)	Inhalation	Oral	
Acenaphthene				DATA INADEQUATE FOR QUANTITATIVE RISK ASSESSMENT					U.S. EPA, 1987
Acenaphthylene				DATA INADEQUATE FOR QUANTITATIVE RISK ASSESSMENT					U.S. EPA, 1987
Acetone subchronic (RfD <sub>s</sub> )	NA; 100 mg/kg/day for 90 days by gavage	NA	rat	NA; increased liver and kidney weight, nephro- toxicity	ND	NA	NA	100	U.S. EPA, 1988/ U.S. EPA, 1986a,b, 1988
chronic (RfD)	NA; 100 mg/kg/day for 90 days by gavage	NA	rat	NA; increased liver and kidney weight, nephro- toxicity	ND	1E-1 <sup>a</sup>	NA	1000	U.S. EPA, 1988/ U.S. EPA, 1986a,b, 1988
Acetonitrile subchronic (RfD <sub>s</sub> )	100 ppm (168 mg/m <sup>3</sup> ) 6 hours/day, 65/92 days (39.0 mg/kg/day); 100 ppm (168 mg/m <sup>3</sup> ) 6 hours/day, 65/92 days (19.3 mg/kg/day)	mouse	mouse	elevated relative liver weight; elevated relative liver weight	0.5 (1E-1)	6E-2 <sup>b</sup>	300	300	Coate, 1983b; U.S. EPA, 1987a/ Coate, 1983b; U.S. EPA, 1987a
chronic (RfD)	100 ppm (168 mg/m <sup>3</sup> ) 6 hours/day, 65/92 days (39.0 mg/kg/day); 100 ppm (168 mg/m <sup>3</sup> ) 6 hours/day, 65/92 days (19.3 mg/kg/day)	mouse	mouse	decreased RBC counts and hemato- crit and hepatic lesions; decreased RBC counts and hematocrit and hepatic lesions	0.05 (1E-2)	6E-3 <sup>a,b</sup>	3000	3000	Coate, 1983b; U.S. EPA, 1987a/ Coate, 1983b; U.S. EPA, 1987a,b
Acetophenone subchronic (RfD <sub>s</sub> )	0.007 mg/m <sup>3</sup> contin- uously for 70 days (0.0045 mg/kg/day); 10,000 ppm diet (8450 ppm, correcting for volatilization) for 17 weeks (423 mg/kg/day)	rat	rat	congestion of cardiac vessels and liver dys- trophy, reduced albumin/globulin ratio; none observed	2E-4 (5E-5)	1E+0	100	300	Imasheva, 1966; U.S. EPA, 1987a/ Hagan et al., 1967; U.S. EPA, 1987b

HEALTH EFFECTS ASSESSMENTS SUMMARY TABLE A: SUBCHRONIC AND CHRONIC TOXICITY (OTHER THAN CARCINOGENICITY)  
Update: March, 1989

Compound	Exposure Inhalation; Oral	Species		Effect of Concern Inhalation; Oral	Reference Dose		Uncertainty Factor		Reference Inhalation/Oral
		Inhalation	Oral		Inhalation [mg/m <sup>3</sup> (mg/kg/day)]	Oral (mg/kg/day)	Inhalation	Oral	
Acelophenone chronic (RfD)	0.007 mg/m <sup>3</sup> continuously for 70 days (0.0045 mg/kg/day); 10,000 ppm diet (8450 ppm, correcting for volatilization) for 17 weeks (423 mg/kg/day)	rat	rat	congestion of cardiac vessels and liver dystrophy, reduced albumin/globulin ratio; none observed	2E-5(5E-6)	1E-1 <sup>a</sup>	1000	3000	Imasheva, 1966; U.S. EPA, 1987a; Hagan et al., 1967; U.S. EPA, 1987b
Adiponitrile				DATA INADEQUATE FOR QUANTITATIVE RISK ASSESSMENT					U.S. EPA, 1987
Aldrin subchronic (RfD <sub>s</sub> )	NA; 0.5 ppm in diet for 2 years (0.025 mg/kg/day)	NA	rat	NA; liver lesions	ND	3E-5	NA	1000	NA/Fitzhugh, et al., 1964; U.S. EPA, 1985
chronic (RfD)	NA; 0.5 ppm in diet for 2 years (0.025 mg/kg/day)	NA	rat	NA; liver lesions (Cancer: see Table B)	ND	3E-5 <sup>a</sup>	NA	1000	NA/Fitzhugh et al., 1964; U.S. EPA, 1985
Aluminum				DATA INADEQUATE FOR QUANTITATIVE RISK ASSESSMENT					U.S. EPA, 1987
Ammonia subchronic (RfD <sub>s</sub> ) 9934 mg/L in drinking water	0.36 mg/m <sup>3</sup> continuous;	human	human	odor threshold; taste threshold	0.36 <sup>c</sup>	34 mg/L in drinking water <sup>d</sup>	none	none	Carson et al., 1981; U.S. EPA, 1987/Campbell et al., 1958; U.S. EPA, 1981, 1987; WHO, 1986
chronic (RfD)	0.36 mg/m <sup>3</sup> continuous; 34 mg/L in drinking water	human	human	odor threshold; taste threshold	0.36 <sup>c</sup>	34 mg/L in drinking water <sup>d</sup>	none	none	Carson et al., 1981; U.S. EPA, 1987/Campbell et al., 1958; U.S. EPA, 1981, 1987; WHO, 1986

HEALTH EFFECTS ASSESSMENTS SUMMARY TABLE A: SUBCHRONIC AND CHRONIC TOXICITY (OTHER THAN CARCINOGENICITY)  
Update: March, 1989

Compound	Exposure Inhalation; Oral	Species		Effect of Concern Inhalation; Oral	Reference Dose		Uncertainty factor		Reference Inhalation/Oral
		Inhalation	Oral		Inhalation [mg/m <sup>3</sup> (mg/kg/day)]	Oral (mg/kg/day)	Inhalation	Oral	
Antimony and Compounds									
Antimony									
subchronic (RfD <sub>s</sub> )	NA; 5 ppm Sb from antimony potassium tartrate in drinking water, lifetime (0.35 mg Sb/kg/day)	NA	rat	cancer; reduced lifespan, altered blood chemistries	NDe	4E-4	NA	1000	U.S. EPA, 1987/ Schroeder et al., 1970; U.S. EPA, 1985b
chronic (RfD)	NA; 5 ppm Sb from antimony potassium tartrate in drinking water, lifetime (0.35 mg Sb/kg/day)	NA	rat	cancer; reduced lifespan, altered blood chemistries	NDe	4E-4 <sup>a</sup>	NA	1000	U.S. EPA, 1987/ Schroeder et al., 1970; U.S. EPA, 1985a,b, 1987
Antimony pentoxide									
subchronic (RfD <sub>s</sub> )	NA; 5 ppm Sb from antimony potassium tartrate in drinking water, lifetime (0.35 mg Sb/kg/day, 0.46 mg Sb <sub>2</sub> O <sub>5</sub> kg/day)	NA	rat	cancer; reduced lifespan, altered blood chemistries	NDe	5E-4 <sup>f</sup>	NA	1000	U.S. EPA, 1987/ Schroeder et al., 1970; U.S. EPA, 1985b
chronic (RfD)	NA; 5 ppm Sb from antimony potassium tartrate in drinking water, lifetime (0.35 mg Sb/kg/day, 0.46 mg Sb <sub>2</sub> O <sub>5</sub> kg/day)	NA	rat	cancer; reduced lifespan, altered blood chemistries	NDe	5E-4 <sup>f</sup>	NA	1000	U.S. EPA, 1987/ Schroeder et al., 1970; U.S. EPA, 1985a,b, 1987
Antimony potassium tartrate									
subchronic (RfD <sub>s</sub> )	NA; 5 ppm Sb from antimony potassium tartrate in drinking water, lifetime (0.35 mg Sb/kg/day, 0.93 mg SbK tartrate/kg/day)	NA	rat	cancer; reduced lifespan, altered blood chemistries	NDe	9E-4 <sup>f</sup>	NA	1000	U.S. EPA, 1987/ Schroeder et al., 1970; U.S. EPA, 1985b,

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Update: March, 1989

Compound	Exposure Inhalation; Oral	Species		Effect of Concern Inhalation; Oral	Reference Dose		Uncertainty Factor		Reference Inhalation/Oral
		Inhalation	Oral		Inhalation {mg/m <sup>3</sup> (mg/kg/day)}	Oral (mg/kg/day)	Inhalation	Oral	
Antimony potassium tartrate chronic (RfD)	NA; 5 ppm Sb from antimony potassium tartrate in drinking water, lifetime (0.35 mg Sb/kg/day, 0.93 mg SbK tartrate/kg/day)	NA	rat	cancer; reduced lifespan, altered blood chemistries	ND <sup>e</sup>	9E-4 <sup>f</sup>	NA	1000	U.S. EPA, 1987/Schroeder et al., 1970; U.S. EPA, 1985b, 1987
Antimony tetroxide subchronic (RfD <sub>S</sub> )	NA; 5 ppm Sb from antimony potassium tartrate in drinking water, lifetime (0.35 mg Sb/kg/day, 0.44 mg Sb <sub>2</sub> O <sub>4</sub> /kg/day)	NA	rat	cancer; reduced lifespan, altered blood chemistries	ND <sup>e</sup>	4E-4 <sup>f</sup>	NA	1000	U.S. EPA, 1987/Schroeder et al., 1970; U.S. EPA, 1985b
chronic (RfD)	NA; 5 ppm Sb from antimony potassium tartrate in drinking water, lifetime (0.35 mg Sb/kg/day, 0.44 mg Sb <sub>2</sub> O <sub>4</sub> /kg/day)	NA	rat	cancer; reduced lifespan, altered blood chemistries	ND <sup>e</sup>	4E-4 <sup>f</sup>	NA	1000	U.S. EPA, 1987/Schroeder et al., 1970; U.S. EPA, 1985a,b, 1987
Antimony trioxide subchronic (RfD <sub>S</sub> )	NA; 5 ppm Sb from antimony potassium tartrate in drinking water, lifetime (0.35 mg Sb/kg/day, 0.42 mg Sb <sub>2</sub> O <sub>3</sub> /kg/day)	NA	rat	cancer; reduced lifespan, altered blood chemistries	ND <sup>e</sup>	4E-4 <sup>f</sup>	NA	1000	U.S. EPA, 1987/Schroeder et al., 1970; U.S. EPA, 1985b
chronic (RfD)	NA; 5 ppm Sb from antimony potassium tartrate in drinking water, lifetime (0.35 mg Sb/kg/day, 0.42 mg Sb <sub>2</sub> O <sub>3</sub> /kg/day)	NA	rat	cancer; reduced lifespan, altered blood chemistries	ND <sup>e</sup>	4E-4 <sup>f</sup>	NA	1000	U.S. EPA, 1987/Schroeder et al., 1970; U.S. EPA, 1985a,b, 1987

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		Inhalation	Oral		Inhalation [mg/m <sup>3</sup> (mg/kg/day)]	Oral (mg/kg/day)	Inhalation	Oral	
Arsenic subchronic (RfD <sub>S</sub> )	NA; 1 µg/kg/day	NA	human	NA; keralosis and hyperpigmentation	ND	NA	NA	1	U.S. EPA, 1984/ Tseng, 1977
chronic (RfD)	NA; 1 µg/kg/day	NA	human	cancer; keratosis and hyperpigmentation (cancer: see Table B)	ND	NA	NA	1	U.S. EPA, 1984/ Tseng, 1977
Barium subchronic (RfD <sub>S</sub> )	1.15 mg BaCO <sub>3</sub> /m <sup>3</sup> (0.80 mg Ba/m <sup>3</sup> ) 4 hours/day for 4 months (0.14 mg Ba/kg/day); 100 ppm Ba from BaCl <sub>2</sub> (5.1 mg Ba/kg/day) in drinking water for ≤16 months	rat	rat	fetotoxicity; increased blood pressure	5E-3 (1E-3)	5E-2	100	100	Tarasenko et al., 1977; U.S. EPA, 1984/ Perry et al., 1983; U.S. EPA, 1985b
chronic (RfD)	1.15 mg BaCO <sub>3</sub> /m <sup>3</sup> (0.80 mg Ba/m <sup>3</sup> ) 4 hours/day for 4 months (0.14 mg Ba/kg/day); 100 ppm Ba from BaCl <sub>2</sub> (5.1 mg Ba/kg/day) in drinking water for ≤16 months	rat	rat	fetotoxicity; increased blood pressure	5E-4 (1E-4)	5E-2 <sup>a,9</sup>	1000	100	Tarasenko et al., 1977; U.S. EPA, 1984/ Perry et al., 1983; U.S. EPA, 1984, 1985a,b
Benzidine subchronic (RfD <sub>S</sub> )	NA; 160 ppm benzidine dihydrochloride in drinking water for 33 months (27.2 mg/kg/day)	NA	mouse	NA; brain cell and liver cell changes	ND	3E-3 <sup>a</sup>	NA	1000	U.S. EPA, 1987a/ Littlefield et al., 1983; U.S. EPA, 1987b
chronic (RfD)	NA; 160 ppm benzidine dihydrochloride in drinking water for 33 months (27.2 mg/kg/day)	NA	mouse	NA; brain cell and liver cell changes (Cancer: see Table B)	ND	3E-3 <sup>a</sup>	NA	1000	U.S. EPA, 1987a/ Littlefield et al., 1983; U.S. EPA, 1987b



**HEALTH EFFECTS ASSESSMENTS SUMMARY TABLE A: SUBCHRONIC AND CHRONIC TOXICITY (OTHER THAN CARCINOGENICITY)**  
Update: March, 1989

Compound	Exposure Inhalation; Oral	Species		Effect of Concern Inhalation; Oral	Reference Dose		Uncertainty Factor		Reference Inhalation/Oral
		Inhalation	Oral		Inhalation [mg/m <sup>3</sup> (mg/kg/day)]	Oral (mg/kg/day)	Inhalation	Oral	
<b>Benzoic acid</b> subchronic (RfD <sub>s</sub> )	NA; per capita daily dietary intake of benzoic acid equivalent to 312 mg/day	NA	human	NA; irritation, malaise	ND	4E+0	NA	1	U.S. EPA, 1987a/ FASEB, 1973; U.S. EPA, 1987a
chronic (RfD)	NA; per capita daily dietary intake of benzoic acid equivalent to 312 mg/day	NA	human	NA; irritation, malaise	ND	4E+0 <sup>a</sup>	NA	1	U.S. EPA, 1987a/ FASEB, 1973; U.S. EPA, 1987a,b
<b>Beryllium</b> subchronic (RfD <sub>s</sub> )	NA; 5 ppm in drinking water for lifetime (0.54 mg/kg/day)	NA	rat	NA; none observed	ND	5E-3	NA	100	U.S. EPA, 1987/ Schroeder and Miltchener, 1975; U.S. EPA, 1985
chronic (RfD)	NA; 5 ppm in drinking water for lifetime (0.54 mg/kg/day)	NA	rat	NA; none observed (Cancer: see Table B)	ND	5E-3 <sup>a</sup>	NA	100	U.S. EPA, 1987/ Schroeder and Miltchener, 1975; U.S. EPA, 1985
<b>Bisphenol A</b> subchronic (RfD <sub>s</sub> )	NA; 0-1000 ppm for 18 weeks, 2 generations (NOAEL 750 ppm = 62 mg/kg/day)	NA	rat	NA; reduced body weight	ND	6E-1	NA	100	U.S. EPA, 1988a/ U.S. EPA, 1984c, 1988a
chronic (RfD)	NA; 0, 1,000, 2,000 ppm (1000 ppm = 50 mg/kg/day)	NA	rat	NA; reduced body weight	ND	5E-2 <sup>a</sup>	NA	1,000	U.S. EPA, 1988a/ NTP, 1982; U.S. EPA, 1988a,b
<b>Boron</b> subchronic (RfD <sub>s</sub> )	NA; 350 ppm in diet (8.75 mg/kg/day) for 2 years	NA	dog	NA; testicular lesions	ND	9E-2	NA	100	U.S. EPA, 1987/ Weir and Fisher, 1972; U.S. EPA, 1987
chronic (RfD)	NA; 350 ppm in diet (8.75 mg/kg/day) for 2 years	NA	dog	NA; testicular lesions	ND	9E-2	NA	100	U.S. EPA, 1987/ Weir and Fisher, 1972; U.S. EPA, 1987

**HEALTH EFFECTS ASSESSMENTS SUMMARY TABLE A: SUBCHRONIC AND CHRONIC TOXICITY (OTHER THAN CARCINOGENICITY)**  
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Compound	Exposure Inhalation; Oral	Species		Effect of Concern Inhalation; Oral	Reference Dose		Uncertainty Factor		Reference Inhalation/Oral
		Inhalation	Oral		Inhalation [mg/m <sup>3</sup> (mg/kg/day)]	Oral (mg/kg/day)	Inhalation	Oral	
<b>Bromomethane</b> subchronic (RfD <sub>s</sub> )	65 mg/m <sup>3</sup> 7.5 hours/ day, 5 days/week for 6 months (7.6 mg/kg/ day); 2 mg/kg 5 days/ week for 13 weeks (1.4 mg/kg/day)	rabbit	rat	paralysis and lung damage; hyperplasia of forestomach epithelium	0.3 (8E-2)	1E-2	100	100	Irish et al., 1940; U.S. EPA, 1987/Danse et al., 1984 U.S. EPA, 1987
chronic (RfD)	65 mg/m <sup>3</sup> 7.5 hours/ day, 5 days/week for 6 months (7.6 mg/kg/ day); 2 mg/kg 5 days/ week for 13 weeks 1.4 mg/kg/day)	rabbit	rat	paralysis and lung damage; hyperplasia of forestomach epithelium	0.03 (8E-3)	1E-3 <sup>a</sup>	1000	1000	Irish et al., 1940/Danse et al., 1984; U.S. EPA, 1986a, 1987, 1988
<b>Cadmium</b> subchronic (RfD <sub>s</sub> )	NA; NA	NA	NA	cancer; NA	ND	ND <sup>h</sup>	NA	NA	U.S. EPA, 1984/ U.S. EPA, 1984
chronic (RfD)	NA; NA	NA	human	cancer (see Summary Table B); renal damage	ND	1E-3 (food) <sup>1,3</sup> 5E-4 (water)	NA	10	U.S. EPA, 1984/ U.S. EPA, 1980b, 1988
<b>Caprolactam</b> subchronic (RfD <sub>s</sub> )	NA; 0.1% diet 90 days (50 mg/kg/day)	NA	rat	NA; renal effects	ND	5E-1	NA	100	U.S. EPA, 1980a/ Powers et al., 1984; U.S. EPA, 1988a
chronic (RfD)	NA; 1000 ppm for 3 generations (50 mg/kg/day)	NA	rat	NA; reduced body weight	ND	5E-1 <sup>a</sup>	NA	100	U.S. EPA, 1980a/ Serota et al., 1984; U.S. EPA, 1988a,b
<b>Carbon tetrachloride</b> subchronic (RfD <sub>s</sub> )	NA; 1 mg/day, 5 days/ week for 12 weeks (0.71 mg/kg/day)	NA	rat	NA; liver lesions	ND	7E-3	NA	100	U.S. EPA, 1984/ Bruckner et al. 1986; U.S. EPA, 1985
chronic (RfD)	NA; 1 mg/day, 5 days/ week for 12 weeks (0.71 mg/kg/day)	NA	rat	NA; liver lesions (Cancer: see Table B)	ND	7E-4 <sup>a</sup>	NA	1000	U.S. EPA, 1984/ Bruckner et al., 1986; U.S. EPA, 1985

**HEALTH EFFECTS ASSESSMENTS SUMMARY TABLE A: SUBCHRONIC AND CHRONIC TOXICITY (OTHER THAN CARCINOGENICITY)**  
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Compound	Exposure Inhalation; Oral	Species		Effect of Concern Inhalation; Oral	Reference Dose		Uncertainty factor		Reference Inhalation/Oral
		Inhalation	Oral		Inhalation (mg/m <sup>3</sup> )	Oral (mg/kg/day)	Inhalation	Oral	
<b>Chloral</b>									
subchronic (RfD <sub>s</sub> )	NA; 15.7 mg/kg/day from drinking water	NA	mouse	NA; hepatotoxicity (Cancer: CAG Group C, data in- adequate to estimate potency)	ND	2E-2	NA	1000	U.S. EPA, 1988a/ Sanders et al., 1982; U.S. EPA, 1988a
chronic (RfD)	NA; 15.7 mg/kg/day from drinking water	NA	mouse	NA; hepatotoxicity (Cancer: CAG Group C, data in- adequate to estimate potency)	ND	2E-3 <sup>a</sup>	NA	10,000	U.S. EPA, 1988a/ Sanders et al., 1982; U.S. EPA, 1988a,b
<b>Chlordane</b>									
subchronic (RfD <sub>s</sub> )	NA; 1 ppm in diet for 130 weeks (0.045 mg/kg/day)	NA	rat	NA; liver necrosis	ND	5E-5	NA	1000	U.S. EPA, 1988/ Velsicol Chemical Corp., 1983; U.S. EPA, 1985
chronic (RfD)	NA; 1 ppm in diet for 130 weeks (0.045 mg/kg/day)	NA	rat	NA; liver necrosis (Cancer: see Table B)	ND	5E-5 <sup>a</sup>	NA	1000	U.S. EPA, 1988/ Velsicol Chemical Corp., 1983; U.S. EPA, 1985
<b>Chlorinated cyclopentadienes</b>									
Chlorocyclopentadiene				DATA INADEQUATE FOR QUANTITATIVE RISK ASSESSMENT					U.S. EPA, 1988
<b>Hexachlorocyclo- pentadiene</b>									
subchronic (RfD <sub>s</sub> )	0.15 ppm (1.67 mg/m <sup>3</sup> 6 hours/day, 5 days/ week for 13 weeks (0.2 mg/kg/day); 10 mg/kg, 5 days/week for 13 weeks (7.1 mg/kg/day)	rat	rat	respiratory tract lesions; fore- stomach lesions	7E-4 (2E-4)	7E-2	100	100	Battelle Northwest Laboratories, 1984; U.S. EPA, 1988/SRI, 1981a; Abdo et al., 1984; U.S. EPA, 1988

HEALTH EFFECTS ASSESSMENTS SUMMARY TABLE A: SUBCHRONIC AND CHRONIC TOXICITY (OTHER THAN CARCINOGENICITY)  
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Compound	Exposure Inhalation; Oral	Species		Effect of Concern Inhalation; Oral	Reference Dose		Uncertainty Factor		Reference Inhalation/Oral
		Inhalation	Oral		Inhalation (mg/m <sup>3</sup> )	Oral (mg/kg/day)	Inhalation	Oral	
Hexachlorocyclo- pentadiene chronic (RfD)	0.15 ppm (1.67 mg/m <sup>3</sup> 6 hours/day, 5 days/ week for 13 weeks (0.2 mg/kg/day); 10 mg/kg, 5 days/week for 13 weeks (7.1 mg/kg/day)	rat	rat	respiratory tract lesions; fore- stomach lesions	7E-5 (2E-5)	7E-3 <sup>a</sup>	1,000	1,000	Battelle Northwest Laboratories, 1984; U.S. EPA, 1988/SRI, 1981a; Abdo et al., 1984; U.S. EPA, 1985, 1988
Pentachlorocyclo- pentadiene				DATA INADEQUATE FOR QUANTITATIVE RISK ASSESSMENT					U.S. EPA, 1988
Tetrachlorocyclo- pentadiene				DATA INADEQUATE FOR QUANTITATIVE RISK ASSESSMENT					U.S. EPA, 1988
Trichlorocyclo- pentadiene				DATA INADEQUATE FOR QUANTITATIVE RISK ASSESSMENT					U.S. EPA, 1988
Chlorinated phenols 2-Chlorophenol subchronic (RfD <sub>s</sub> )	NA; 50 ppm in drinking water from weaning through birth of first litter (5 mg/kg/day)	NA	rat	NA; reproductive effects	ND	5E-3	NA	1000	U.S. EPA, 1987a,b/Exon and Koeller, 1982; U.S. EPA, 1987a,b
chronic (RfD)	NA; 50 ppm in drinking water from weaning through birth of first litter (5 mg/kg/day)	NA	rat	NA; reproductive effects	ND	5E-3 <sup>a</sup>	NA	1000	U.S. EPA, 1987a,b/Exon and Koeller, 1982; U.S. EPA, 1987a,b, 1988
Chlorophenol, 3- and 4-				DATA INADEQUATE FOR QUANTITATIVE RISK ASSESSMENT					U.S. EPA, 1987
2,4-Dichlorophenol subchronic (RfD <sub>s</sub> )	NA; 3 ppm in drinking water for 2 generations (0.3 mg/kg/day)	NA	rat	NA; immune function	ND	3E-3	NA	100	U.S. EPA, 1987a,b/Exon and Koeller, 1985; U.S. EPA, 1987a,b

HEALTH EFFECTS ASSESSMENTS SUMMARY TABLE A: SUBCHRONIC AND CHRONIC TOXICITY (OTHER THAN CARCINOGENICITY)  
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Compound	Exposure Inhalation; Oral	Species		Effect of Concern Inhalation; Oral	Reference Dose		Uncertainty Factor		Reference
		Inhalation	Oral		Inhalation [mg/m <sup>3</sup> (mg/kg/day)]	Oral (mg/kg/day)	Inhalation	Oral	
2,4-Dichlorophenol chronic (RfD)	NA; 3 ppm in drinking water for 2 generations (0.3 mg/kg/day)	NA	rat	NA; immune function	ND	3E-3 <sup>a</sup>	NA	100	U.S. EPA, 1987a,b/Exon and Koller, 1985; U.S. EPA, 1986 1987a,b.
Dichlorophenol, 2,3-, 2,5-, 2,6-, 3,4- and 3,5-				DATA INADEQUATE FOR QUANTITATIVE RISK ASSESSMENT					U.S. EPA, 1987
2,3,4,6-Tetrachlorophenol subchronic (RfD <sub>s</sub> )	NA; 25 mg/kg/day for 90 days	NA	rat	NA; increased liver weights and centri- lobular hypertrophy	ND	3E-1	NA	100	U.S. EPA, 1987a/ U.S. EPA, 1986, 1987b
chronic (RfD)	NA; 25 mg/kg/day for 90 days	NA	rat	NA; increased liver weights and centri- lobular hypertrophy	ND	3E-2 <sup>a</sup>	NA	1000	U.S. EPA, 1987a/ U.S. EPA, 1986, 1987b
Tetrachlorophenol, 2,3,4,5-, 2,3,5,6-				DATA INADEQUATE FOR QUANTITATIVE RISK ASSESSMENT					U.S. EPA, 1987
2,4,5-Trichlorophenol subchronic (RfD <sub>s</sub> )	NA; 1000 ppm of diet for 98 days (100 mg/ kg/day)	NA	rat	NA; hepatotoxicity, kidney effects	ND	1E+0	NA	100	U.S. EPA, 1984, 1987/McCollister et al., 1961; U.S. EPA, 1984, 1987
chronic (RfD)	NA; 1000 ppm of diet for 98 days (100 mg/ kg/day)	NA	rat	NA; hepatotoxicity, kidney effects	ND	1E-1 <sup>a</sup>	NA	1000	U.S. EPA, 1984, 1987/McCollister et al., 1961; U.S. EPA, 1984, 1985, 1987
2,4,6-Trichlorophenol - see Table B									
Trichlorophenol, 2,3,4-, 2,3,5-, 2,3,6-, and 3,4,5-				DATA INADEQUATE FOR QUANTITATIVE RISK ASSESSMENT					U.S. EPA, 1987
Pentachlorophenol - see Pentachlorophenol									

**HEALTH EFFECTS ASSESSMENTS SUMMARY TABLE A: SUBCHRONIC AND CHRONIC TOXICITY (OTHER THAN CARCINOGENICITY)**  
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Compound	Exposure Inhalation; Oral	Species		Effect of Concern Inhalation; Oral	Reference Dose		Uncertainty Factor		Reference
		Inhalation	Oral		Inhalation [mg/m <sup>3</sup> {mg/kg/day}]	Oral (mg/kg/day)	Inhalation	Oral	
<b>Chlorinated toluenes</b>									
2,3,6-Trichlorotoluene subchronic (RfD <sub>s</sub> )	NA; 0.5 ppm in diet (0.05 mg/kg/day) for 28 days	NA	rat	NA; liver kidney, thyroid lesions	ND	5E-5	NA	1000	U.S. EPA, 1987/ Chu et al., 1984; U.S. EPA, 1987
chronic (RfD)	NA; NA	NA	NA	NA; NA	ND	ND	NA	NA	U.S. EPA, 1987/ U.S. EPA, 1987
<b>α,2,6-Trichloro- toluene</b>									
subchronic (RfD <sub>s</sub> )	NA; 0.5 ppm in diet (0.05 mg/kg/day) for 28 days	NA	rat	NA; liver, kidney, thyroid lesions	ND	5E-5	NA	1000	U.S. EPA, 1987/ Chu et al., 1984; U.S. EPA, 1987
chronic (RfD)	NA; NA	NA	NA	NA; NA	ND	ND	NA	NA	U.S. EPA, 1987/ U.S. EPA, 1987
<b>Chloroacetaldehyde</b>				DATA INADEQUATE FOR QUANTITATIVE RISK ASSESSMENT					U.S. EPA, 1988
<b>Chloroacetic acid</b>									
subchronic (RfD <sub>s</sub> )	NA; 30 mg/kg, 5 days/ week for 13 weeks (21.4 mg/kg/day)	NA	rat	NA; myocarditis	ND	2E-2	NA	1000	U.S. EPA, 1988/ IRDC, 1982a; U.S. EPA, 1988
chronic (RfD)	NA; 30 mg/kg, 5 days/ week for 13 weeks (21.4 mg/kg/day)	NA	rat	NA; myocarditis	ND	2E-3	NA	10,000	U.S. EPA, 1988/ IRDC, 1982a; U.S. EPA, 1988
<b>Chloroanilines (see also Table B)</b>									
2-Chloroaniline				DATA INADEQUATE FOR QUANTITATIVE RISK ASSESSMENT (SEE TABLE B)					U.S. EPA, 1987
3-Chloroaniline				DATA INADEQUATE FOR QUANTITATIVE RISK ASSESSMENT (SEE TABLE B)					U.S. EPA, 1987
4-Chloroaniline subchronic (RfD <sub>s</sub> )	NA; 250 ppm in diet for 78 weeks (12.5 mg/kg/day)	NA	rat	NA; proliferative lesions of the spleen	ND	4E-3	NA	3000	U.S. EPA, 1987a/ NCI, 1979; U.S. EPA, 1987b

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Compound	Exposure Inhalation; Oral	Species		Effect of Concern Inhalation; Oral	Reference Dose		Uncertainty Factor		Reference Inhalation/Oral
		Inhalation	Oral		Inhalation [mg/m <sup>3</sup> (mg/kg/day)]	Oral (mg/kg/day)	Inhalation	Oral	
4-Chloroaniline chronic (RFD)	NA; 250 ppm in diet for 78 weeks (12.5 mg/kg/day)	NA	rat	NA; proliferative lesions of the spleen (Cancer: see Table B)	ND	4E-3 <sup>a</sup>	NA	3000	U.S. EPA, 1987a/ NCI 1979; U.S. EPA, 1987b
Chlorobenzene subchronic (RFD <sub>S</sub> )	75 ppm (345 mg/m <sup>3</sup> ) 7 hours/day, 5 days/ week for 120 days (53 mg/kg/day); 27.3 mg/kg/day by capsule for 90 days	rat	dog	liver and kidney effects; liver and kidney effects	0.2 (5E-2)	3E-1	1,000	100	Dilley, 1977; U.S. EPA, 1984/ Monsanto, 1967a; U.S. EPA, 1984
chronic (RFD)	75 ppm (345 mg/m <sup>3</sup> ) 7 hours/day, 5 days/ week for 120 days (53 mg/kg/day); 27.3 mg/kg/day by capsule for 90 days	rat	dog	liver and kidney effects; liver and kidney effects	0.02 (5E-3)	3E-2 <sup>h</sup>	10,000	1000	Dilley, 1977; U.S. EPA, 1984/ Monsanto, 1967a; U.S. EPA, 1984
p-Chlorobenzoic acid subchronic (RFD <sub>S</sub> )	NA; 0.2% in diet for 5 months (173.3 mg/kg/day)	NA	rat	NA; none observed	ND	2E+0	NA	100	U.S. EPA, 1987/ Kleckebusch et al., 1960; U.S. EPA, 1987
chronic (RFD)	NA; 0.2% in diet for 5 months (173.3 mg/kg/day)	NA	rat	NA; none observed	ND	2E-1	NA	1000	U.S. EPA, 1987/ Kleckebusch et al., 1960; U.S. EPA, 1987
4-Chlorobenzotri- fluoride subchronic (RFD <sub>S</sub> )	NA; 15 mg/kg/day by gavage daily for 90 days	NA	rat	NA; renal tubular degeneration	ND	2E-1	NA	100	U.S. EPA, 1988/ Hooker Chemical Co., 1981; U.S. EPA, 1988
chronic (RFD)	NA; 15 mg/kg/day by gavage daily for 90 days	NA	rat	NA; renal tubular degeneration	ND	2E-2	NA	1000	U.S. EPA, 1988/ Hooker Chemical Co., 1981; U.S. EPA, 1988

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Compound	Exposure Inhalation; Oral	Species		Effect of Concern Inhalation; Oral	Reference Dose		Uncertainty Factor		Reference Inhalation/Oral
		Inhalation	Oral		Inhalation [mg/m <sup>3</sup> (mg/kg/day)]	Oral (mg/kg/day)	Inhalation	Oral	
p-Chloro-m-cresol subchronic (RFD <sub>S</sub> )	NA; 200 mg/kg/day for 28 days	NA	rat	NA; decrease in weight gain	ND	2E+0	NA	100	U.S. EPA, 1988/ Madsen et al., 1986; U.S. EPA, 1988
chronic (RFD)	NA; NA	NA	NA	NA; NA	ND	ND	NA	NA	U.S. EPA, 1988/ U.S. EPA, 1988
Chloroform subchronic (RFD <sub>S</sub> )	NA; 15 mg/kg, 6 days/ week for 7.5 years (12.9 mg/kg/day)	NA	dog	NA; liver lesions	ND	1E-2	NA	1000	U.S. EPA, 1988/ Heywood et al., 1979; U.S. EPA, 1985
chronic (RFD)	NA; 15 mg/kg, 6 days/ week for 7.5 years (12.9 mg/kg/day)	NA	dog	NA; liver lesions (Cancer: see Table B)	ND	1E-2 <sup>a</sup>	NA	1000	U.S. EPA, 1988/ Heywood et al., 1979; U.S. EPA, 1985
2-Chloropropane subchronic (RFD <sub>S</sub> )	250 ppm (803 mg/m <sup>3</sup> ), 6 hours/day, 5 days/ weeks for 4 weeks (91.4 mg/kg/day); NA	rat	NA	liver effects; NA	3E+0 (9E-1)	ND	100	NA	Gage, 1970; U.S. EPA, 1987/ U.S. EPA, 1987
chronic (RFD)	250 ppm (803 mg/m <sup>3</sup> ), 6 hours/day, 5 days/ weeks for 4 weeks (91.4 mg/kg/day); NA	rat	NA	liver effects; NA	3E-1 (9E-2)	ND	1000	NA	Gage, 1970; U.S. EPA, 1987/ U.S. EPA, 1987
Copper subchronic (RFD <sub>S</sub> )	NA; 5.3 mg, single dose	NA	human	NA; local GI irritation	ND	1.3 mg/kg <sup>k</sup>	NA	NA	U.S. EPA, 1984/ U.S. EPA, 1987
chronic (RFD)	NA; NA	NA	human	NA; local GI irritation <sup>l</sup>	ND	1.3 mg/kg <sup>k</sup>	NA	NA	U.S. EPA, 1984/ U.S. EPA, 1987



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Compound	Exposure Inhalation; Oral	Species		Effect of Concern Inhalation; Oral	Reference Dose		Uncertainty Factor		Reference Inhalation/Oral
		Inhalation	Oral		Inhalation [mg/m <sup>3</sup> (mg/kg/day)]	Oral (mg/kg/day)	Inhalation	Oral	
<b>Cresols</b>									
m-Cresol subchronic (RfD <sub>s</sub> )	NA; 50 mg/kg/day for 90 days	NA	rat	NA; reduced body weight gain, neuro- toxicity	ND	5E-1	NA	100	U.S. EPA, 1984/ Microbiological Associates, 1986; Toxicity Research Labora- tories, 1987; U.S. EPA, 1987
chronic (RfD)	NA; 50 mg/kg/day for 90 days	NA	rat	NA; reduced body weight gain, neuro- toxicity	ND	5E-2 <sup>a</sup>	NA	1000	U.S. EPA, 1984/ Microbiological Associates, 1986; Toxicity Research Labora- tories, 1987; U.S. EPA, 1987
o-Cresol subchronic (RfD <sub>s</sub> )	NA; 50 mg/kg/day for 90 days	NA	rat	NA; reduced body weight gain, neuro- toxicity	ND	5E-1	NA	100	U.S. EPA, 1984/ Microbiological Associates, 1986; Toxicity Research Labora- tories, 1987; U.S. EPA, 1987
chronic (RfD)	NA; 50 mg/kg/day for 90 days	NA	rat	NA; reduced body weight gain, neuro- toxicity	ND	5E-2 <sup>a</sup>	NA	1000	U.S. EPA, 1984/ Microbiological Associates, 1986; Toxicity Research Labora- tories, 1987; U.S. EPA, 1987
p-Cresol subchronic (RfD <sub>s</sub> )	NA; 50 mg/kg/day for 90 days	NA	rat	NA; reduced body weight gain, neuro- toxicity	ND	5E-1	NA	100	U.S. EPA, 1984/ Microbiological Associates, 1986; Toxicity Research Laboratories, 1987; U.S. EPA, 1987

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		Inhalation	Oral		Inhalation [mg/m <sup>3</sup> (mg/kg/day)]	Oral (mg/kg/day)	Inhalation	Oral	
p-Cresol chronic (RfD)	NA; 50 mg/kg/day for 90 days	NA	rat	NA; reduced body weight gain, neuro- toxicity	ND	5E-2 <sup>a</sup>	NA	1000	U.S. EPA, 1984/ Microbiological Associates, 1986; Toxicity Research Laboratories, 1987; U.S. EPA, 1987
Cumene subchronic (RfDs)	3.7 ppm (18 mg/m <sup>3</sup> ) continuously for 90 days (8.6 mg/kg/day); 110 mg/kg/day for 194 days	guinea pig	rat	hematological; renal	1E-1 (3E-2) <sup>m</sup>	4E-1	300	300	Jenkins et al., 1970; U.S. EPA, 1987b/Wolfe, 1956; U.S. EPA, 1987b
chronic (RfD)	3.7 ppm (18 mg/m <sup>3</sup> ) continuously for 90 days (8.6 mg/kg); 110 mg/kg for 194 days	guinea pig	rat	hematologic; renal	1E-2 (3E-3) <sup>m</sup>	4E-2 <sup>a</sup>	3000	3000	Jenkins et al., 1970; U.S. EPA, 1987b/Wolfe et al., 1956; U.S. EPA, 1987b
Cyanide subchronic (RfDs)	NA; 10.8 mg/CN/kg/day for 104 weeks from diet treated with HCN	NA	rat	NA; weight loss, thyroid effects and myelin degeneration	ND	2E-2	NA	500	U.S. EPA, 1984/ Howard and Hanzal, 1955; U.S. EPA, 1984, 1985
chronic (RfD)	NA; 10.8 mg CN/kg/day for 104 weeks from diet treated with HCN	NA	rat	NA; weight loss, thyroid effects and myelin degeneration <sup>1</sup>	ND	2E-2 <sup>a</sup>	NA	500	U.S. EPA, 1984/ Howard and Hanzal, 1955; U.S. EPA, 1984, 1985
Cyanohydrins Acetone cyanohydrin subchronic (RfDs)	10.1 ppm (35.2 mg/m <sup>3</sup> ) 6 hours/day, 5 days/week for 14 weeks (4.0 mg/kg/ day); 10.8 mg CN/kg/day for 104 weeks from diet treated with HCN	rat	rat	CNS signs; body weight, thyroid and CNS effects	1E-1 (4E-2)	7E-2 <sup>n</sup>	100	500	Blank and Thake, 1984/ U.S. EPA, 1988/Howard and Hanzal, 1955; U.S. EPA, 1985a,b, 1988

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Compound	Exposure Inhalation; Oral	Species		Effect of Concern Inhalation; Oral	Reference Dose		Uncertainty Factor		Reference Inhalation/Oral
		Inhalation	Oral		Inhalation [mg/m <sup>3</sup> (mg/kg/day)]	Oral (mg/kg/day)	Inhalation	Oral	
Acetone cyanohydrin chronic (RFD)	10.1 ppm (35.2 mg/m <sup>3</sup> ) 6 hours/day, 5 days/week for 14 weeks (4.0 mg/kg/ day); 10.8 mg CN/kg/day for 104 weeks from diet treated with HCN	rat	rat	CNS signs; body weight, thyroid and CNS effects	1E-1 (4E-2)	7E-2 <sup>n</sup>	100	500	Blank and Thake, 1984/ U.S. EPA, 1988/Howard and Manzal, 1955; U.S. EPA, 1985a,b, 1988
Ethylene cyanohydrin subchronic (RfD <sub>s</sub> )	NA; 30 mg/kg/day in drinking water for 90 days	NA	rat	NA; decreased heart and brain weights	ND	3E-1	NA	100	U.S. EPA, 1988/ Sauerhoff et al., 1976; U.S. EPA, 1988
chronic (RFD)	NA; 30 mg/kg/day in drinking water for 90 days	NA	rat	NA; decreased heart and brain weights	ND	3E-1	NA	100	U.S. EPA, 1988/ Sauerhoff et al., 1976; U.S. EPA, 1988
Benzaldehyde cyanohydrin				DATA INADEQUATE FOR QUANTITATIVE RISK ASSESSMENT					U.S. EPA, 1988
Formaldehyde cyanohydrin				DATA INADEQUATE FOR QUANTITATIVE RISK ASSESSMENT					U.S. EPA, 1988
Lactonitrile				DATA INADEQUATE FOR QUANTITATIVE RISK ASSESSMENT					U.S. EPA, 1988
Cyclohexylamine subchronic (RfD <sub>s</sub> )	NA; 600 ppm cyclohexy- lamine-HCl in diet for 90 days (30 mg/kg/ day) cyclohexylamine)	NA	rat	NA; reduced body weight	NA	3E-1	NA	100	U.S. EPA, 1987a/ Gaunt et al., 1974; U.S. EPA, 1987a
chronic	NA; 600 ppm cyclohexy- lamine-HCl in diet for 2 years (18 mg/kg/day) cyclohexylamine	NA	rat	NA; testicular effects	NA	2E-1 <sup>a</sup>	NA	100	U.S. EPA, 1987a/ Gaunt et al., 1976; U.S. EPA, 1987a,b
Cyclopentadiene subchronic (RfD <sub>s</sub> )	250 ppm (676 mg/m <sup>3</sup> ) for 135, 7-hour expo- sures in 194 days (87.3 mg/kg/day); NA	rat	NA	liver and kidney lesions; NA	3E+0 (9E-1)	ND	100	NA	Dow, 1987; U.S. EPA, 1987/ U.S. EPA, 1987
chronic (RFD)	NA; NA	NA	NA	NA; NA	ND	ND	NA	NA	U.S. EPA, 1987/ U.S. EPA, 1987

HEALTH EFFECTS ASSESSMENTS SUMMARY TABLE A: SUBCHRONIC AND CHRONIC TOXICITY (OTHER THAN CARCINOGENICITY)  
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Compound	Exposure Inhalation; Oral	Species		Effect of Concern Inhalation; Oral	Reference Dose		Uncertainty Factor		Reference Inhalation/Oral
		Inhalation	Oral		Inhalation [mg/m <sup>3</sup> (mg/kg/day)]	Oral (mg/kg/day)	Inhalation	Oral	
<b>DDT</b>									
subchronic (RFD <sub>s</sub> )	NA; 1 ppm in diet for 27 weeks (0.05 mg/kg/day)	NA	rat	NA; liver lesions	ND	5E-4	NA	100	U.S. EPA, 1984/Laug et al., 1950; U.S. EPA, 1985
chronic (RfD)	NA; 1 ppm in diet for 27 weeks (0.05 mg/kg/day)	NA	rat	NA; liver lesions (Cancer: see Table B)	ND	5E-4 <sup>a</sup>	NA	100	U.S. EPA, 1984/Laug et al., 1950; U.S. EPA, 1985, 1988
<b>Dibenzofuran</b>									
DATA INADEQUATE FOR QUANTITATIVE RISK ASSESSMENT									
<b>Dichlorobenzenes</b>									
<b>1,2-Dichlorobenzene</b>									
subchronic (RFD <sub>s</sub> )	290 mg/m <sup>3</sup> 7 hours/day, 5 days/week for up to 7 months (44 mg/kg/day); 125 mg/kg/day, 5 days/week for 13 weeks (89 mg/kg/day)	rat	rat	decreased body weight gain; liver effects	2E+0 (4E-1)	9E-1	100	100	Hollingsworth et al., 1958; U.S. EPA, 1987/NTP, 1985; U.S. EPA, 1987
chronic (RfD)	290 mg/m <sup>3</sup> 7 hours/day, 5 days/week for up to 7 months (44 mg/kg/day); 125 mg/kg/day, 5 days/week for 13 weeks (89 mg/kg/day)	rat	rat	decreased body weight gain; liver effects	2E-1 (4E-2)	9E-2 <sup>d</sup>	1000	1000	Hollingsworth et al., 1958; U.S. EPA, 1987/NTP, 1985; U.S. EPA, 1987
<b>1,3-Dichlorobenzene</b>									
DATA INADEQUATE FOR QUANTITATIVE RISK ASSESSMENT									
<b>1,4-Dichlorobenzene</b>									
subchronic (RFD <sub>s</sub> )	75 ppm (454.6 mg/m <sup>3</sup> ) 5 hours/day, 5 days/week for 76 weeks; NA	rat	NA	liver and kidney kidney effects; NA	7E-1 (NA)	ND	100	NA	Riley et al., 1980; U.S. EPA, 1988/U.S. EPA, 1987
chronic (RfD)	75 ppm (454.6 mg/m <sup>3</sup> ) 5 hours/day, 5 days/week for 76 weeks; NA	rat	NA	liver and kidney kidney effects; (Cancer: see Table B)	7E-1 (NA) <sup>d</sup>	ND	100	NA	Riley et al., 1980; U.S. EPA, 1988/U.S. EPA, 1987
<b>Dichlorobutenes</b>									
DATA INADEQUATE FOR QUANTITATIVE RISK ASSESSMENT (SEE TABLE B)									
U.S. EPA, 1987									

HEALTH EFFECTS ASSESSMENTS SUMMARY TABLE A: SUBCHRONIC AND CHRONIC TOXICITY (OTHER THAN CARCINOGENICITY)  
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Compound	Exposure Inhalation; Oral	Species		Effect of Concern Inhalation; Oral	Reference Dose		Uncertainty Factor		Reference Inhalation/Oral
		Inhalation	Oral		Inhalation (mg/m <sup>3</sup> )	Oral (mg/kg/day)	Inhalation	Oral	
1,1-Dichloroethane subchronic (RfDs)	500 ppm (2025 mg/m <sup>3</sup> ) 6 hours/day, 5 days/week for 13 weeks (138 mg/kg/ day); 500 ppm (2025 mg/m <sup>3</sup> ) 6 hours/day, 5 days/week for 13 weeks (115 mg/kg/day)	cat	rat	kidney damage; none	5E+0 (1E+0)	1E+0	100	100	Hofmann et al., 1971; U.S. EPA, 1984/Hofmann et al., 1971; U.S. EPA, 1983b, 1984
chronic (RfDs)	500 ppm (2025 mg/m <sup>3</sup> ) 6 hours/day, 5 days/week for 13 weeks (138 mg/kg/ day); 500 ppm (2025 mg/m <sup>3</sup> ) 6 hours/day, 5 days/week for 13 weeks ( mg/kg/day)	cat	rat	kidney damage; none (Cancer: see Table B)	5E-1 (1E-1)	1E-1	1000	1000	Hofmann et al., 1971; U.S. EPA, 1984/Hofmann et al., 1971; U.S. EPA, 1983b, 1984
1,1-Dichloroethylene subchronic (RfDs)	NA; 50 ppm in drinking water for 2 years (9 mg/kg/day)	NA	rat	NA; liver lesions	ND	9E-3	NA	1000	U.S. EPA, 1984/ Quast et al., 1983; U.S. EPA, 1985
chronic (RfD)	NA; 50 ppm in drinking water for 2 years (9 mg/kg/day)	NA	rat	NA; liver lesions (Cancer: see Table B)	ND	9E-3 <sup>a</sup>	NA	1000	U.S. EPA, 1984/ Quast et al., 1983; U.S. EPA, 1985
1,2-c-Dichloroethylene				DATA INADEQUATE FOR QUANTITATIVE RISK ASSESSMENT					U.S. EPA, 1984
1,2-t-Dichloroethylene				DATA INADEQUATE FOR QUANTITATIVE RISK ASSESSMENT					U.S. EPA, 1984
Dicyclopentadiene subchronic (RfDs)	1 ppm (5.4 mg/m <sup>3</sup> ), 6 hours/day, 5 days/ week for 90 days (0.61 mg/kg/day); 690 ppm in diet for 3 generations (32 mg/kg/day for males)	rat	rat	liver dysfunction; none	2E-3 (6E-4)	3E-1	1000	100	Dodd et al., 1982; U.S. EPA, 1987/Litton Bionetics, 1980; U.S. EPA, 1987

HEALTH EFFECTS ASSESSMENTS SUMMARY TABLE A: SUBCHRONIC AND CHRONIC TOXICITY (OTHER THAN CARCINOGENICITY)  
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Compound	Exposure Inhalation; Oral	Species		Effect of Concern Inhalation; Oral	Reference Dose		Uncertainty factor		Reference Inhalation/Oral
		Inhalation	Oral		Inhalation [mg/m <sup>3</sup> (mg/kg/day)]	Oral (mg/kg/day)	Inhalation	Oral	
Dicyclopentadiene chronic (RfD)	1 ppm (5.4 mg/m <sup>3</sup> ), 6 hours/day, 5 days/ week for 90 days (0.61 mg/kg/day); 690 ppm in diet for 3 generations (32 mg/kg/day for males)	rat	rat	liver dysfunction; none	2E-4 (6E-5)	3E-2	10,000	1000	Dodd et al., 1982; U.S. EPA, 1987/Litton Bionetics, 1980; U.S. EPA, 1987
Dieldrin subchronic (RfDs)	NA; 0.1 ppm in diet for 2 years (0.005 mg/kg/day)	NA	rat	NA; liver lesions	ND	5E-5	NA	100	U.S. EPA, 1987/ Walker et al., 1969; U.S. EPA, 1987b
chronic (RfD)	NA; 0.1 ppm in diet for 2 years (0.005 mg/kg/day)	NA	rat	NA; liver lesions (Cancer: see Table 8)	ND	5E-5 <sup>a</sup>	NA	100	U.S. EPA, 1987/ Walker et al., 1969; U.S. EPA, 1987b
Dimethylphenols 2,6-Dimethylphenol subchronic (RfDs)	NA; 0.6 mg/kg/day for 8 months	NA	rat	NA; effects on blood pressure, weight gain and histological appear- ance of several organs	ND	6E-3	NA	100	U.S. EPA, 1987/ Veldre and Janes, 1979; U.S. EPA, 1986, 1987
chronic (RfD)	NA; 0.6 mg/kg/day for 8 months	NA	rat	NA; effects on blood pressure, weight gain and histological appear- ance of several organs	ND	6E-4 <sup>a</sup>	NA	1000	U.S. EPA, 1987/ Veldre and Janes, 1979; U.S. EPA, 1986, 1987
3,4-Dimethylphenol subchronic (RfDs)	NA; 1.4 mg/kg/day for 8 months	NA	rat	NA; reduced growth, internal lesions	ND	1E-2	NA	100	U.S. EPA, 1987/ Veldre and Janes, 1979; U.S. EPA, 1987, 1988

**HEALTH EFFECTS ASSESSMENTS SUMMARY TABLE A: SUBCHRONIC AND CHRONIC TOXICITY (OTHER THAN CARCINOGENICITY)**  
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Compound	Exposure Inhalation; Oral	Species		Effect of Concern Inhalation; Oral	Reference Dose		Uncertainty Factor		Reference Inhalation/Oral
		Inhalation	Oral		Inhalation (mg/m <sup>3</sup> )	Oral (mg/kg/day)	Inhalation	Oral	
3,4-Dimethylphenol chronic (RfD)	NA; 1.4 mg/kg/day for 8 months	NA	rat	NA; reduced growth, internal lesions	ND	1E-3 <sup>a</sup>	NA	1000	U.S. EPA, 1987/ Veldre and Janes, 1979; U.S. EPA, 1987, 1988
Endosulfan subchronic (RfD <sub>s</sub> )	NA; 3 ppm in diet in 2-generation reproduc- tive study (0.15 mg/kg/day)	NA	rat	NA; mild kidney lesions	ND	2E-4	NA	1000	U.S. EPA, 1987a/ Huntington Research Center, 1984; U.S. EPA, 1987a
chronic (RfD)	NA; 3 ppm in diet in 2-generation reproduc- tive study (0.15 mg/kg/day)	NA	rat	NA; mild kidney lesions	ND	5E-5 <sup>a</sup>	NA	3000	U.S. EPA, 1987a/ Huntington Research Center, 1984; U.S. EPA, 1987b
Endrin subchronic (RfD <sub>s</sub> )	NA; 1 ppm in diet for 18 months (0.045 mg/kg/day)	NA	dog	NA; increased relative organ weights	ND	5E-4	NA	100	U.S. EPA, 1987/ Treon et al., 1955; U.S. EPA, 1985a, 1987
chronic (RfD)	NA; 1 ppm in diet for >2 years (0.025 mg/kg/day)	NA	dog	NA; convulsions and liver lesions	ND	3E-4 <sup>a</sup>	NA	100	U.S. EPA, 1987/ CBI; U.S. EPA, 1985a, 1987, 1988
Ethylbenzene subchronic (RfD <sub>s</sub> )	NA; 136 mg/kg 5 days/week for 182 days (97.1 mg/kg/day)	NA	rat	NA; hepatotoxicity and nephrotoxicity	ND	1E+0	NA	100	U.S. EPA, 1984/ Wolf et al., 1956; U.S. EPA, 1984, 1985
chronic (RfD)	NA; 136 mg/kg 5 days/week for 182 days (97.1 mg/kg/day)	NA	rat	NA; hepatotoxicity and nephrotoxicity <sup>1</sup>	ND	1E-1 <sup>a</sup>	NA	1000	U.S. EPA, 1984/ Wolf et al., 1956; U.S. EPA, 1984, 1985

**HEALTH EFFECTS ASSESSMENTS SUMMARY TABLE A: SUBCHRONIC AND CHRONIC TOXICITY (OTHER THAN CARCINOGENICITY)**  
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Compound	Exposure Inhalation; Oral	Species		Effect of Concern Inhalation; Oral	Reference Dose		Uncertainty Factor		Reference Inhalation/Oral
		Inhalation	Oral		Inhalation [mg/m <sup>3</sup> (mg/kg/day)]	Oral (mg/kg/day)	Inhalation	Oral	
Ethyl Chloride									U.S. EPA, 1987
	DATA INADEQUATE FOR QUANTITATIVE RISK ASSESSMENT								
Ethylenediamine subchronic (RfDs)	59 ppm (145 mg/m <sup>3</sup> ) 7 hours/day, 5 days/week for 30 days (25.8 mg/kg/ day); 3-month dietary study with ethylene- diamine dihydrochloride (22.6 mg ethylene- diamine/kg/day)	rat	rat	death, kidney and liver lesions; liver and hematologic changes	1E+0 (3E-1)	2E-1	100	100	Pozzani and Carpenter, 1954; U.S. EPA, 1988/ Yang et al., 1983; U.S. EPA, 1988
chronic (RfD)	NA; 3-month dietary study with ethylene- diamine dihydrochloride (22.6 mg ethylene- diamine/kg/day)	NA	rat	NA; liver and hematologic changes	ND	2E-2	NA	1000	U.S. EPA, 1988/ Yang et al., 1983; U.S. EPA, 1988
Ethylene glycol subchronic (RfDs)	NA; 200 mg/kg/day in developmental toxicity	NA	rat	NA; fetotoxicity	ND	2E+0	NA	100	U.S. EPA, 1987a/ Maronpot et al., 1983; U.S. EPA, 1987a,b
chronic (RfD)	NA; 200 mg/kg/day in 2-year dietary study	NA	rat	NA; mortality, liver and kidney effects	ND	2E+0 <sup>a</sup>	NA	100	U.S. EPA, 1987a/ DePass et al., 1986a; U.S. EPA, 1987a,b
Ethyl ether subchronic (RfDs)	NA; 500 mg/kg/day for 90 days	NA	rat	NA; liver effects	ND	5E+0	NA	100	U.S. EPA, 1987/ American Biogenics Corp., 1986; U.S. EPA, 1987
chronic (RfD)	NA; 500 mg/kg/day for 90 days	NA	rat	NA; liver effects	ND	5E-1 <sup>h</sup>	NA	1000	U.S. EPA, 1987/ American Biogenics Corp., 1986; U.S. EPA, 1987



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Compound	Exposure Inhalation; Oral	Species		Effect of Concern Inhalation; Oral	Reference Dose		Uncertainty Factor		Reference Inhalation/Oral
		Inhalation	Oral		Inhalation [mg/m <sup>3</sup> (mg/kg/day)]	Oral (mg/kg/day)	Inhalation	Oral	
Furan subchronic (RfD <sub>s</sub> )	NA; 2 mg/kg, 5 days/week for 13 weeks (1.4 mg/kg/day)	NA	mouse	NA; hepatic lesions	ND	1E-2	NA	100	U.S. EPA, 1987/ SRI, 1982b; U.S. EPA, 1987
chronic (RfD)	NA; 2 mg/kg, 5 days/week for 13 weeks (1.4 mg/kg/day)	NA	mouse	NA; hepatic lesions	ND	1E-3 <sup>a</sup>	NA	1000	U.S. EPA, 1987/ SRI, 1982b; U.S. EPA, 1986, 1987
Furfural subchronic (RfD <sub>s</sub> )	20 ppm (77 mg/m <sup>3</sup> ), 6 hours/day, 5 days/week for 13 weeks (13 mg/kg); 11 mg/kg, 5 days/week for 13 weeks (7.9 mg/ kg/day)	hamster	rat	olfactory degenera- tion; hepatotoxicity	5E-1 [1E-1]	3E-2	100	300	Feron et al., 1979; U.S. EPA, 1988/SRI, 1981; U.S. EPA, 1987
chronic (RfD)	20 ppm (77 mg/m <sup>3</sup> ), 6 hours/day, 5 days week for 13 weeks (13 mg/kg); 11 mg/kg, 5 days/week for 13 weeks (7.9 mg/kg/ day)	hamster	rat	olfactory degenera- tion; hepatotoxicity	5E-2 [1E-2]	3E-3 <sup>a</sup>	1000	3000	Feron et al., 1979; U.S. EPA, 1988/SRI, 1981; U.S. EPA, 1987
Glycol ethers 2-Ethoxyethanol subchronic (RfD <sub>s</sub> )	10 ppm (37 mg/m <sup>3</sup> ) 6 hours/day on days 6-15 of gestation (6.8 mg/kg/ day); 50 µA (46.6 mg/kg/ day) on days 1-21 of gestation	rat	rat	fetotoxicity; fetotoxicity	2E-1 (7E-2)	5E-1	100	100	Doe, 1984a; U.S. EPA, 1984/ Slenger et al., 1971; U.S. EPA, 1984
chronic (RfD)	100 ppm (369 mg/m <sup>3</sup> ) 6 hours/day, 5 days/ week for 13 weeks (49.9 mg/kg/day) 500 mg/kg 5 days/week for 103 weeks (357 mg/kg/day)	rat	rat	altered hematology; reduced body weight	2E-1 (5E-2)	4E-1	1000	1000	Barbee et al., 1984; U.S. EPA, 1984/Melnick, 1984; U.S. EPA, 1985

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Compound	Exposure Inhalation; Oral	Species		Effect of Concern Inhalation; Oral	Reference Dose		Uncertainty Factor		Reference Inhalation/Oral
		Inhalation	Oral		Inhalation (mg/m <sup>3</sup> )	Oral (mg/kg/day)	Inhalation	Oral	
2-Methoxyethanol subchronic (RfD <sub>s</sub> )	10 ppm (31 mg/m <sup>3</sup> ) 6 hours/day, 5 days/ week for 13 weeks (2.9 mg/kg/day); 10 ppm (31 mg/m <sup>3</sup> ) 6 hours/day, 5 days/week for 13 weeks (1.47 mg/kg/day)	rabbit	rabbit	fetotoxicity and testicular effects; fetotoxicity and testicular effects	1E-1 (3E-2) <sup>a</sup>	1E-2 <sup>b</sup>	100	100	Miller et al., 1982; U.S. EPA, 1986/Miller et al., 1982; U.S. EPA, 1986
chronic (RfD)	10 ppm (31 mg/m <sup>3</sup> ) 6 hours/day, 5 days/ week for 13 weeks (2.9 mg/kg/day); 10 ppm (31 mg/m <sup>3</sup> ) 6 hours/day, 5 days/week for 13 weeks (1.47 mg/kg/day)	rabbit	rabbit	fetotoxicity and testicular effects; fetotoxicity and testicular effects	1E-2 (3E-3) <sup>a</sup>	1E-3 <sup>b,9</sup>	1000	1000	Miller et al., 1982; U.S. EPA, 1986/Miller et al., 1982; U.S. EPA, 1986
Diethylene glycol monoethyl ether subchronic (RfD <sub>s</sub> )	NA; diet provided 500 mg/kg/day for 90 days	NA	rat	NA; impaired renal function, increased testes weight	ND	5E+0	NA	100	U.S. EPA, 1984/ Hall et al., 1966; U.S. EPA, 1984
chronic (RfD)	NA; 0.2% in drinking water (200 mg/kg/day) for 2 years	NA	rat	NA; kidney histo- pathology	ND	2E+0	NA	100	U.S. EPA, 1984/ Smyth et al., 1964; U.S. EPA, 1984
Ethylene glycol monobutyl ether subchronic (RfD <sub>s</sub> )	25 ppm (121 mg/m <sup>3</sup> ) 6 hours/day, 5 days/ week for 13 weeks (16 mg/kg/day); NA	rat	NA	altered hematology; NA	6E-1 (2E-1)	ND	100	NA	Dodd et al., 1983/U.S. EPA, 1984
chronic (RfD)	25 ppm (121 mg/m <sup>3</sup> ) 6 hours/day, 5 days/ week for 13 weeks (16 mg/kg/day); NA	rat	NA	altered hematology; NA	6E-2 (2E-2)	ND	1000	NA	Dodd et al., 1983/U.S. EPA, 1984

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Compound	Exposure Inhalation; Oral	Species		Effect of Concern Inhalation; Oral	Reference Dose		Uncertainty Factor		Reference Inhalation/Oral
		Inhalation	Oral		Inhalation (mg/m <sup>3</sup> )	Oral (mg/kg/day)	Inhalation	Oral	
Propylene glycol monomethyl ether subchronic (RfD <sub>S</sub> )	1000 ppm (3685 mg/m <sup>3</sup> ) 6 hours/day, 5 days/ week for 13 weeks (489 mg/kg/day); 947 mg/kg, 5 days/week for 35 days (676 mg/ kg/day) by gavage	rat	rat	liver histo- pathology; liver and kidney histo- pathology	2E+1 (5E+0)	7E+0	100	100	Miller et al., 1984; U.S. EPA, 1984/Rowe et al., 1954; U.S. EPA, 1984
chronic (RfD)	1000 ppm (3685 mg/m <sup>3</sup> ) 6 hours/day, 5 days/ week for 13 weeks (489 mg/kg/day); 947 mg/kg, 5 days/week for 35 days (676 mg/kg/day) by gavage	rat	rat	liver histo- pathology; liver and kidney histo- pathology	2E+0 (5E-1)	7E-1	1000	1000	Miller et al., 1984; U.S. EPA, 1984/Rowe et al., 1954; U.S. EPA, 1984
Propylene glycol monoethyl ether subchronic (RfD <sub>S</sub> )	NA; 30-day drinking water (680 mg/kg/day)	NA	rat	NA; reduced weight gain	ND	7E+0	NA	100	U.S. EPA, 1984/ Smyth and Carpenter, 1948; U.S. EPA, 1984
chronic (RfD)	NA; 30-day drinking water (680 mg/kg/day)	NA	rat	NA; reduced weight gain	ND	7E-1	NA	1000	U.S. EPA, 1984/ Smyth and Carpenter, 1948; U.S. EPA, 1984
Haloethers 2,4,4'-Trichloro- 2'-hydroxydiphenylether subchronic (RfD <sub>S</sub> )	NA; 500 mg/kg, 6 days/ /week for 4 weeks (429 mg/kg/day)	NA	rat	ND; ND	ND	4E+0	NA	100	U.S. EPA, 1987/ Lyman and Furia, 1969; U.S. EPA, 1987
chronic (RfD)	NA; NA	NA	NA	ND; ND	ND	ND	NA	NA	U.S. EPA, 1987/ U.S. EPA, 1987

Other haloethers: see Table B

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Compound	Exposure Inhalation; Oral	Species		Effect of Concern Inhalation; Oral	Reference Dose		Uncertainty Factor		Reference Inhalation/Oral
		Inhalation	Oral		Inhalation [mg/m <sup>3</sup> (mg/kg/day)]	Oral (mg/kg/day)	Inhalation	Oral	
Halogenated (fully) methanes									
Dichlorodifluoromethane (F-12)									
subchronic (RfD <sub>S</sub> )	4136 mg/m <sup>3</sup> , 8 hours/day, 5 days/week for 6 weeks (482.3 mg/kg/day); 90 mg/kg/day for 90 days	guinea pig	dog	lung and liver lesions; none	2E+0 (5E-1)	9E-1	1000	100	Prendergast et al., 1967; U.S. EPA, 1987/Clayton, 1967; U.S. EPA, 1987
chronic (RfD)	4136 mg/m <sup>3</sup> , 8 hours/day, 5 days/week for 6 weeks (482.3 mg/kg/day); 15 mg/kg/day for 2 years	guinea pig	rat	lung and liver lesions; depressed body weight gain	2E-1 (5E-2)	2E-1 <sup>a</sup>	10,000	100	Prendergast et al., 1967; U.S. EPA, 1987/Sherman, 1974; U.S. EPA, 1982, 1985, 1987
Trichlorofluoromethane (F-11)									
subchronic (RfD <sub>S</sub> )	5600 mg/m <sup>3</sup> continuously for 90 days (1940 mg/kg/day); 1000 mg/kg/day, 5 days/week for 6 weeks (714.3 mg/kg/day)	dog	rat	elevated BUN, lung lesions; mortality	7E+0 (2E+0)	7E-1	1000	1000	Jenkins et al., 1970; U.S. EPA, 1987/NCI, 1978; U.S. EPA, 1987
chronic (RfD)	5600 mg/m <sup>3</sup> continuously for 90 days (1940 mg/kg/day); 488 mg/kg/day, 5 days/week for 66 weeks (348.6 mg/kg/day)	dog	rat	elevated BUN, lung lesions; mortality	7E-1 (2E-1)	3E-1 <sup>a</sup>	10,000	1000	Jenkins et al., 1970; U.S. EPA, 1987/NCI, 1978; U.S. EPA, 1985, 1987
Heptachlor									
subchronic (RfD <sub>S</sub> )	NA; 3 ppm in diet for 2 years (0.15 mg/kg/day)	NA	rat	NA; increased liver weight	ND	5E-4	NA	300	U.S. EPA, 1987a/Velsicol Chemical, 1955; U.S. EPA, 1987b
chronic (RfD)	NA; 3 ppm in diet for 2 years (0.15 mg/kg/day)	NA	rat	NA; increased liver weight (Cancer: see Table B)	ND	5E-4 <sup>a</sup>	NA	300	U.S. EPA, 1987a/Velsicol Chemical, 1955; U.S. EPA, 1987b

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Compound	Exposure Inhalation; Oral	Species		Effect of Concern Inhalation; Oral	Reference Dose		Uncertainty Factor		Reference Inhalation/Oral
		Inhalation	Oral		Inhalation [mg/m <sup>3</sup> (mg/kg/day)]	Oral (mg/kg/day)	Inhalation	Oral	
Hexachlorobenzene subchronic (RfD <sub>s</sub> )	NA; 1.6 ppm in diet for 130 weeks (0.08 mg/kg/ day)	NA	rat	NA; liver and hema- tologic effects	ND	8E-4	NA	100	U.S. EPA, 1984/ Arnold et al., 1985; U.S. EPA, 1988
chronic (RfD)	NA; 1.6 ppm in diet for 130 weeks (0.08 mg/kg/ day)	NA	rat	NA; liver and hema- tologic effects (Cancer: see Table B)	ND	8E-4 <sup>a</sup>	NA	100	U.S. EPA, 1984/ Arnold et al., 1985; U.S. EPA, 1988
Hexachlorobutadiene subchronic (RfD <sub>s</sub> )	NA; 2 year dietary study (0.2 mg/kg/day)	NA	rat	NA; kidney toxicity	ND	2E-3	NA	100	U.S. EPA, 1984/ Kociba et al., 1977; U.S. EPA, 1985
chronic (RfD)	NA; 2 year dietary study (0.2 mg/kg/day)	NA	rat	NA; kidney toxicity (Cancer: see Table B)	ND	2E-3 <sup>a</sup>	NA	100	U.S. EPA, 1984/ Kociba et al., 1977; U.S. EPA, 1985
Hexachloroethane subchronic (RfD <sub>s</sub> )	NA; 16 week dietary study (1 mg/kg/day)	NA	rat	NA; kidney degenera- tion	ND	1E-2	NA	100	U.S. EPA, 1987a/ Gorzinski et al., 1985; U.S. EPA, 1987b
chronic (RfD)	NA; 16 week dietary study (1 mg/kg/day)	NA	rat	NA; kidney degenera- tion (Cancer: see Table B)	ND	1E-3 <sup>a</sup>	NA	1000	U.S. EPA, 1987a/ Gorzinski et al., 1985; U.S. EPA, 1987b
Hexavalent chromium subchronic (RfD <sub>s</sub> )	NA; 25 ppm Cr VI in drinking water for 1 year (2.4 mg/kg/day)	NA	rat	cancer; not defined	ND	2E-2	NA	100	U.S. EPA, 1984/ MacKenzie et al., 1958; U.S. EPA, 1984
chronic (RfD)	NA; 25 ppm Cr VI in drinking water for 1 year (2.4 mg/kg/day)	NA	rat	cancer (see Table B); not defined	ND	5E-3 <sup>a</sup>	NA	500	U.S. EPA, 1984/ MacKenzie et al., 1958; U.S. EPA, 1984, 1986

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Compound	Exposure Inhalation; Oral	Species		Effect of Concern Inhalation; Oral	Reference Dose		Uncertainty Factor		Reference Inhalation/Oral
		Inhalation	Oral		Inhalation [mg/m <sup>3</sup> (mg/kg/day)]	Oral (mg/kg/day)	Inhalation	Oral	
<b>p-Hydroquinone</b> subchronic (RfD <sub>s</sub> )	NA; 300 mg/day for 3-5 months (4.29 mg/kg/day)	NA	human	NA; hematological effects	ND	4E-1	NA	10	U.S. EPA, 1987/ Carlson and Brewer, 1953; U.S. EPA, 1987
chronic (RfD)	NA; 300 mg/day for 3-5 months (4.29 mg/kg/day)	NA	human	NA; hematological effects	ND	4E-2	NA	100	U.S. EPA, 1987/ Carlson and Brewer, 1953; U.S. EPA, 1987
<b>Iron</b>				DATA INADEQUATE FOR QUANTITATIVE RISK ASSESSMENT					U.S. EPA, 1984
<b>Isophorone</b> subchronic (RfD <sub>s</sub> )	NA; 90-day oral (capsules) study (150 mg/kg/day)	NA	dog	NA; kidney lesions	ND	1.5E+0	NA	100	U.S. EPA, 1987/ Rohm and Haas, 1972; NTP, 1986; U.S. EPA, 1986
chronic (RfD)	NA; 90-day oral (capsules) study (150 mg/kg/day)	NA	dog	NA; kidney lesions (Cancer: see Table B)	ND	1.5E-1 <sup>a</sup>	NA	1000	U.S. EPA, 1987/ Rohm and Haas, 1972; NTP, 1986; U.S. EPA, 1986
<b>Lead</b> subchronic (RfD <sub>s</sub> )	NA; NA	NA	NA	NA; NA	NDP	ND <sup>q</sup>	NA	NA	U.S. EPA, 1984, 1986/U.S. EPA, 1984, 1986
chronic (RfD)	NA; NA	NA	NA	CNS effects; CNS effects (Cancer: see Table B)	NDP	ND <sup>q</sup>	NA	NA	U.S. EPA, 1984, 1986/U.S. EPA, 1984, 1986
<b>Lindane</b> (gamma hexachlorocy- clohexane) subchronic (RfD <sub>s</sub> )	NA; 4 ppm in diet for 12 weeks (0.33 mg/kg/ day)	NA	rat	NA; liver and and kidney toxicity	ND	3E-3	NA	100	U.S. EPA, 1984/ Zoecon Corp., 1983; U.S. EPA, 1986
chronic (RfD)	NA; 4 ppm in diet for 12 weeks (0.33 mg/kg day)	NA	rat	NA; liver and kidney toxicity (Cancer: see Table B)	ND	3E-4 <sup>a</sup>	NA	1000	U.S. EPA, 1984/ Zoecon Corp., 1983; U.S. EPA, 1986

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Compound	Exposure Inhalation; Oral	Species		Effect of Concern Inhalation; Oral	Reference Dose		Uncertainty Factor		Reference Inhalation/Oral
		Inhalation	Oral		Inhalation [mg/m <sup>3</sup> (mg/kg/day)]	Oral (mg/kg/day)	Inhalation	Oral	
<b>Manganese</b> subchronic (RfD <sub>s</sub> )	0.3 mg/m <sup>3</sup> occupational (2.1 mg/day); 1050 ppm Mn from Mn <sub>3</sub> O <sub>4</sub> from day 1 of gestation through 224 days of age (52.5 mg Mn/kg/day)	human	rat	CNS; reproductive	1E-3(3E-4)	5E-1	100	100	Saric et al., 1977; U.S. EPA, 1984/Laskey et al., 1982; U.S. EPA, 1984
chronic (RfD)	0.3 mg/m <sup>3</sup> occupational (2.1 mg/day); 1 mg MnCl <sub>2</sub> ·4 H <sub>2</sub> O/l for >2 years (22 mg Mn/kg/ day) in drinking water	human	rat	CNS; CNS <sup>1</sup>	1E-3(3E-4)	2E-1	100	100	Saric et al., 1977; U.S. EPA, 1984/Leung et al., 1981; Lai et al., 1982c; U.S. EPA, 1984
<b>Mercury, alkyl and inorganic</b> subchronic (RfD <sub>s</sub> )	NA; 0.003 mg/kg/day in humans associated with Hg in blood at 200 ng/ml	NA	human	NA; CNS effects	ND	3E-4	NA	10	U.S. EPA, 1984/ U.S. EPA, 1980b, 1984
chronic (RfD)	NA; 0.003 mg/kg/day in humans associated with Hg in blood at 200 ng/ml	NA	human	NA; CNS effects	ND	3E-4 <sup>a,r</sup>	NA	10	U.S. EPA, 1984/ U.S. EPA, 1980b, 1984, 1985
<b>Mercury, mercurial</b> subchronic (RfD <sub>s</sub> )	NA; several oral and parenteral studies in the Brown Norway rat	NA	rat	NA; kidney effects	ND	3E-4	NA	1000	U.S. EPA, 1984/ Fitzhugh et al., 1950; Orr et al., 1978; Bernaudin et al., 1981; Andres, 1984; U.S. EPA, 1987, 1988

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Compound	Exposure Inhalation; Oral	Species		Effect of Concern Inhalation; Oral	Reference Dose		Uncertainty Factor		Reference Inhalation/Oral
		Inhalation	Oral		Inhalation [mg/m <sup>3</sup> (mg/kg/day)]	Oral (mg/kg/day)	Inhalation	Oral	
Mercury, mercurial chronic (RFD)	NA; several oral and parenteral studies in the Brown Norway rat	NA	rat	NA; kidney effects <sup>1</sup>	ND	3E-4 <sup>1</sup>	NA	1000	U.S. EPA, 1984/ Fitzhugh et al., 1950; Dru et al., 1978; Bernaudin et al., 1981; Andres, 1984; U.S. EPA, 1987, 1988
Methomyl subchronic (RFD <sub>s</sub> )	NA; 100 ppm in diet (2.5 mg/kg/day) for 24 months	NA	dog	NA; kidney lesions	ND	3E-2	NA	100	U.S. EPA, 1988/ Kaplan and Sherman, 1977; U.S. EPA, 1988
chronic (RFD <sub>s</sub> )	NA; 100 ppm in diet (2.5 mg/kg/day) for 24 months	NA	dog	NA; kidney lesions	ND	3E-2 <sup>a</sup>	NA	100	U.S. EPA, 1988/ Kaplan and Sherman, 1977; U.S. EPA, 1988
Methylene chloride (dichloromethane) subchronic (RFD <sub>s</sub> )	200 ppm (694.8 mg/m <sup>3</sup> ) 6 hours/day, 5 days/week for 2 years; 24-month drinking water study [5.85 mg/kg/day (males) 6.47 mg/kg/day (females)]	rat	rat	NA; liver toxicity;	3 (NA)	6E-2	100	100	Nitschke et al., 1988; U.S. EPA, 1988/National Coffee Associa- tion, 1982; U.S. EPA, 1985
chronic (RFD)	200 ppm (694.8 mg/m <sup>3</sup> ) 6 hours/day, 5 days/week for 2 years; 24-month drinking water study [5.85 mg/kg/day (males) 6.47 mg/kg/day (females)]	rat	rat	NA; liver toxicity; (Cancer: see Table B)	3 (NA) <sup>1</sup>	6E-2 <sup>a</sup>	100	100	Nitschke et al., 1988; U.S. EPA, 1988/National Coffee Associa- tion, 1982; U.S. EPA, 1985



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Compound	Exposure Inhalation; Oral	Species		Effect of Concern Inhalation; Oral	Reference Dose		Uncertainty Factor		Reference Inhalation/Oral
		Inhalation	Oral		Inhalation (mg/m <sup>3</sup> )	Oral (mg/kg/day)	Inhalation	Oral	
Methyl ethyl ketone subchronic (RfDs)	235 ppm (693 mg/m <sup>3</sup> ) 7 hours/day, 5 days/ week for 12 weeks (92 mg/kg/day); 235 ppm (693 mg/m <sup>3</sup> ) 7 hours/ day, 5 days/week for 12 weeks (46 mg/kg/day)	rat	rat	CNS; fetotoxicity	3E-0 (9E-1) <sup>s</sup>	5E-1 <sup>b</sup>	100	100	LaBelle and Brieger, 1955; U.S. EPA, 1985/ LaBelle and Brieger, 1955; U.S. EPA, 1985
chronic (RfD)	235 ppm (693 mg/m <sup>3</sup> ) 7 hours/day, 5 days/ week for 12 weeks (92 mg/kg/day); 235 ppm (693 mg/m <sup>3</sup> ) 7 hours/ day, 5 days/week for 12 weeks (46 mg/kg/day)	rat	rat	CNS; fetotoxicity	3E-1 (9E-2) <sup>s</sup>	5E-2 <sup>a,b</sup>	1000	1000	LaBelle and Brieger, 1955; U.S. EPA, 1985/ LaBelle and Brieger, 1955; U.S. EPA, 1985
Methyl isobutyl ketone subchronic (RfDs)	50 ppm (205 mg/m <sup>3</sup> ) 6 hours/day, 5 days/ week for 90 days (23.3 mg/kg/day); 50 mg/kg/day by gavage for 13 weeks	rat	rat	liver and kidney effects; liver and kidney effects	8E-1 (2E-1)	5E-1	100	100	Union Carbide Corp., 1983b; U.S. EPA, 1987/ Microbiological Associates, 1986; U.S. EPA, 1987
chronic (RfD)	50 ppm (205 mg/m <sup>3</sup> ) 6 hours/day, 5 days/ week for 90 days (23.3 mg/kg/day); 50 mg/kg/day by gavage for 13 weeks	rat	rat	liver and kidney effects; liver and kidney effects	8E-2 (2E-2)	5E-2 <sup>a</sup>	1000	1000	Union Carbide Corp., 1983b; U.S. EPA, 1987/ Microbiological Associates, 1986; U.S. EPA, 1986, 1987
Methyl Styrene (industrial mixture) subchronic (RfDs)	10 ppm (48.3 mg/m <sup>3</sup> ) 6 hours/day, 5 days/week for 103 weeks (11.2 mg/ kg/day); 10 ppm (48.3 mg/m <sup>3</sup> ) 6 hours/day, 5 days/week for 103 weeks (5.6 mg/kg/day)	mouse	mouse	nasal lesions; nasal lesions	4E-2 (1E-2)	6E-3 <sup>b</sup>	1000	1000	MRI, 1984a; U.S. EPA, 1987/ MRI, 1984a; U.S. EPA, 1987

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Compound	Exposure Inhalation; Oral	Species		Effect of Concern Inhalation; Oral	Reference Dose		Uncertainty Factor		Reference Inhalation/Oral
		Inhalation	Oral		Inhalation [mg/m <sup>3</sup> (mg/kg/day)]	Oral (mg/kg/day)	Inhalation	Oral	
Methyl Styrene (industrial mixture) chronic	10 ppm (48.3 mg/m <sup>3</sup> ) 6 hours/day, 5 days/week for 103 weeks (11.2 mg/kg/day); 10 ppm (48.3 mg/m <sup>3</sup> ) 6 hours/day, 5 days/week for 103 weeks (5.6 mg/kg/day)	mouse	mouse	nasal lesions; nasal lesions	4E-2 (1E-2)	6E-3 <sup>b</sup>	1000	1000	MRI, 1984a; U.S. EPA, 1987/ MRI, 1984a; U.S. EPA, 1987
Mirex subchronic (RfD <sub>s</sub> )	NA; 0.1 ppm in diet, multigenerational study (0.015 mg/kg/day)	NA	prairie vole	NA; decreased pup survival	ND	2E-6	NA	10,000	U.S. EPA, 1987a/ Shannon, 1976; U.S. EPA, 1987b
chronic (RfD)	NA; 0.1 ppm in diet, multigenerational study (0.015 mg/kg/day)	NA	prairie vole	NA; decreased pup survival (Cancer: see Table 8)	ND	2E-6 <sup>a</sup>	NA	10,000	U.S. EPA, 1987a/ Shannon, 1976; U.S. EPA, 1987b
Monochlorobutanes 1-Chlorobutane subchronic (RfD <sub>s</sub> )	NA; 120 mg/kg, 5 days/week for 13 weeks by gavage (86 mg/kg/day)	NA	rat	NA; CNS and hematopoietic effects	ND	9E-1	NA	100	U.S. EPA, 1988/ NTP, 1986; U.S. EPA, 1988
chronic (RfD)	NA; 60 mg/kg, 5 days/week for 103 weeks by gavage (43 mg/kg/day)	NA	rat	NA; mortality, CNS and hematologic effects	ND	4E-1	NA	100	U.S. EPA, 1988/ NTP, 1986; U.S. EPA, 1988
2-Chlorobutane				DATA INADEQUATE FOR QUANTITATIVE RISK ASSESSMENT					U.S. EPA, 1988/ U.S. EPA, 1988
t-Butylchloride				DATA INADEQUATE FOR QUANTITATIVE RISK ASSESSMENT					U.S. EPA, 1988/ U.S. EPA, 1988
Naphthalene subchronic (RfD <sub>s</sub> )	NA; 10-20 mg/day in diet 6 days/week for ~700 days (41 mg/kg/day) <sup>5</sup>	NA	rat	NA; ocular and internal lesions	ND	4E-1 <sup>t</sup>	NA	100	U.S. EPA, 1988/ Schmahl, 1955; U.S. EPA, 1988

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Compound	Exposure Inhalation; Oral	Species		Effect of Concern Inhalation; Oral	Reference Dose		Uncertainty Factor		Reference Inhalation/Oral
		Inhalation	Oral		Inhalation [mg/m <sup>3</sup> (mg/kg/day)]	Oral (mg/kg/day)	Inhalation	Oral	
Naphthalene chronic (RfD)	NA; 10-20 mg/day in diet 6 days/week for $\approx$ 700 days (41 mg/kg/day) <sup>s</sup>	NA	rat	NA; ocular and internal lesions	ND	4E-19.t	NA	100	U.S. EPA, 1988/ Schmah1, 1955; U.S. EPA, 1986; 1988
Nickel subchronic (RfDs)	NA; 100 ppm Ni from nickel sulfate in diet for 2 years (5 mg Ni/kg/day)	NA	rat	cancer; reduced body and organ weight	ND	2E-2	NA	300	U.S. EPA, 1984/ Ambrose et al., 1976; U.S. EPA, 1987
chronic (RfD)	NA; 100 ppm Ni from nickel sulfate in diet for 2 years (5 mg Ni/kg/day)	NA	rat	cancer (see Table B); reduced body and organ	ND	2E-2 <sup>a</sup>	NA	300	U.S. EPA, 1984/ Ambrose et al., 1976; U.S. EPA, 1987
Nitriles, Selected Methacrylonitrile subchronic (RfDs)	3.2 ppm (9 mg/m <sup>3</sup> ), 7 hours/day, 5 days/week for 90 days (0.63 mg/ kg/day); 3.2 ppm (9 mg/m <sup>3</sup> ) 7 hours/day 5 days/week for 90 days (0.32 mg/kg/day)	dog	dog	increased SGOT and SGPT, loss of hind- limb motor control, brain lesions; in- creased SGOT and SGPT, loss of hind- limb motor control, brain lesions	7E-3 (2E-3) <sup>m</sup>	1E-3 <sup>b</sup>	300	300	Pozzani et al., 1968; U.S. EPA, 1987b/Pozzani et al., 1968; U.S. EPA, 1987b
chronic (RfD)	3.2 ppm (9 mg/m <sup>3</sup> ), 7 hours/day, 5 days/week for 90 days (0.63 mg/ kg/day); 3.2 ppm (9 mg/m <sup>3</sup> ) 7 hours/day 5 days/week for 90 days (0.32 mg/kg/day)	dog	dog	increased SGOT and SGPT, loss of hind- limb motor control, brain lesions; in- creased SGOT and SGPT, loss of hind- limb motor control, brain lesions	7E-4 (2E-4) <sup>m</sup>	1E-4 <sup>a,b</sup>	3000	3000	Pozzani et al., 1968; U.S. EPA, 1987b/Pozzani et al., 1968; U.S. EPA, 1987b
Nicotinonitrile				DATA INADEQUATE FOR QUANTITATIVE RISK ASSESSMENT					U.S. EPA, 1987
Succinonitrile				DATA INADEQUATE FOR QUANTITATIVE RISK ASSESSMENT					U.S. EPA, 1987

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Compound	Exposure Inhalation; Oral	Species		Effect of Concern Inhalation; Oral	Reference Dose		Uncertainty factor		Reference Inhalation/Oral
		Inhalation	Oral		Inhalation [mg/m <sup>3</sup> (mg/kg/day)]	Oral (mg/kg/day)	Inhalation	Oral	
Nitrobenzene subchronic (RfDs)	5 ppm (25 mg/m <sup>3</sup> ) 6 hours/day, 5 days/ week for 90 days (5.8 mg/kg/day); 5 ppm (25 mg/m <sup>3</sup> ) 6 hours/day, 5 days/ week for 90 days (4.64 mg/kg/day)	mouse	mouse	hematological, adrenal, renal and hepatic lesions; hematological, adrenal, renal and hepatic lesions;	2E-2 (6E-3)	5E-3 <sup>b</sup>	1000	1000	CIIT, 1984; U.S. EPA, 1987/ CIIT, 1984; U.S. EPA, 1987
	chronic (RfD)	mouse	mouse	hematological, adrenal, renal and hepatic lesions; hematological, adrenal, renal and hepatic lesions;	2E-3 (6E-4)	5E-4 <sup>a,b</sup>	10,000	10,000	CIIT, 1984; U.S. EPA, 1987/ CIIT, 1984; U.S. EPA, 1985, 1987
Nitrofurans nitrofurantoin Subchronic (RfDs)	NA; 300 ppm diet for 13 weeks, (69.7 mg/kg/ day)	NA	mouse	NA; testicular damage	ND	7E-1	NA	100	U.S. EPA, 1987/ SRI, 1980; U.S. EPA, 1987
	chronic RfD	NA	mouse	NA; testicular damage	ND	7E-2	NA	1000	U.S. EPA, 1987/ SRI, 1980; U.S. EPA, 1987
Other nitrofurans: see Table B									
Nitrophenols		DATA INADEQUATE FOR QUANTITATIVE RISK ASSESSMENT							U.S. EPA, 1987
Parathion subchronic (RfDs)	NA; CBI	NA	human	NA; cholinesterase inhibition	ND	6E-3	NA	10	U.S. EPA, 1987/ U.S. EPA, 1987
	chronic (RfD)	NA	human	NA; cholinesterase inhibition, cancer <sup>u</sup>	ND	6E-3 <sup>9</sup>	NA	10	U.S. EPA, 1987/ U.S. EPA, 1987

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		Inhalation	Oral		Inhalation [mg/m <sup>3</sup> (mg/kg/day)]	Oral (mg/kg/day)	Inhalation	Oral	
Pentachlorophenol subchronic (RfD <sub>S</sub> )	NA; 3 mg/kg/day by gavage 62 days before mating through gestation	NA	rat	NA; fetotoxicity	ND	3E-2	NA	100	U.S. EPA, 1984/ Schwetz et al., 1978; U.S. EPA, 1984
chronic (RfD)	NA; 3 mg/kg/day by gavage for 22-24 months	NA	rat	NA; liver and kidney pathology <sup>1</sup>	ND	3E-2 <sup>a</sup>	NA	100	U.S. EPA, 1984/ Schwetz et al., 1978; U.S. EPA, 1984, 1985
n-Pentane				DATA INADEQUATE FOR QUANTITATIVE RISK ASSESSMENT					U.S. EPA, 1987
Phenanthrene				DATA INADEQUATE FOR QUANTITATIVE RISK ASSESSMENT					U.S. EPA, 1987
Phenol subchronic (RfD <sub>S</sub> )	NA; 60 mg/kg/day by gavage during organo- genesis	NA	rat	NA; reduced fetal body weight	ND	6E-1	NA	100	U.S. EPA, 1984/ Research Triangle Institute, 1983; U.S. EPA, 1988
chronic (RfD)	NA; 60 mg/kg/day by gavage during organo- genesis	NA	rat	NA; reduced fetal body weight	ND	6E-1 <sup>1</sup>	NA	100	U.S. EPA, 1984/ Research Triangle Institute, 1983; U.S. EPA, 1988
Phthalic acid esters (selected) Bis(2-ethylhexyl) phthalate subchronic (RfD <sub>S</sub> )	NA; 0.04% of diet for 1 year (19 mg/kg/day)	NA	guinea pig	NA; increased relative liver weight	ND	2E-2	NA	1000	U.S. EPA, 1987/ Carpenter et al., 1953; U.S. EPA, 1986
chronic (RfD)	NA; 0.04% of diet for 1 year (19 mg/kg/day)	NA	guinea pig	NA; increased relative liver weight (Cancer: see (Table B)	ND	2E-2 <sup>a</sup>	NA	1000	U.S. EPA, 1987/ Carpenter et al., 1953; U.S. EPA, 1986

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		Inhalation	Oral		Inhalation [mg/m <sup>3</sup> (mg/kg/day)]	Oral (mg/kg/day)	Inhalation	Oral	
Butyl benzyl phthalate subchronic (RfD <sub>S</sub> )	NA; 0.28% of diet for 26 weeks (159 mg/kg/day)	NA	rat	NA; effects on body weight gain, testes, liver, kidney	ND	2E+0	NA	100	U.S. EPA, 1987/ NTP, 1985; U.S. EPA, 1987
chronic (RfD)	NA; 0.28% of diet for 26 weeks (159 mg/kg/day)	NA	rat	NA; effects on body weight gain, testes, liver, kidney <sup>u</sup>	ND	2E-1	NA	1000	U.S. EPA, 1987/ NTP, 1985; U.S. EPA, 1986, 1987
Diethyl phthalate subchronic (RfD <sub>S</sub> )	NA; 1% in diet for 16 weeks (750 mg/kg/day)	NA	rat	NA; reduced terminal body weight	ND	8E+0	NA	100	U.S. EPA, 1987a/ Brown et al., 1978; U.S. EPA, 1987a
chronic (RfD)	NA; 1% in diet for 16 weeks (750 mg/kg/day)	NA	rat	NA; reduced terminal body weight <sup>l</sup>	ND	8E-1 <sup>a</sup>	NA	1000	U.S. EPA, 1987a/ Brown et al., 1978; U.S. EPA, 1987a,b
Di-n-butyl phthalate subchronic (RfD <sub>S</sub> )	NA; 0.25% of diet for 52 weeks (125 mg/kg/day)	NA	rat	NA; mortality	ND	1E+0	NA	100	U.S. EPA, 1987/ Smith, 1953; U.S. EPA, 1987
chronic (RfD)	NA; 0.25% of diet for 52 weeks (125 mg/kg/day)	NA	rat	NA; mortality <sup>l</sup>	ND	1E-1 <sup>a</sup>	NA	1000	U.S. EPA, 1987/ Smith, 1953; U.S. EPA, 1986 1987
Dimethyl phthalate				DATA INADEQUATE FOR QUANTITATIVE RISK ASSESSMENT <sup>9,1</sup>					U.S. EPA, 1987
Di-n-octyl phthalate				DATA INADEQUATE FOR QUANTITATIVE RISK ASSESSMENT					U.S. EPA, 1987
n-Propyl alcohol				DATA INADEQUATE FOR QUANTITATIVE RISK ASSESSMENT					U.S. EPA, 1987
Propylene glycol subchronic (RfD <sub>S</sub> )	170-350 mg/m <sup>3</sup> (mean: 260 mg/m <sup>3</sup> ) contin- uously for 18 months (166 mg/kg/day); 6% in diet for 20 weeks (3 g/kg/day)	rat	rat	none observed; renal lesions	6E+0 (2E+0)	3E+1	100	100	Robertson, 1947; U.S. EPA, 1987/ Guerrant et al., 1947; U.S. EPA, 1987

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Compound	Exposure Inhalation; Oral	Species		Effect of Concern Inhalation; Oral	Reference Dose		Uncertainty Factor		Reference Inhalation/Oral
		Inhalation	Oral		Inhalation [mg/m <sup>3</sup> (mg/kg/day)]	Oral (mg/kg/day)	Inhalation	Oral	
Propylene glycol chronic (RfD)	170-350 mg/m <sup>3</sup> (mean: 260 mg/m <sup>3</sup> ) contin- uously for 18 months (166 mg/kg/day); 50,000 ppm in diet for 2 years (2.1 g/kg/day)	rat	dog	none observed; de- crease in RBC, hematocrit, hemo- globin in dogs	6E+0 (2E+0)	2E+1	100	100	Robertson, 1947; U.S. EPA, 1987/ Gaunt et al., 1972; U.S. EPA, 1987
Pyrene				DATA INADEQUATE FOR QUANTITATIVE RISK ASSESSMENT					U.S. EPA, 1984
Selenium subchronic (RfD <sub>s</sub> )	0.1 mg/m <sup>3</sup> occupational; (0.7 mg/day); 4.8 ppm in diet for 6 weeks (0.41 mg/kg/day)	human	rat	ND; mortality	4E-3 (1E-3)	4E-3	10	100	Glover, 1967; U.S. EPA, 1984/ Halverson et al., 1966; U.S. EPA, 1985
chronic (RfD)	0.1 mg/m <sup>3</sup> occupational (0.7 mg/day); 3.2 mg/day from diet of seleniferous foodstuffs	human	human	ND; hair and nail loss, dermatitis	4E-3 (1E-3)	3E-3 <sup>a</sup>	10	15	Glover, 1967; U.S. EPA, 1984/ Yang et al., 1983; U.S. EPA, 1984, 1985
Sodium cyanide subchronic (RfD <sub>s</sub> )	NA; 10.8 mg CN/kg/day from diet containing HCN (equivalent to NaCN at 20.4 mg/kg/day)	NA	rat	NA; CNS	ND	4E-2	NA	500	U.S. EPA, 1984/ Howard and Hanzal, 1955; U.S. EPA, 1984
chronic (RfD)	NA; 10.8 mg CN/kg/day from diet containing HCN (equivalent to NaCN at 20.4 mg/kg/day)	NA	rat	NA; CNS	ND	4E-2 <sup>a</sup>	NA	500	U.S. EPA, 1984/ Howard and Hanzal, 1955; U.S. EPA, 1984, 1985
Sodium diethyldithio- carbamate subchronic (RfD <sub>s</sub> )	NA; 30 mg/kg/day for 90 days	NA	rat	NA; decreased body weight gain, renal and hemotological effects	ND	3E-1	NA	100	U.S. EPA, 1988/ Sunderman et al., 1967; U.S. EPA, 1988

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Compound	Exposure Inhalation; Oral	Species		Effect of Concern Inhalation; Oral	Reference Dose		Uncertainty Factor		Reference Inhalation/Oral
		Inhalation	Oral		Inhalation [mg/m <sup>3</sup> (mg/kg/day)]	Oral (mg/kg/day)	Inhalation	Oral	
Sodium diethyldithio- carbamate chronic (RfD)	NA; 30 mg/kg/day for 90 days	NA	rat	NA; cataracts and reduced body weight in chronic study (Cancer: see Table B)	ND	3E-2 <sup>a</sup>	NA	1000	U.S. EPA, 1988/ Sunderman et al., 1967; U.S. EPA, 1985 1988
Sulfuric acid subchronic (RfD <sub>S</sub> )	0.066-0.098 mg/m <sup>3</sup> occupational; NA	human	NA	respiratory; NA	ND <sup>v</sup>	ND	NA	NA	Carson et al., 1981; U.S. EPA, 1984/NA
chronic (RfD)	0.066-0.098 mg/m <sup>3</sup> occupational; NA	human	NA	respiratory; NA	ND <sup>v</sup>	ND	NA	NA	Carson et al., 1981; U.S. EPA 1984/NA
Tetrachloroethylene (perchloroethylene) subchronic (RfD <sub>S</sub> )	NA; 20 mg/kg 5 days/week for 6 weeks (14 mg/kg/day)	NA	mouse	NA; hepatotoxicity	ND	1E-1	NA	100	U.S. EPA, 1988/ Buben and O'Flaherty, 1985; U.S. EPA, 1987
chronic (RfD)	NA; 20 mg/kg 5 days/week for 6 weeks (14 mg/kg/day)	NA	mouse	NA; hepatotoxicity (Cancer: see Table B)	ND	1E-2 <sup>a</sup>	NA	1000	U.S. EPA, 1988/ Buben and O'Flaherty, 1985; U.S. EPA, 1987
Thallium and Compounds Thallium (in soluble salts) subchronic RfD <sub>S</sub> )	NA; 0.20 mg/thallium/kg/ day (from thallium sulfate) for 90 days	NA	rat	NA; increased SGOT and serum LDH levels, alopecia	ND	7E-4	NA	300	U.S. EPA, 1988a/ MRI, 1986; U.S. EPA, 1986b
chronic (RfD)	NA; 0.20 mg/thallium/kg/ day (from thallium sulfate) for 90 days	NA	rat	NA; increased SGOT and serum LDH levels, alopecia	ND	7E-5	NA	3000	U.S. EPA, 1988a/ MRI, 1986; U.S. EPA, 1986b



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Compound	Exposure Inhalation; Oral	Species Inhalation Oral	Effect of Concern Inhalation; Oral	Reference Dose		Uncertainty Factor		Reference Inhalation/Oral	
				Inhalation (mg/m <sup>3</sup> )	Oral (mg/kg/day)	Inhalation	Oral		
Thallium(III) oxide [Thallic oxide] subchronic (RfDs)	NA; 0.02 mg/thallium/kg/ day (from thallium sulfate) for 90 days	NA	rat	NA; increased SGOT and serum LDH levels, alopecia	ND	7E-4	NA	300	U.S. EPA, 1988a/ MRI, 1986; U.S. EPA, 1986b 1988b
chronic (RfD)	NA; 0.02 mg/thallium/kg/ day (from thallium sulfate) for 90 days	NA	rat	NA; increased SGOT and serum LDH levels, alopecia	ND	7E-5 <sup>a</sup>	NA	3000	U.S. EPA, 1988a/ MRI, 1986; U.S. EPA, 1986b 1988b
Thallium(I) acetate subchronic (RfDs)	NA; 0.20 mg/thallium/kg/ day (from thallium sulfate) for 90 days	NA	rat	NA; increased SGOT and serum LDH levels, alopecia	ND	9E-4	NA	300	U.S. EPA, 1988a/ MRI, 1986; U.S. EPA, 1986b, 1988b
chronic (RfD)	NA; 0.20 mg/thallium/kg/ day (from thallium sulfate) for 90 days	NA	rat	NA; increased SGOT and serum LDH levels, alopecia	ND	9E-5 <sup>a</sup>	NA	3000	U.S. EPA, 1988a/ MRI, 1986; U.S. EPA, 1986b, 1988b
Thallium(I) carbonate subchronic (RfDs)	NA; 0.20 mg/thallium/kg/ day (from thallium sulfate) for 90 days	NA	rat	NA; increased SGOT and serum LDH levels, alopecia	ND	8E-4	NA	300	U.S. EPA, 1988a/ MRI, 1986; U.S. EPA, 1986b, 1988b
chronic (RfD)	NA; 0.20 mg/thallium/kg/ day (from thallium sulfate) for 90 days	NA	rat	NA; increased SGOT and serum LDH levels, alopecia	ND	8E-5 <sup>a</sup>	NA	3000	U.S. EPA, 1988a/ MRI, 1986; U.S. EPA, 1986b, 1988b
Thallium(I) chloride subchronic (RfDs)	NA; 0.20 mg/thallium/kg/ day (from thallium sulfate) for 90 days	NA	rat	NA; increased SGOT and serum LDH levels, alopecia	ND	8E-4	NA	300	U.S. EPA, 1988a/ MRI, 1986; U.S. EPA, 1986b, 1988b

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Compound	Exposure Inhalation; Oral	Species		Effect of Concern Inhalation; Oral	Reference Dose		Uncertainty Factor		Reference Inhalation/Oral
		Inhalation	Oral		Inhalation {mg/m <sup>3</sup> (mg/kg/day)}	Oral (mg/kg/day)	Inhalation	Oral	
Thallium(I) chloride chronic (RfD)	NA; 0.20 mg/thallium/kg/ day (from thallium sulfate) for 90 days	NA	rat	NA; increased SGOT and serum LDH levels, alopecia	ND	8E-5 <sup>a</sup>	NA	3000	U.S. EPA, 1988a/ MRI, 1986; U.S. EPA, 1986b, 1988b
Thallium(I) nitrate subchronic (RfD <sub>s</sub> )	NA; 0.20 mg/thallium/kg/ day (from thallium sulfate) for 90 days	NA	rat	NA; increased SGOT and serum LDH levels, alopecia	ND	9E-4	NA	300	U.S. EPA, 1988a/ MRI, 1986; U.S. EPA, 1986b, 1988b
chronic (RfD)	NA; 0.20 mg/thallium/kg/ day (from thallium sulfate) for 90 days	NA	rat	NA; increased SGOT and serum LDH levels, alopecia	ND	9E-5 <sup>a</sup>	NA	3000	U.S. EPA, 1988a/ MRI, 1986; U.S. EPA, 1986b, 1988b
Thallium selenide (Tl <sub>2</sub> Se) subchronic (RfD <sub>s</sub> )	NA; 0.20 mg/thallium/kg/ day (from thallium sulfate) for 90 days	NA	rat	NA; increased SGOT and serum LDH levels, alopecia	ND	9E-4	NA	300	U.S. EPA, 1988a/ MRI, 1986; U.S. EPA, 1986b, 1988b
chronic (RfD)	NA; 0.20 mg/thallium/kg/ day (from thallium sulfate) for 90 days	NA	rat	NA; increased SGOT and serum LDH levels, alopecia	ND	9E-5 <sup>a</sup>	NA	3000	U.S. EPA, 1988a/ MRI, 1986; U.S. EPA, 1986b, 1988b
Thallium(I) sulfate subchronic (RfD <sub>s</sub> )	NA; 0.25 mg/kg/day for 90 days	NA	rat	NA; increased SGOT and serum LDH levels, alopecia	ND	8E-4	NA	300	U.S. EPA, 1988a/ MRI, 1986; U.S. EPA, 1986b, 1988b
chronic (RfD)	NA; 0.25 mg/kg/day for 90 days	NA	rat	NA; increased SGOT and serum LDH levels, alopecia	ND	8E-5 <sup>a</sup>	NA	3000	U.S. EPA, 1988a/ MRI, 1986; U.S. EPA, 1986b, 1988b

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Compound	Exposure Inhalation; Oral	Species		Effect of Concern Inhalation; Oral	Reference Dose		Uncertainty Factor		Reference Inhalation/Oral
		Inhalation	Oral		Inhalation (mg/m <sup>3</sup> )	Oral (mg/kg/day)	Inhalation	Oral	
Tin and Compounds subchronic (RFD <sub>s</sub> )	NA; 2000 ppm stannous chloride in diet for 2 years (62 mg Sn/kg/day)	NA	rat	NA; liver and kidney lesions	ND	6E-1	NA	100	U.S. EPA, 1987/ NTP, 1982; U.S. EPA, 1987
chronic (RFD)	NA; 2000 ppm stannous chloride in diet for 2 years (62 mg Sn/kg/day)	NA	rat	NA; liver and kidney lesions	ND	6E-1	NA	100	U.S. EPA, 1987/ NTP, 1982; U.S. EPA, 1987
Toluene subchronic (RFD <sub>s</sub> )	300 ppm (1130 mg/m <sup>3</sup> ) 6 hours/day, 5 days/week for 24 months (149.9 mg/kg/day); 590 mg/day 5 days/week for 138 doses (42 mg/kg/day) by gavage	rat	rat	CNS effects; CNS effects	5E+0 (1E+0)	4E-1	100	100	CIIT, 1980; U.S. EPA, 1984/ Wolf et al., 1956
chronic (RFD)	300 ppm (1130 mg/m <sup>3</sup> ) 6 hours/day, 5 days/week for 24 months (149.9 mg/kg/day); 300 ppm (1130 mg/m <sup>3</sup> ) 6 hours/day, 5 days/week for 24 months (29 mg/kg/day) <sup>b</sup>	rat	rat	CNS effects; CNS effects <sup>1</sup>	5E+0 (1E+0)	3E-1 <sup>a,b,g</sup>	100	100	CIIT, 1980; U.S. EPA, 1984/ CIIT, 1980; U.S. EPA, 1984, 1985a,b
1,2,4-Trichlorobenzene subchronic (RFD <sub>s</sub> )	3 ppm (22 mg/m <sup>3</sup> ) 6 hours/day, 5 days/week for 3 months (2.5 mg/kg/day); 20 mg/kg/day by gavage for 90 days	rat	rat	increased uroporphyrin; increased liver-to-body weight ratio	9E-2 (3E-2)	2E-1	100	100	Watanabe et al., 1978; U.S. EPA, 1987/Carlson and Tardiff, 1976; U.S. EPA, 1987
chronic (RFD)	3 ppm (22 mg/m <sup>3</sup> ) 6 hours/day, 5 days/week for 3 months (2.5 mg/kg/day); 20 mg/kg/day by gavage for 90 days	rat	rat	increased uroporphyrin; increased liver-to-body weight ratio	9E-3 (3E-3)	2E-2 <sup>a,g</sup>	1000	1000	Watanabe et al., 1978; U.S. EPA, 1987/Carlson and Tardiff, 1976; U.S. EPA, 1986, 1987

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Compound	Exposure Inhalation; Oral	Species		Effect of Concern Inhalation; Oral	Reference Dose		Uncertainty Factor		Reference Inhalation/Oral
		Inhalation	Oral		Inhalation [mg/m <sup>3</sup> (mg/kg/day)]	Oral (mg/kg/day)	Inhalation	Oral	
1,1,1-Trichloroethane subchronic (RfD <sub>s</sub> )	500 ppm (2730 mg/m <sup>3</sup> ) 7 hours/day, 5 days/ week for 6 months (304 mg/kg/day); 500 ppm (2730 mg/m <sup>3</sup> ) 7 hours/day for 6 months (90 mg/kg/day) <sup>b</sup>	guinea pig	guinea pig	hepatotoxicity; hepatotoxicity	1E+1 (3E+0) <sup>s</sup>	9E-1 <sup>b</sup>	100	100	Torkelson et al., 1958; U.S. EPA, 1986/ Torkelson et al., 1958; U.S. EPA, 1986
chronic (RfD)	500 ppm (2730 mg/m <sup>3</sup> ) 7 hours/day, 5 days/ week for 6 months (304 mg/kg/day); 500 ppm (2730 mg/m <sup>3</sup> ) 7 hours/day for 6 months (90 mg/kg/day) <sup>b</sup>	guinea pig	guinea pig	hepatotoxicity; hepatotoxicity	1E+0 (3E-1) <sup>s</sup>	9E-2 <sup>a,b</sup>	1000	1000	Torkelson et al., 1958; U.S. EPA, 1986/ Torkelson et al., 1958; U.S. EPA, 1986
1,1,2-Trichloroethane subchronic (RfD <sub>s</sub> )	NA; 3.9 mg/kg/day by drinking water for 90 days	NA	mouse	NA; clinical chemistry altera- tions	ND	4E-2	NA	100	U.S. EPA, 1984/ White et al., 1985; Sanders et al., 1985; U.S. EPA, 1988
chronic (RfD)	NA; 3.9 mg/kg/day by drinking water for 90 days	NA	mouse	NA; clinical chemistry altera- tions (Cancer: see Table B)	ND	4E-3 <sup>a</sup>	NA	1000	U.S. EPA, 1984/ White et al., 1985; Sanders et al., 1985; U.S. EPA, 1988
Trichloropropanes 1,1,1-Trichloropropane				DATA INADEQUATE FOR QUANTITATIVE RISK ASSESSMENT					U.S. EPA, 1987/ U.S. EPA, 1987
1,2,2--Trichloropropane				DATA INADEQUATE FOR QUANTITATIVE RISK ASSESSMENT					U.S. EPA, 1987/ U.S. EPA, 1987
1,1,2-Trichloropropane subchronic (RfD <sub>s</sub> )	NA; 100 mg/l in drinking water for 13 weeks (15 mg/kg/day)	NA	rat	histopathological lesions in liver, kidney and thyroid	ND	5E-2	NA	300	U.S. EPA, 1987a/ Villeneuve et al., 1985; U.S. EPA, 1987b

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Compound	Exposure Inhalation; Oral	Species		Effect of Concern Inhalation; Oral	Reference Dose		Uncertainty Factor		Reference Inhalation/Oral
		Inhalation	Oral		Inhalation (mg/m <sup>3</sup> )	Oral (mg/kg/day)	Inhalation	Oral	
1,1,2-Trichloropropane chronic (RfD)	NA; 100 mg/L in drinking water for 13 weeks (15 mg/kg/day)	NA	rat	histopathological lesions in liver, kidney and thyroid	ND	5E-3 <sup>a</sup>	NA	3000	U.S. EPA, 1987a Villeneuve et al., 1985; U.S. EPA, 1987b
1,2,3-Trichloropropane subchronic (RfDs)	NA; 8 mg/kg 5 days/week for 120 days (5.7 mg/kg/day)	NA	rat	NA; transient clini- cal signs, liver and kidney lesions, decrease in RBC, hematocrit and hemoglobin	ND	6E-2	NA	100	U.S. EPA, 1987/ NTP, 1983a; U.S. EPA, 1987
chronic (RfD)	NA; 8 mg/kg 5 days/week for 120 days (5.7 mg/kg/day)	NA	rat	NA; transient clini- cal signs, liver and kidney lesions, decrease in RBC, hematocrit and hemoglobin	ND	6E-3 <sup>a</sup>	NA	1000	U.S. EPA, 1987/ NTP, 1983a; U.S. EPA, 1986, 1987
Trihalogenated methanes Bromodichloromethane subchronic (RfDs)	NA; 25 mg/day by gavage 5 days/week for 102 weeks (17.9 mg/kg/day)	NA	mouse	NA; renal cytomegaly	ND	2E-2	NA	1000	U.S. EPA, 1987a/ NTP, 1986/ U.S. EPA, 1987b
chronic (RfD)	NA; 25 mg/day by gavage 5 days/week for 102 weeks (17.9 mg/kg/day)	NA	mouse	NA, renal cytomegaly (Cancer: see Table B)	ND	2E-2 <sup>a</sup>	NA	1000	U.S. EPA, 1987a/ NTP, 1986; U.S. EPA, 1987b
Bromoform subchronic (RfDs)	NA; 25 mg/kg 5 days/ week for 13 weeks (17.9 mg/kg/day)	NA	rat	NA; liver effects	ND	2E-1	NA	100	U.S. EPA, 1987a/ NTP, 1980; U.S. EPA, 1987b
chronic (RfD)	NA; 25 mg/kg 5 days/ week for 13 weeks (17.9 mg/kg/day)	NA	rat	NA; liver effects	ND	2E-2 <sup>a</sup>	NA	1000	U.S. EPA, 1987a/ NTP, 1980; U.S. EPA, 1987b

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		Inhalation	Oral		Inhalation (mg/m <sup>3</sup> )	Oral (mg/kg/day)	Inhalation	Oral	
Chlorodibromomethane subchronic (RfD <sub>s</sub> )	NA; 30 mg/kg 5 days/week for 13 weeks (21.4 mg/kg/day)	NA	NA	NA; liver lesions	ND	2E-1	NA	100	U.S. EPA, 1987a/ NTP, 1985; U.S. EPA, 1987b
chronic (RfD)	NA; 30 mg/kg 5 days/week for 13 weeks (21.4 mg/kg/day)	NA	rat	NA; liver lesions (Cancer: see Table B)	ND	2E-2 <sup>a</sup>	NA	1000	U.S. EPA, 1987a/ NTP, 1985; U.S. EPA, 1987b
Trimethylbenzenes				DATA INADEQUATE FOR QUANTITATIVE RISK ASSESSMENT					U.S. EPA, 1987
Trivalent chromium subchronic (RfD <sub>s</sub> )	NA; 5% Cr <sub>2</sub> O <sub>3</sub> in diet 5 days/week for 90 days (1400 mg Cr/kg/day)	NA	rat	NA; hepatotoxicity	ND	1E+1	NA	100	U.S. EPA, 1984/ Ivankovic and Preussman, 1975; U.S. EPA, 1984
chronic (RfD)	NA; 5% Cr <sub>2</sub> O <sub>3</sub> in diet 5 days/week for 600 feedings (1468 mg Cr/kg/day)	NA	rat	NA; hepatotoxicity	ND	1E+0 <sup>a</sup>	NA	1000	U.S. EPA, 1984/ Ivankovic and Preussman, 1975; U.S. EPA, 1984, 1985
Vanadium and compounds Sodium metavanadate subchronic (RfD <sub>s</sub> )	NA; 10 ppm sodium metavanadate in drink- ing water for 3 months (1.32 mg sodium meta- vanadate/kg/day)	NA	rat	NA; impaired kidney function	ND	1E-2	NA	100	U.S. EPA, 1987/ Domingo et al., 1985; U.S. EPA, 1987
chronic (RfD)	NA; 10 ppm sodium metavanadate in drink- ing water for 3 months (1.32 mg sodium meta- vanadate/kg/day)	NA	rat	NA; impaired kidney function	ND	1E-3	NA	1000	U.S. EPA, 1987/ Domingo et al., 1985; U.S. EPA, 1987
Vanadium subchronic (RfD <sub>s</sub> )	NA; 5 ppm vanadium from vanadyl sulfate in drinking water for lifetime (0.7 mg/kg/day)	NA	rat	NA; none observed	ND	7E-3	NA	100	U.S. EPA, 1987/ Schroeder et al., 1970; U.S. EPA, 1987

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		Inhalation	Oral		Inhalation (mg/m <sup>3</sup> )	Oral (mg/kg/day)	Inhalation	Oral	
Vanadium chronic (RfD)	NA; 5 ppm vanadium from vanadyl sulfate in drinking water for lifetime (0.7 mg/kg/day)	NA	rat	NA; none observed	ND	7E-3	NA	100	U.S. EPA, 1987/ Schroeder et al., 1970; U.S. EPA, 1987
Vanadium pentoxide subchronic (RfD <sub>S</sub> )	NA; 10 ppm vanadium in diet from vanadium pentoxide for lifetime (0.9 mg vanadium pent- oxide/kg/day)	NA	rat	NA; none observed	ND	9E-3	NA	100	U.S. EPA, 1987/ Stokinger et al., 1953; U.S. EPA, 1987
chronic (RfD)	NA; 10 ppm vanadium in diet from vanadium pentoxide for lifetime (0.9 mg vanadium pent- oxide/kg/day)	NA	rat	NA; none observed	ND	9E-3 <sup>a</sup>	NA	100	U.S. EPA, 1987/ Stokinger et al., 1953; U.S. EPA, 1986, 1987
Vanadyl sulfate subchronic (RfD <sub>S</sub> )	NA; 5 ppm vanadium from vanadyl sulfate in drinking water for life- time (2.24 mg vanadyl sulfate/kg/day)	NA	rat	NA; none observed	ND	2E-2	NA	100	U.S. EPA, 1987/ Schroeder et al., 1970; U.S. EPA, 1987
chronic (RfD)	NA; 5 ppm vanadium from vanadyl sulfate in drinking water for life- time (2.24 mg vanadyl sulfate/kg/day)	NA	rat	NA; none observed	ND	2E-2	NA	100	U.S. EPA, 1987/ Schroeder et al., 1970; U.S. EPA, 1987
Xylenes o-Xylene subchronic (RfD <sub>S</sub> )	150 mg/m <sup>3</sup> continuous on days 7-14 of gesta- tion (95.6 mg/kg/day); 500 mg/kg mixed xylenes 5 days/week by gavage for 13 weeks (357 mg mixed xylenes/kg/day)	rat	rat	fetotoxicity; none observed	3E+0 (1E+0)	4E+0	100	100	Ungvary et al., 1980; U.S. EPA, 1984/NTP, 1986

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		Inhalation	Oral		Inhalation [mg/m <sup>3</sup> (mg/kg/day)]	Oral (mg/kg/day)	Inhalation	Oral	
o-Xylene chronic (RfD)	4750 mg/m <sup>3</sup> , 8 hours/ day, 7 days/week for 1 year (1009 mg/kg/day); 250 mg/kg mixed xylenes 5 days/week for 103 weeks (179 mg mixed xylenes/kg/day)	rat	rat	hepatomegaly; hyper- activity, decreased body weight, in- creased mortality at higher dosage	7E-1 (2E-1)	2E+0	5000	100	Tatrai et al., 1981; U.S. EPA, 1984/NTP, 1986; U.S. EPA, 1986a
m-Xylene subchronic (RfDs)	4750 mg/m <sup>3</sup> , 8 hours/ day, 7 days/week for 1 year (1009 mg/kg/ day) <sup>W</sup> ; 500 mg/kg mixed xylenes 5 days/week for 103 weeks (357 mg mixed xylenes/kg/day)	rat	rat	hepatomegaly; none observed	4E+0 (1E+0)	4E+0	1000	100	Tatrai et al., 1981; U.S. EPA, 1984/NTP, 1986
chronic (RfD)	4750 mg/m <sup>3</sup> , 8 hours/ day, 7 days/week for 1 year (1009 mg/kg/day) <sup>W</sup> ; 250 mg/kg mixed xylenes 5 days/week for 103 weeks (179 mg mixed xylenes/kg/day)	rat	rat	hepatomegaly; hyper- activity, decreased body weight, in- creased mortality at higher dosage	7E-1 (2E-1))	2E+0	5000	100	Tatrai et al., 1981; U.S. EPA, 1984/NTP, 1986; U.S. EPA, 1986a
p-Xylene subchronic (RfDs)	NA; NA	NA	rat	fetotoxicity; NA	ND	ND	NA	NA	U.S. EPA, 1984/ U.S. EPA, 1984
chronic (RfD)	NA; NA	NA	NA	fetotoxicity; NA	ND	ND	NA	NA	U.S. EPA, 1984/ U.S. EPA, 1984
Mixed xylenes subchronic (RfDs)	433 mg/m <sup>3</sup> 6 hours/day on days 6-15 of gesta- tion (69 mg/kg/day); 500 mg/kg mixed xylenes 5 days/week by gavage for 13 weeks (357 mg mixed xylenes/kg/day)	rat	rat	fetotoxicity; none observed	2E+0 (7E-1)	4E+0	100	100	Lifton Bionetics, 1978; U.S. EPA, 1984/ NTP, 1986



HEALTH EFFECTS ASSESSMENTS SUMMARY TABLE A: SUBCHRONIC AND CHRONIC TOXICITY (OTHER THAN CARCINOGENICITY)  
Update: March, 1989

Compound	Exposure Inhalation; Oral	Species		Effect of Concern Inhalation; Oral	Reference Dose		Uncertainty Factor		Reference Inhalation/Oral
		Inhalation	Oral		Inhalation [mg/m <sup>3</sup> (mg/kg/day)]	Oral (mg/kg/day)	Inhalation	Oral	
Mixed xylenes chronic (RfD)	3500 mg/m <sup>3</sup> 6 hours/ day 5 days/week for 13 weeks (398 mg/kg/ day); 250 mg/kg mixed xylenes 5 days/week for 103 weeks (179 mg mixed xylenes/kg/day)	rat	rat	none observed; hyperactivity, decreased body weight and in- creased mortality at higher dosage <sup>e</sup>	1E+0 (4E-1)	2E+0 <sup>d</sup>	1000	100	Carpenter et al., 1975; U.S. EPA, 1984/ NTP, 1986; U.S. EPA, 1987
Zinc subchronic (RfD <sub>5</sub> )	NA; 2.14 mg/kg/day therapeutic dosage	NA	human	NA; anemia	ND	2E-1	NA	10	U.S. EPA, 1984/ Pories et al., 1967; Prasad et al., 1975; U.S. EPA, 1984
chronic (RfD)	NA; 2.14 mg/kg/day therapeutic dosage	NA	human	NA; anemia	ND	2E-1	NA	10	U.S. EPA, 1984/ Pories et al., 1967; Prasad et al., 1975; U.S. EPA, 1984

<sup>a</sup>Verified, available on IRIS

<sup>b</sup>Based on route-to-route extrapolation

<sup>c</sup>Specifically related to organoleptic threshold and potential for respiratory tract irritation, not to systemic toxicity.

<sup>d</sup>Specifically related to organoleptic threshold; safe concentration may be higher but data are inadequate to assess.

<sup>e</sup>Inhalation study with antimony trioxide in rats (Watt, 1980, 1981, 1983; ASARCO, Inc., 1980) provides qualitative evidence of lung cancer; cancer potency not estimated.

<sup>f</sup>Calculated by analogy to antimony by correcting for differences in molecular weight.

<sup>g</sup>Under review by Oral RfD Work Group

<sup>h</sup>Because of background dietary exposure, an RfD<sub>50</sub> was not estimated.

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<sup>i</sup>Verified 2 separate RfD<sub>s</sub>, 1E-3 for food and 5E-4 for water

<sup>j</sup>Verified, IRIS input pending

<sup>k</sup>Current drinking water standard of 1.3 mg/L; Drinking Water Criteria Document concluded toxicity data were inadequate for calculation of an RfD for copper.

<sup>l</sup>CRAVE-verified as a CAG Group D substance

<sup>m</sup>These values differ from those in the HEED (U.S. EPA, 1987a) because the uncertainty factor for deriving the inhalation RfD values presented herein were changed to correspond to those used by IRIS (U.S. EPA, 1987b) for generating the oral RfD from the same (inhalation) study.

<sup>n</sup>Calculated by analogy to free cyanide by correcting for differences in molecular weight.

<sup>o</sup>These values differ from those in the HEA (U.S. EPA, 1984) because the study chosen as the basis for the inhalation RfD values was changed to conform to the inhalation study chosen as the basis of the oral RfD derived in a more recent HEEP (U.S. EPA, 1986).

<sup>p</sup>Final Draft of Ambient Water Quality Criteria Document (600/8-83-028f) declines to derive an air quality criterion for lead.

<sup>q</sup>Not verified and further discussion not scheduled

<sup>r</sup>Based on RfD for methyl mercury

<sup>s</sup>These values differ from those in the HEA (U.S. EPA, 1984) because the study chosen as the basis for the inhalation RfD values was changed to conform to the inhalation study chosen as the basis of the oral RfD derived on IRIS.

<sup>t</sup>A minor calculation error in estimation of transformed dose in 1986 HEEP is corrected here.

<sup>u</sup>Verified as a Group C carcinogen; no quantitative estimate available.

<sup>v</sup>Reported effects occurred at portal of entry; estimates of mg/day reference doses are inappropriate because effects at portal of entry depend on concentration in air. An acceptable air concentration of 0.07 mg/m<sup>3</sup> was estimated by Carson et al. (1981) from available data,

<sup>w</sup>Experiment performed with o-xylene.

NA = Not applicable or not available; ND = not determined

Notes: To estimate acceptable water concentrations from oral RfD<sub>s</sub>/RfD, multiply by 70 and divide by 2 L.

If exposure occurs by both oral and inhalation routes, the route-specific RfD<sub>s</sub>/RfD must be proportionally reduced.

HEALTH EFFECTS ASSESSMENTS SUMMARY TABLE B: CARCINOGENICITY  
Update: March, 1989

Compound	Exposure	Species		Tumor Site		CAG Group/q <sub>1</sub> <sup>a</sup> and Unit Risk Slope		Reference
	Inhalation; Oral	Inhalation	Oral	Inhalation	Oral	Inhalation ( $\mu\text{g}/\text{m}^3$ ) <sup>-1</sup> [( $\text{mg}/\text{kg}/\text{day}$ ) <sup>-1</sup> ]	Oral ( $\text{mg}/\text{kg}/\text{day}$ ) <sup>-1</sup>	Inhalation/Oral
Acrolein	NA; NA	NA	NA	NA	NA	C/ND <sup>a</sup>	C/ND <sup>a</sup>	U.S. EPA, 1987a,b/ U.S. EPA, 1987a,b
Acrylonitrile	occupational; three drinking water studies	human	rat	lung	multiple	B1/6.8E-5 [2.4E-1] <sup>a</sup>	B1/5.4E-1 <sup>a</sup>	O'Berg, 1980; U.S. EPA, 1983a, 1987a,b/Quast et al., 1980a; Bio/dynamics, Inc., 1980a,b; U.S. EPA, 1983a, 1987a,b
Aldrin	three dietary studies <sup>b</sup> ; three dietary studies	mouse	mouse	liver (also see Table A)	liver	B2/4.9E-3 [1.7E+1] <sup>a,b</sup>	B2/1.7E+1 <sup>a</sup>	NCI, 1977; Davis and Fitzhugh, 1962; Epstein, 1975; Davis, 1965; U.S. EPA, 1986b, 1987b/ NCI, 1977; Davis and Fitzhugh, 1962; Epstein, 1975; Davis, 1965; U.S. EPA, 1986b, 1987a,b
Arsenic	100-5000 $\mu\text{g}/\text{m}^3$ continuous; 0.01-1.8 $\text{mg}/\text{L}$ in drinking water	human	human	respiratory tract	skin	A/4.3E-3 [5.0E+1] <sup>a</sup>	A/NA <sup>k</sup>	Brown and Chu, 1983a,b,c; Lee- Feldstein, 1983; Higgins, 1982; Enterline and Marsh, 1982; U.S. EPA, 1984a,b, 1988/U.S. EPA, 1988
Asbestos	occupational; dietary	human	rat	lung and mesothelioma	large intestine	A/2.4-1 (fibers/mL) <sup>-1f</sup>	A/ND	U.S. EPA, 1986/NTP, 1985; U.S. EPA, 1985

HEALTH EFFECTS ASSESSMENTS SUMMARY TABLE B: CARCINOGENICITY  
Update: March, 1989

Compound	Exposure	Species		Tumor Site		CAG Group/q <sub>1</sub> <sup>a</sup> and Unit Risk Slope		Reference
	Inhalation; Oral	Inhalation	Oral	Inhalation	Oral	Inhalation ( $\mu\text{g}/\text{m}^3$ ) <sup>-1</sup> [(mg/kg/day) <sup>-1</sup> ]	Oral (mg/kg/day) <sup>-1</sup>	Inhalation/Oral
Benzene	occupational; occupational <sup>b</sup>	human	human	leukemia	leukemia	A/8.3E-6 [2.9E-2] <sup>a</sup>	A/2.9E-2 <sup>a,b</sup>	Ott et al., 1978; Rinsky et al., 1981; Wong et al., 1983; U.S. EPA, 1985, 1987a,b/Ott et al., 1978; Rinsky et al., 1981; Wong et al., 1983; U.S. EPA, 1985, 1987a,b
Benzidine	occupational; occupational <sup>b</sup>	human	human	urinary bladder (also see Table A)	urinary bladder	A/6.7E-2 [2.3E+2] <sup>a</sup>	A/2.3E+2 <sup>a,b</sup>	Zavon et al., 1973; U.S. EPA, 1986b/ Zavon et al., 1973; U.S. EPA, 1980a, 1986a,b, 1987
Benzo(a)pyrene	2.2-9.5 mg/m <sup>3</sup> , 4.5 hours/day for <96.4 weeks; 1-250 ppm diet for ~110 days	hamster	mouse	respiratory tract	stomach	B2/ND <sup>a</sup>	B2/ND <sup>a</sup>	Thyssen et al., 1981; U.S. EPA, 1987/Neal and Rigdon, 1967; U.S. EPA, 1980b, 1987
Beryllium	occupational; 5 ppm in drinking water for lifetime	human	rat	lung (also see Table A)	total tumors	B2/2.4E-3 [8.4] <sup>a</sup>	B2/ND <sup>a</sup>	Wagoner et al., 1980; U.S. EPA, 1987, 1988/ Schroeder and Milchener, 1975a; U.S. EPA, 1986b, 1988
Cadmium	occupational; NA	human	NA	respiratory tract (also see Table A)	NA	B1/1.8E-3 [6.1E+0] <sup>a</sup>	ND/ND <sup>c</sup>	Thun et al., 1985; U.S. EPA, 1985a, 1986/U.S. EPA, 1984

**HEALTH EFFECTS ASSESSMENTS SUMMARY TABLE B: CARCINOGENICITY**  
Update: March, 1989

Compound	Exposure	Species		Tumor Site		CAG Group/q <sub>1</sub> * and Unit Risk Slope		Reference
	Inhalation; Oral	Inhalation	Oral	Inhalation	Oral	Inhalation ( $\mu\text{g}/\text{m}^3$ ) <sup>-1</sup> [(mg/kg/day) <sup>-1</sup> ]	Oral (mg/kg/day) <sup>-1</sup>	Inhalation/Oral
Carbon tetrachloride	several gavage studies <sup>b</sup> ; several gavage studies	several	several	liver (also see Table A)	liver	B2/1.5E-5 <sup>a,b,d</sup> [1.3E-1] <sup>a,b</sup> [5.2E-2] <sup>d</sup>	B2/1.3E-1 <sup>a</sup>	Della Porta et al., 1961; Edwards et al., 1942; NCI, 1976; U.S. EPA, 1984a,b, 1986/ Della Porta et al., 1961; Edwards et al., 1942; NCI, 1976; U.S. EPA, 1984, 1986
Chlordane	two dietary bioassays <sup>b</sup> ; two dietary bioassays	mouse	mouse	liver (also see Table A)	liver	B2/3.7E-4 [1.3E+0] <sup>a,b</sup>	B2/1.3E+0 <sup>a</sup>	IRDC, 1973; NCI, 1977; U.S. EPA, 1986a, 1987, 1988/ IRDC, 1973; NCI, 1977; U.S. EPA, 1986a, 1987, 1988
Chlorinated phenols 2,4,6-Trichlorophenol	diet <sup>b</sup> ; diet	mouse	mouse	liver	liver	B2/5.7E-6 [2E-2] <sup>a,b</sup>	B2/2E-2 <sup>a</sup>	NCI, 1979; U.S. EPA, 1980, 1986, 1987/NCI, 1979; U.S. EPA, 1980, 1984
Other chlorinated phenols: see Table A								
Chlorinated toluenes p,p',o,o'-Tetra-chlorotoluene	0.05-2 $\mu\text{g}$ , 2 times/week; 0.05-2 $\mu\text{g}$ , 2 times/week	mouse	mouse	lung	lung	B2	B2/2.0E+1	Fukada et al., 1979; U.S. EPA, 1987/ Fukada et al., 1979; U.S. EPA, 1987
Chloroanilines 2-Chloroaniline	NA; NA	NA	NA	NA	NA	D/ND	D/ND	U.S. EPA, 1987/ U.S. EPA, 1987

HEALTH EFFECTS ASSESSMENTS SUMMARY TABLE B: CARCINOGENICITY  
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Compound	Exposure	Species		Tumor Site		CAG Group/q <sub>1</sub> <sup>a</sup> and Unit Risk Slope		Reference
	Inhalation; Oral	Inhalation	Oral	Inhalation	Oral	Inhalation ( $\mu\text{g}/\text{m}^3$ ) <sup>-1</sup> [( $\text{mg}/\text{kg}/\text{day}$ ) <sup>-1</sup> ]	Oral ( $\text{mg}/\text{kg}/\text{day}$ ) <sup>-1</sup>	Inhalation/Oral
3-Chloroaniline	NA; NA	NA	NA	NA	NA	D/ND	D/ND	U.S. EPA, 1987/ U.S. EPA, 1987
4-Chloroaniline	NA; diet 0, 250, 500 ppm	NA	rat	NA	spleen	C/ND	C/3.5E-2	U.S. EPA, 1987/ NCI, 1979; U.S. EPA, 1987
Chloroform	138-477 mg/kg/day; 200-188 ppm in drinking water for 104 weeks	mouse	rat	liver (also see Table A)	kidney	B2/2.3E-5 [8.1E-2] <sup>a</sup>	B2/6.1E-3 <sup>a</sup>	NCI, 1976; U.S. EPA, 1985, 1987, 1988/ Jorgenson et al., 1985; U.S. EPA, 1987, 1988
Chloromethane	24-month inhalation study; 24-month inhalation study <sup>b</sup>	mouse	mouse	kidney	kidney	C/1.8E-6 [6.3E-3]	C/1.3E-2 <sup>b</sup>	CIIT, 1983; NIOSH, 1984; U.S. EPA, 1987/CIIT, 1983; NIOSH, 1984; U.S. EPA, 1986a, 1987
Coal tars	occupational; NA	human	NA	lung	NA	ND/6.2E-4 [2.2E+0] <sup>e</sup>	ND/ND	Redmond et al., 1979; Mazumdar et al., 1975; U.S. EPA, 1984/NA
Creosote	NA; NA	NA	NA	NA	NA	B1/ND <sup>a</sup>	B1/ND <sup>a</sup>	U.S. EPA, 1987/ U.S. EPA, 1987
DDT	NA; several dietary studies <sup>b</sup>	mouse, rat	mouse, rat	liver (also see Table A)	liver	B2/9.7E-5 [3.4E-1] <sup>a,b</sup>	B2/3.4E-1 <sup>a</sup>	U.S. EPA, 1986a,b/ U.S. EPA, 1984, 1986a,b
Dichlorobenzenes								
1,2-Dichlorobenzene	NA; NA	NA	NA	NA (also see Table A)	NA	D/ND	D/ND	U.S. EPA, 1987/ U.S. EPA, 1987
1,3-Dichlorobenzene	NA; NA	NA	NA	NA (also see Table A)	NA	D/ND	D/ND	U.S. EPA, 1987/ U.S. EPA, 1987

HEALTH EFFECTS ASSESSMENTS SUMMARY TABLE B: CARCINOGENICITY  
Update: March, 1989

Compound	Exposure	Species		Tumor Site		CAG Group/q <sub>1</sub> <sup>a</sup> and Unit Risk Slope		Reference
	Inhalation; Oral	Inhalation	Oral	Inhalation	Oral	Inhalation ( $\mu\text{g}/\text{m}^3$ ) <sup>-1</sup> [(mg/kg/day) <sup>-1</sup> ]	Oral (mg/kg/day) <sup>-1</sup>	Inhalation/Oral
1,4-Dichlorobenzene <sup>9</sup>	NA; 103-week gavage study	NA	mouse	NA (also see Table A)	liver	B2/ND	B2/2.4E-2	U.S. EPA, 1987/ NTP, 1986; U.S. EPA, 1987
3,3'-Dichlorobenzidine	NA; lifetime dietary study	NA	rat	NA	mammary	B2/ND <sup>f</sup>	B2/4.5E-1 <sup>f</sup>	U.S. EPA, 1988/ Stula et al., 1975; U.S. EPA, 1988
Dichlorobutenes 1,4-Dichloro-2-butene	0.5-5 ppm 6 hours/day, 5 days/ week 90 days; NA	rat	NA	nasal passages	NA	B2/2.6E-3 [9.3]	B2/ND	EI Dupont de Nemours, 1986; U.S. EPA, 1987/ U.S. EPA, 1987
1,1-Dichloroethane	NA; gavage	NA	rat	NA	hemangio- sarcoma	ND/ND	B2/9.1E-2	U.S. EPA, 1984/ NCI, 1978; U.S. EPA, 1985
1,2-Dichloroethane (ethylene chloride)	gavage <sup>b</sup> ; gavage	rat	rat	circulatory system	circulatory system	B2/2.6E-5 [9.1E-2] <sup>a,b</sup>	B2/9.1E-2 <sup>a</sup>	NCI, 1978; U.S. EPA, 1985, 1986/ NCI, 1978; U.S. EPA, 1985, 1986
1,1-Dichloroethylene (vinylidene chloride)	10 and 25 ppm for 12 months; gavage	mouse	rat	kidney (also see Table A)	adrenal	C/5E-5 [1.2E+0] <sup>a</sup>	C/6E-1 <sup>a</sup>	Maltoni et al., 1985; U.S. EPA, 1985, 1987/ NTP, 1982; U.S. EPA, 1985, 1987
1,2-Dichloropropane <sup>9</sup>	NA; gavage	NA	mouse	NA	liver	B2/ND	B2/6.8E-2	U.S. EPA, 1987/ NTP, 1986; U.S. EPA, 1987

HEALTH EFFECTS ASSESSMENTS SUMMARY TABLE B: CARCINOGENICITY  
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Compound	Exposure	Species		Tumor Site		CAG Group/q <sub>1</sub> * and Unit Risk Slope		Reference
	Inhalation; Oral	Inhalation	Oral	Inhalation	Oral	Inhalation ( $\mu\text{g}/\text{m}^3$ ) <sup>-1</sup> [(mg/kg/day) <sup>-1</sup> ]	Oral (mg/kg/day) <sup>-1</sup>	Inhalation/Oral
Dieldrin	several dietary studies <sup>b</sup> ; several dietary studies	mouse	mouse	liver (also see Table A)	liver	B2/4.6E-3 [1.6E-1] <sup>a,b</sup>	B2/1.6E-1 <sup>a</sup>	Thorpe and Walker, 1973; Davis, 1965; Walker et al., 1972; Tennekes et al., 1981; Meierhenrey et al., 1983; NCI, 1978; U.S. EPA, 1987b/Thorpe and Walker, 1973; Davis, 1965; Walker et al., 1972; Tennekes et al., 1981; Meierhenrey et al., 1983; NCI, 1978; U.S. EPA, 1987a,b
Dinitrotoluenes 2,4-Dinitrotoluene	NA; 2-year dietary study	NA	rat	NA	liver, mammary gland	B2/ND <sup>f</sup>	B2/6.8E-1 <sup>f</sup>	U.S. EPA, 1987/ Ellis et al., 1979; U.S. EPA, 1987, 1988
2,6-Dinitrotoluene	NA; NA	NA	NA	NA	NA	B2/ND	B2/ND	U.S. EPA, 1987/ U.S. EPA, 1987
1,2-Diphenylhydrazine	2-year dietary study <sup>b</sup> ; 2-year dietary study	rat	rat	liver	liver	B2/2.2E-4 [8.0E-1] <sup>a,b</sup>	B2/8.0E-1 <sup>a</sup>	NCI, 1978; U.S. EPA, 1980a, 1986/NCI, 1978; U.S. EPA, 1980a, 1986, 1987, 1988
Ethylene dibromide	88-103 week inhalation study; 49-week gavage study	rat	rat	nasal cavity	forestomach	B2/2.2E-4 [7.6E-1] <sup>a</sup>	B2/8.5E-1 <sup>a</sup>	NTP, 1982; U.S. EPA, 1987b/NCI, 1978; U.S. EPA, 1987a,b
Fluorenes	NA; NA	NA	NA	NA	NA	0/ND	0/ND	U.S. EPA, 1987/ U.S. EPA, 1987



**HEALTH EFFECTS ASSESSMENTS SUMMARY TABLE B: CARCINOGENICITY**  
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Compound	Exposure	Species		Tumor Site		CAG Group/q <sub>1</sub> <sup>a</sup> and Unit Risk Slope		Reference
	Inhalation; Oral	Inhalation	Oral	Inhalation	Oral	Inhalation ( $\mu\text{g}/\text{m}^3$ ) <sup>-1</sup> [(mg/kg/day) <sup>-1</sup> ]	Oral (mg/kg/day) <sup>-1</sup>	Inhalation/Oral
Haloethers Bis(2-chloroethyl) ether	560-day oral study <sup>b</sup> ; 560-day oral study	mouse	mouse	liver	liver	B2/3.3E-4 [1.1E+0] <sup>a,b</sup>	B2/1.1E+0 <sup>a</sup>	Innes et al., 1969; U.S. EPA, 1980a, 1986; Innes et al., 1969; U.S. EPA, 1980a 1986, 1987
Bis(chloromethyl)- ether	0.1 ppm 6 hours/day 5 days/week for 10 to 100 days; 0.1 ppm 6 hours/day 5 days/ week for 10 to 100 days <sup>b</sup>	rat	rat	respiratory tract	ND	A/6.2E-2 [2.2E+2] <sup>a</sup>	A/2.2E+2 <sup>a,b</sup>	Kuschner et al., 1975; U.S. EPA, 1988/U.S. EPA, 1988
Bis(2-chloro-1-methyl- ethyl)ether	100-200 mg/kg 5 days/ week for 103 weeks <sup>b</sup> ; 100-200 mg/kg 5 days/ week for 103 weeks;	mouse	mouse	liver, lung	liver, lung	C/2E-3 [7E-2]	C/7E-2	NTP, 1982; U.S. EPA, 1987/ NTP 1982; U.S. EPA, 1987
Chloromethyl methyl ether	NA; NA	human	NA	lung	NA	A/ND <sup>a</sup>	A/ND <sup>a</sup>	U.S. EPA, 1987, 1988/U.S. EPA, 1988
Heptachlor	dietary studies <sup>b</sup> ; dietary studies	mouse	mouse	liver (also see Table A)	liver	B2/1.3E-3 [4.5E+0] <sup>a,b</sup>	B2/4.5E+0 <sup>a</sup>	Davis, 1965; Epstein, 1976; NCI, 1977; Reuber, 1977; U.S. EPA, 1986c, 1987b/Davis, 1965; Epstein, 1976; NCI, 1977; Reuber, 1977; U.S. EPA, 1986c 1987a,b
Hexachlorobenzene <sup>f</sup>	diet <sup>b</sup> ; diet	hamster	hamster	liver (also see Table A)	liver	B2/4.9E-4 <sup>b</sup> [1.7E+0] <sup>b</sup>	B2/1.7E+0	Cabral et al., 1977; U.S. EPA, 1984, 1989/ Cabral et al., 1977; U.S. EPA, 1984, 1985

**HEALTH EFFECTS ASSESSMENTS SUMMARY TABLE B: CARCINOGENICITY**  
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Compound	Exposure	Species		Tumor Site		CAG Group/q <sub>1</sub> * and Unit Risk Slope		Reference
	Inhalation; Oral	Inhalation	Oral	Inhalation	Oral	Inhalation ( $\mu\text{g}/\text{m}^3$ ) <sup>-1</sup> [(mg/kg/day) <sup>-1</sup> ]	Oral (mg/kg/day) <sup>-1</sup>	Inhalation/Oral
Hexachlorobutadiene	diet <sup>b</sup> ; diet	rat	rat	kidney (also see Table A)	kidney	C/2.2E-5 [7.8E-2] <sup>a,b</sup>	C/1.8E-2 <sup>a</sup>	Kociba et al., 1977a; U.S. EPA, 1986/Kociba et al., et al., 1977a; U.S. EPA, 1980, 1984, 1986
Hexachloroethane	90-week gavage study <sup>b</sup> ; 90-week gavage study	mouse	mouse	liver (also see Table A)	liver	C/4.0E-6 [1.4E-2] <sup>a,b</sup>	C/1.4E-2 <sup>a</sup>	NCI, 1978; U.S. EPA, 1986/NCI, 1978; U.S. EPA, 1980a, 1986, 1987
Hexavalent chromium	occupational; NA	human	NA	lung (also see Table A)	NA	A/1.2E-2 [4.1E+1] <sup>a</sup>	ND/ND <sup>c</sup>	Mancuso, 1975; U.S. EPA, 1984a,b, 1986/NA
Isophorone	NA; 2-year gavage study	NA	rat	NA	kidney, preputial gland (also see Table A)	C/ND	C/4.1E-3	U.S. EPA, 1987/ NTP, 1986; U.S. EPA, 1986a, 1987
Lead	NA; NA	NA	NA	NA (also see Table A)	NA	B2/ND <sup>a</sup>	B2/ND <sup>a</sup>	U.S. EPA, 1984, 1988/U.S. EPA, 1984, 1988
Lindane <sup>g</sup>	NA; diet	NA	mouse	NA (also see Table A)	liver	B2-C/ND	B2-C/1.3E+0	U.S. EPA, 1984/ Thorpe and Walker, 1973; U.S. EPA, 1984, 1986
Methylene chloride (dichloromethane)	2000 or 4000 ppm; inhalation and drinking water studies	mouse	mouse	lung, liver (also see Table A)	liver	B2/4.1E-6 [1.4E-2] <sup>a</sup>	B2/7.5E-3 <sup>a</sup>	NTP, 1986; U.S. EPA, 1984, 1986/NTP, 1986; NCA, 1983; U.S. EPA, 1985b 1986
Mirex	NA; 2-year dietary study	NA	rat	NA (also see Table A)	liver, adrenal	B2/ND	B2/1.8E+0	U.S. EPA, 1987/ NTP, 1987; U.S. EPA, 1987

**HEALTH EFFECTS ASSESSMENTS SUMMARY TABLE B: CARCINOGENICITY**  
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Compound	Exposure	Species		Tumor Site		CAG Group/q <sub>1</sub> <sup>a</sup> and Unit Risk Slope		Reference
	Inhalation; Oral	Inhalation	Oral	Inhalation	Oral	Inhalation ( $\mu\text{g}/\text{m}^3$ ) <sup>-1</sup> [(mg/kg/day) <sup>-1</sup> ]	Oral (mg/kg/day) <sup>-1</sup>	Inhalation/Oral
Nickel	occupational; NA	human	NA	respiratory tract (also see Table A)	NA	nickel refinery dust: A/ 2.4E-4 [0.4E-1] <sup>a</sup> nickel subsulfide: A/4.8E-4 [1.7E+0] <sup>a</sup>	ND/ND <sup>c</sup>	U.S. EPA, 1986; Chovil et al., 1981; Enterline and Marsh, 1982; Magnus et al., 1982; Peto et al., 1984; U.S. EPA, 1987a,b/ U.S. EPA, 1984
Nitrofurans Furazolidone	NA; 0-1000 ppm diet for 45 weeks	NA	rat	NA	mammary	B2/ND	B2/3.8E+0	U.S. EPA, 1987/ U.S. DHEW, 1976a,b; U.S. EPA, 1987
Furium	NA; 0-1000 ppm for 28 weeks	NA	mouse	NA	leukemia	B2/ND	B2/5.0E+1	U.S. EPA, 1987/ Cohen et al., 1970; U.S. EPA, 1987
Nitrofurazone	NA; 0, 1000 ppm diet for 46 weeks	NA	rat	NA	mammary	B2/ND	B2/1.5E+0	U.S. EPA, 1987/ Erturk et al., 1970c; U.S. EPA, 1987
Other nitrofurans: see Table A								
N-Nitrosodiphenyl- amine	NA; 700-day dietary study	NA	rat	NA	urinary bladder	B2/ND <sup>a</sup>	B2/4.9E-3 <sup>a</sup>	U.S. EPA, 1987a/ NCI, 1979; U.S. EPA, 1980a, 1986a, 1987a,b
PAH	inhalation study with benzo(a)pyrene; dietary study with benzo(a)pyrene	hamster	mouse	respiratory tract	stomach	B2/ND <sup>a</sup>	B2/ND <sup>a</sup>	Thyssen et al., 1981; U.S. EPA, 1987/Neal and Rigdon, 1967; U.S. EPA, 1980, 1987
Parathion	NA; NA	NA	NA	NA (also see Table A)	NA	C/ND <sup>a</sup>	C/ND <sup>a</sup>	U.S. EPA, 1987a,b/ U.S. EPA, 1987a,b

**HEALTH EFFECTS ASSESSMENTS SUMMARY TABLE B: CARCINOGENICITY**  
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Compound	Exposure	Species		Tumor Site		CAG Group/q <sub>1</sub> <sup>a</sup> and Unit Risk Slope		Reference
	Inhalation; Oral	Inhalation	Oral	Inhalation	Oral	Inhalation ( $\mu\text{g}/\text{m}^3$ ) <sup>-1</sup> [( $\text{mg}/\text{kg}/\text{day}$ ) <sup>-1</sup> ]	Oral ( $\text{mg}/\text{kg}/\text{day}$ ) <sup>-1</sup>	Inhalation/Oral
PCBs (polychlorinated biphenyls)	NA; Aroclor 1260 in diet	NA	rat	NA	liver	B2/ND	B2/7.7E+0 <sup>f</sup>	U.S. EPA, 1984, 1987b/Norback and Weltman, 1985; U.S. EPA, 1987a,b
Phthalic acid esters(selected)								
Bis(2-ethylhexyl) phthalate	NA; 103-week dietary study	NA	mouse	NA (also see Table A)	liver	B2/ND <sup>a</sup>	B2/1.4E-2 <sup>a</sup>	U.S. EPA, 1987/ NTP, 1982a, U.S. EPA, 1986, 1988
Butyl benzyl phthalate U.S. EPA, 1987a,b/		NA; NA	NA	NA (also see Table A)	NA	NA	C/ND <sup>a</sup>	C/ND <sup>a</sup> U.S. EPA, 1987a,b
Other phthalic acid esters	NA; NA	NA	NA	NA (also see Table A)	NA	D/ND	D/ND	U.S. EPA, 1987/ U.S. EPA, 1987
Sodium diethyldithio- carbamate	NA; diet	NA	mouse	NA (also see Table A)	hepatoma	C/ND	C/2.7E-1	U.S. EPA, 1988/ BRL, 1968a; U.S. EPA, 1988
2,3,7,8-TCDD <sup>f</sup>	diet <sup>b</sup> ; diet	rat	rat	several	several	B2J/3.3E-5 ( $\text{pg}/\text{m}^3$ ) <sup>-1</sup> [1.56E+5] <sup>b</sup>	B2J/1.56E+5	Kociba et al., 1978; U.S. EPA, 1984, 1989/ Kociba et al., 1978; U.S. EPA, 1984, 1985, 1989
1,1,2,2-Tetrachloro- ethane	gavage <sup>b</sup> ; gavage	mouse	mouse	liver	liver	C/5.8E-5 [2.0E-1] <sup>a,b</sup>	C/2.0E-1 <sup>a</sup>	NCI, 1978; U.S. EPA, 1980, 1986/NCI, 1978; U.S. EPA, 1980, 1986
Tetrachloroethy- lene <sup>g</sup> (perchloro- ethylene)	inhalation; gavage	rat, mouse	mouse	leukemia, liver (also see Table A)	liver	B2/9.5E-7 [3.3E-3]	B2/5.1E-2	NTP, 1986, U.S. EPA 1986a, 1988/NCI, 1977; U.S. EPA, 1985a, 1988

**HEALTH EFFECTS ASSESSMENTS SUMMARY TABLE B: CARCINOGENICITY**  
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Compound	Exposure	Species		Tumor Site		CAG Group/q <sub>1</sub> <sup>a</sup> and Unit Risk Slope		Reference
	Inhalation; Oral	Inhalation	Oral	Inhalation	Oral	Inhalation ( $\mu\text{g}/\text{m}^3$ ) <sup>-1</sup> [( $\text{mg}/\text{kg}/\text{day}$ ) <sup>-1</sup> ]	Oral ( $\text{mg}/\text{kg}/\text{day}$ ) <sup>-1</sup>	Inhalation/Oral
Toxaphene	735-day dietary study <sup>b</sup> ; 735-day dietary study	mouse	mouse	liver	liver	B2/3.2E-4 [1.1E+0] <sup>a,b</sup>	B2/1.1E+0 <sup>a</sup>	Litton Bionetics, Inc., 1978; U.S. EPA, 1987b/ Litton Bionetics, Inc., 1978; U.S. EPA, 1980a, 1987a,b
Trichloroanilines								
2,3,4-Trichloroaniline	NA; NA	NA	NA	NA	NA	ND/ND	ND/ND	U.S. EPA, 1987/ U.S. EPA, 1987
2,4,5-Trichloroaniline	NA; NA	NA	NA	NA	NA	ND/ND	ND/ND	U.S. EPA, 1987/ U.S. EPA, 1987
2,4,6-Trichloroaniline	NA; diet	NA	mouse	NA	unspecified tumors of the vascular system	C/ND	C/3.4E-2	U.S. EPA, 1987/ Weisburger et al., 1978; U.S. EPA, 1987
2,4,6-Trichloroaniline hydrochloride	NA; diet	NA	mouse	NA	unspecified tumors of the vascular system	C/ND	C/2.9E-2	U.S. EPA, 1987/ Weisburger et al., 1978; U.S. EPA, 1987
1,1,2-Trichloroethane	gavage <sup>b</sup> ; gavage	mouse	mouse	liver (also see Table A)	liver	C/1.6E-5 [5.7E-2] <sup>a,b</sup>	C/5.7E-2 <sup>a</sup>	NCI, 1978; U.S. EPA, 1980, 1986/NCI, 1978; U.S. EPA, 1980, 1984, 1986
Trichloroethylene	two gavage studies <sup>b</sup> ; two gavage studies	mouse	mouse	liver	liver	B2/1.3E-6 <sup>a,b,h</sup> [1.3E-2]	B2/1.1E-2 <sup>a</sup>	NCI, 1976; NTP, 1983; U.S. EPA, 1985, 1988b/ U.S. EPA, 1987, 1988a,b
Trihalogenated methanes								
Bromodichloromethane	NA; 102-week gavage study	NA	mouse	NA (also see Table A)	liver	B2/ND	B2/1.3E-1	U.S. EPA, 1987/ NTP, 1986a; U.S. EPA, 1987

**HEALTH EFFECTS ASSESSMENTS SUMMARY TABLE B: CARCINOGENICITY**  
Update: March, 1989

Compound	Exposure	Species		Tumor Site		CAG Group/q <sup>1</sup> and Unit Risk Slope		Reference
	Inhalation; Oral	Inhalation	Oral	Inhalation	Oral	Inhalation ( $\mu\text{g}/\text{m}^3$ ) <sup>-1</sup> [(mg/kg/day) <sup>-1</sup> ]	Oral (mg/kg/day) <sup>-1</sup>	Inhalation/Oral
Bromoform	NA; NA	NA	NA	NA (also see Table A)	NA	D/ND	D/ND	U.S. EPA, 1987/ U.S. EPA, 1987
Chlorodibromoethane	NA; 105-week gavage study	NA	mouse	NA (also see Table A)	liver	B2/ND	B2/8.4E-2	U.S. EPA, 1987/ NTP, 1985; U.S. EPA, 1987
Vinyl chloride <sup>g</sup>	1-year inhalation study; 10-50 ppm diet	rat	rat	liver	lung	A/4.2E-5 [2.95E-1] <sup>1</sup>	A/2.3E+0	Maltoni et al., 1980, 1981; U.S. EPA, 1985b; ATSDR, 1988/feron et al., 1981; U.S. EPA, 1984, 1985a

<sup>a</sup>Verified, on IRIS

<sup>b</sup>Based upon route-to-route extrapolation

<sup>c</sup>There is inadequate evidence for carcinogenicity of this compound by the oral route.

<sup>d</sup>Incorporates an absorption factor of 0.4. Inhalation potency slope of 1.3E-1 (mg/kg/day)<sup>-1</sup> as administered and 5.2E-2 (mg/kg/day)<sup>-1</sup> as absorbed dose.

<sup>e</sup>Based on occupational data for coke-oven workers

<sup>f</sup>Verified, IRIS input pending.

<sup>g</sup>Scheduled for CRAVE review

<sup>h</sup>A new unit risk of 1.7x10<sup>-6</sup> ( $\mu\text{g}/\text{m}^3$ )<sup>-1</sup> has been proposed in the Addendum to the HAD (U.S. EPA, 1987) and adopted in the updated HEA (U.S. EPA, 1988a).

<sup>i</sup>Based on metabolized dose

<sup>j</sup>B2 classification is for 2,3,7,8-TCDD alone. Mixtures consisting of phenoxy herbicides and/or chlorophenols with 2,3,7,8-TCDD as a contaminant are classified as B1 carcinogens.

<sup>k</sup>A unit risk of 5E-5( $\mu\text{g}/\text{L}$ )<sup>-1</sup> has been proposed by the Risk Assessment Forum and this recommendation has been scheduled for SAB review.

NA = Not applicable; ND = not determined

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## HEA SUMMARY TABLE 8: CARCINOGENS

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U.S. EPA. 1987b. Integrated Risk Information System (IRIS). Risk Estimate for Carcinogenicity for Acrolein. Online. (Verification date 12/02/87). Office of Health and Environmental Assessment, Environmental Criteria and Assessment Office, Cincinnati, OH.

### Acrylonitrile

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Quast, J.F., C.E. Wade, C.G. Humiston et al. 1980a. A 2-year toxicity and oncogenicity study with acrylonitrile incorporated in the drinking water of rats. Prepared by the Toxicology Research Laboratory, Health and Environmental Research, Dow Chemical USA, Midland, MI, for the Chemical Manufacturers Association, Washington, DC. (Cited in U.S. EPA, 1983a)

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### Aldrin

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