CHEMICAL UPDATE WORKSHEET

Chemical Name:	**1,2,4,5-Tetrachlorobenzene (DD)**
CAS #:	**95-94-3**
Revised By:	RRD Toxicology Unit
Revision Date:	August 19, 2015

(A) Chemical-Physical Properties

	Part 201 Value	Updated Value	Reference Source	Comments
Molecular Weight (g/mol)	215.28	215.89	EPI	EXP
Physical State at ambient temp	Solid	Solid	MDEQ	
Melting Point (˚C)	412	139.50	EPI	EXP
Boiling Point (˚C)	244.5	244.50	EPI	EXP
Solubility (ug/L)	1300	595	EPI	EXP
Vapor Pressure (mmHg at 25˚C)	0.005396	5.40E-03	PC	EXP
HLC (atm-m^3/mol at 25˚C)	1.20E-3	1.00E-03	EPI	EXP
Log Kow (log P; octanol-water)	4.64	4.64	EPI	EXP
Koc (organic carbon; L/Kg)	36400	2220	EPI	EST
Ionizing Koc (L/kg)		NR	NA	NA
Diffusivity in Air (Di; cm^2/s)	0.08	3.19E-02	W9	EST
Diffusivity in Water (Dw; cm^2/s)	8.0E-6	8.75E-06	W9	EST
Soil Water Partition Coefficient (Kd; inorganics)	NR	NR	NA	NA

	Part 201 Value	Updated Value	Reference Source	Comments
Flash Point (˚C)	NA	155	CRC	EXP
Lower Explosivity Level (LEL; unit less)	NA	NA	NA	NA
Critical Temperature (K)		762.95	HSDB	EXP
Enthalpy of Vaporization (cal/mol)		1.14E+04	HSDB	EXP
Density (g/mL, g/cm^3)		1.858	CRC	EXP
EMSOFT Flux Residential 2 m (mg/day/cm^2)	4.26E-06	1.64E-05	EMSOFT	EST
EMSOFT Flux Residential 5 m (mg/day/cm^2)	4.26E-06	1.91E-05	EMSOFT	EST
EMSOFT Flux Nonresidential 2 m (mg/day/cm^2)	5.09E-06	2.25E-05	EMSOFT	EST
EMSOFT Flux Nonresidential 5 m (mg/day/cm^2)	5.09E-06	2.43E-05	EMSOFT	EST

(B) Toxicity Values/Benchmarks

	Part 201 Value	Updated Value	Source/Reference/ Date	Comments/Notes /Issues
Reference Dose (RfD) (mg/kg/day)	3.4E-1	7.0E-3	PPRTV, 2007/ MDEQ, 2016	
RfD details	Rat oral subchronic study. NOAEL = 5 ppm (adjusted by authors to 0.34 mg/kg); LOAEL = 50 ppm; Critical effect = kidney lesions. UF = 1000; (Chu et al., 1984). CCD/RRD date: 11/6/1985. NOTE: it appears that the RfD used in criteria calculation was not adjusted by the UF. ERROR – USEPA IRIS RfD was 3.4E-04.	**Tier 2 Source:** **PPRTV:** **Basis:** PPRTV assessment is more current than IRIS. Original UF = 1,000; MDEQ RRD applied 100 for interspecies extrapolation and intraspecies variability plus 3 fold instead of 10 fold for use of a subchronic LOAEL. See notes below. **PPRTV** (8/07/2007) subchronic RfD = 2.0E-3 mg/kg-day: **Critical Studies**: 1) NTP (National Toxicology Program). 1991a. Toxicity Studies of 1,2,4,5-Tetrachlorobenzene in F344/N Rats and B6C3F1 Mice (Feed Studies). NTP TOX 7. NIH Publication No. 91-3126. NTIS PB91-185983. 2) BRRC (Bushy Run Research Center). 1989. Two-Generation Reproductive Toxicity Study of 1,2,4,5-Tetrachlorobenzene in the Diet of Sprague Dawley Rats. April 14, 1989. Project Report 51-592. TSCATS Microfiche No. OTS0571095. 3) Chu, I., D.C. Villeneuve, V.E. Valli and V.E. Secours. 1984. Toxicity of 1,2,3,4-, 1,2,3,5- and 1,2,4,5-tetrachlorobenzene in the rat: Results of a 90-day feeding study. Drug Chem. Toxicol. 7: 113-127. **Methods**: Three rat studies were considered for development of a provisional subchronic RfD for 1,2,4,5-tetrachlorobenzene. Benchmark dose (BMD) modeling was performed for the liver histopathology data from the Chu et al. (1984) study, the serum thyroxin data from the NTP (1991a) study, and the litter viability data from the BRRC (1989) study. Per PPRTV, the use of the BMDL for liver effects from the Chu et al. (1984) study as the point of departure (POD) would not be protective for effects on thyroxin levels or on pup viability. NOAELs were not observed for either thyroxin levels or pup viability and LOAELs for both effects were only slightly higher than the BMDL based on liver effects. Therefore, the LOAEL of 2.1 mg/kg-day for decreased thyroxin levels in the NTP (1991a) rat study was chosen as the POD. **Critical effects**: 1) NTP, 1991a - LOAEL for decreased thyroxin levels in female		Complete.

	Part 201 Value	Updated Value	Source/Reference/ Date	Comments/Notes /Issues
		rats; 2) BRRC, 1989 - LOAEL for decreased survival in F1 suckling rat pups; and 3) Chu et al., 1984 - BMDL10 for liver lesions in male rats. Designated as a developmental chemical based on decreased survival in pups and the potential developmental impacts from decreased thyroxin levels. **End point or Point of Departure (POD):** LOAEL = 2.1 mg/kg-day for decreased thyroxin levels in the NTP (1991a) study. **Uncertainty Factors**: UF = 1,000 (10 each for intraspecies variability, intraspecies variability, and use of a LOAEL) originally used by PPRTV. MDEQ modified the UF to 300 (10 each for intraspecies variability, interspecies extrapolation, and 3 for use of a LOAEL) since the effects are multiple and from three different studies. Effects include liver toxicity (adults were dosed) and decreased thyroxin levels in females (dosed as adults). No developmental studies were available that looked at neurotoxicity following early life exposure. (2.1/300 = 7.0E-3 mg/kg) **Source and date:** PPRTV, 8/27/2007 **Tier 1 and 2 Sources**: **IRIS:** Per IRIS (3/01/1991), RfD = 3.0E-4 mg/kg-day **Critical Study**: Chu, I., D.C. Villeneuve, V.E. Valli and V.E. Secours. 1984. Toxicity of 1,2,3,4-, 1,2,3,5- and 1,2,4,5-tetrachlorobenzene in the rat: Results of a 90- day feeding study. Drug Chem. Toxicol. 7: 113-127. **Methods**: weanling Sprague-Dawley rats (15/sex/group) were fed diets containing 0, 0.5, 5.0, 50, and 500 ppm of 1,2,4,5-tetrachlorobenzene (TCB) for 13 weeks. **Critical effect(s)**: kidney lesions **End point or Point of Departure (POD):** NOAEL = 5 ppm (0.34 mg/kg-day) **Uncertainty Factors**: UF = 1,000 (10 each for intraspecies variability, interspecies extrapolation, and use of a subchronic study) **Source and date:** IRIS, Last revision date - 3/1/1991. A USEPA screening-level review in 2002 identified one or more significant new studies. **MRL:** No MRL record is available at this time. **Tier 3 Sources:**		

	Part 201 Value	Updated Value	Source/Reference/ Date	Comments/Notes /Issues
		WHO (1991): Environmental Health Criteria document for chlorinated benzenes developed an oral Tolerable Daily Intake value (analogous to an RfD) of 1.0E-4 mg/kg-day for 1,2,4,5-tetrachlorobenzene. This value is based on the same subchronic rat study used to derive the IRIS RfD (Chu et al., 1984), but a lower dose level was chosen as the NOAEL and different uncertainty factors were applied. **Health Canada** (1993) derived a tolerable daily intake (TDI) value of 2.1E-4 mg/kg-day from a NOAEL for histopathological effects in the thyroid (2.1 mg/kg-day) seen in a the NTP (1991a) study. A total uncertainty factor of 10,000 was applied (10 each for interspecies and intraspecies variability, use of a subchronic study, and database uncertainty). **MDEQ:** Per DEQ-CCD/RRD (date), RfD = 3.4E-1 mg/kg-day. This value is erroneous and should have been 3.4E-4 mg/kg-day. See Part 201 Value RfD details.		
Oral Cancer Slope Factor (CSF) (mg/kg-day)$^{-1}$)	--	NA	MDEQ, 2015	
CSF details	NA	**Carcinogen Weight-of-Evidence (WOE) Class**: "inadequate for an assessment of human carcinogenic potential" **WOE Basis**: inadequate evidence for carcinogenicity in humans and animals **Source and Date**: PPRTV, 3/30/2005 **Tier 1 and 2 Sources**: **IRIS:** Per IRIS (3/1/1991), no value at this time. **PPRTV:** Per PPRTV (3/30/2005), no value at this time. **MRL:** NA; MRLs are for non-cancer effects only. **Tier 3 Source:** **MDEQ:** Per DEQ-CCD, no value at this time.		Complete
Reference Concentration (RfC) or Initial Threshold	1.0E+0	1.0E+0	MDEQ, 2007	

	Part 201 Value	Updated Value	Source/Reference/ Date	Comments/Notes /Issues
Screening Level (ITSL) (µg/m³)				
RfC/ITSL details	Chronic RfC: 24-hour averaging time. Based on IRIS RfD.	**Tier 3 Source:** **MDEQ:** **Basis:** Tier 1 and 2 values are not available. MDEQ is the only Tier 3 value available. RfD-based ITSL pursuant to R232(1)(b). IRIS identified a LOAEL of 50 ppm in the diet (3.4 mg/kg/day) and a NOAEL of 5.0 ppm (0.34 mg/kg/day) from Chu et al. 1984 based on the critical effect of kidney lesions A total UF of 1,000 was applied resulting in an RfD of 3.0E-4 mg/kg/day. **Source and date:** MDEQ-CCD/AQD, 6/11/2007 **Tier 1 and 2 Sources**: **IRIS:** Per IRIS (3/1/1991), no value at this time. **PPRTV:** Per PPRTV (3/30/2005), no value at this time. **MRL:** No MRL record is available at this time. **Tier 3 Sources:** **MDEQ:** Per DEQ-CCD/AQD (6/11/2007), RfC = 1.0E+0 µg/m³. See above for more detail. **Other Tier 3:** No value is available at this time from these Tier 3 sources/databases: HEAST, NTP ROC, health and environmental agencies of California, Massachusetts, Minnesota, New Jersey, New York, and Texas, WHO (IARC), WHO (IPCS/INCHEM), Canada, The Netherlands (RIVM), ECHA (REACH) and OECD HPV.		Complete
Inhalation Unit Risk Factor (IURF) ((µg/m³)$^{-1}$)	--	NA	MDEQ, 2015	
IURF details	NA	**Carcinogen Weight-of-Evidence (WOE) Class**: "inadequate for an assessment of human carcinogenic potential" **WOE Basis**: inadequate evidence for carcinogenicity in humans and animals **Source and Date**: PPRTV, 3/30/2005		Complete

	Part 201 Value	Updated Value	Source/Reference/ Date	Comments/Notes /Issues
		Tier 1 and 2 Sources: **IRIS:** Per IRIS (3/1/1991), no value at this time. **PPRTV:** Per PPRTV (3/30/2005), no value at this time. **MRL:** NA; MRLs are for non-cancer effects only. **Tier 3 Source:** **MDEQ:** Per DEQ-CCD, no value at this time.		
Mutagenic Mode of Action (MMOA)? (Y/N)	--	NO	USEPA, 2015	
MMOA Details	--	NA Not listed as a carcinogen with mutagenic MOA in the USEPA OSWER List.		
Developmental or Reproductive Effector? (Y/N)	No	Developmental oral RfD - Yes. Developmental Inhalation- No (the RfC is not based on developmental effect) Oral Exposure Pathways - Single Event Exposure category	MDEQ, 2015	
Developmental or Reproductive Toxicity Details	NA	NA		
State Drinking Water Standard (SDWS) (ug/L)	--	NO	SDWA, 1976	
SDWS details	NA	MI Safe Drinking Water Act (SDWA) 1976 PA 399		
Secondary Maximum Contaminant Level (SMCL) (ug/L)	--	NO	SDWA, 1976 and USEPA SMCL List, 2015 NA	
SMCL details	NA	MI Safe Drinking Water Act (SDWA) 1976 PA 399 and USEPA SMCL List, 2015		
Is there an aesthetic value for drinking water? (Y/N)	NO	Not evaluated.	NA	

	Part 201 Value	Updated Value	Source/Reference/ Date	Comments/Notes /Issues
Aesthetic value (ug/L)	NA	NA	NA	
Aesthetic Value details	NA	NA		
Phytotoxicity Value? (Y/N)	NO	Not evaluated.	NA	
Phytotoxicity details	NA	NA	NA	
Others				

(C) Chemical-specific Exposure Factors

	Part 201 Value	Update	Source/Reference/ Dates	Comments/Notes /Issues
Gastrointestinal absorption efficiency value (ABSgi)	---	1.0	MDEQ, 2015/USEPA RAGS-E	
ABSgi details		RAGS E (EPA, 2004) Default Value		
Skin absorption efficiency value (AEd)	---	0.1	MDEQ, 2015	
AEd details				
Ingestion Absorption Efficiency (AEi)		1.0	MDEQ, 2015	
AEi Details				
Relative Source Contribution for Water (RSC_W)		0.2	MDEQ, 2015	
Relative Source Contribution for Soil (RSC_S)		1.0	MDEQ, 2015	
Relative Source Contribution for Air (RSC_A)		1.0	MDEQ, 2015	
Others				

(D) Rule 57 Water Quality Values and GSI Criteria

Current GSI value (µg/L)	2.9 (X)
Updated GSI value (µg/L)	2.9 (X)
Rule 57 Drinking Water Value (µg/L)	2.8

	Rule 57 Value (µg/L)	Verification Date
Human Non-cancer Values- Drinking water source (HNV-drink)	2.8	2/1999
Human Non-Cancer Values- Non-drinking water sources (HNV-Non-drink)	2.9	2/1999
Wildlife Value (WV)	ID	NA
Human Cancer Values for Drinking Water Source (HCV-drink)	NA	NA
Human Cancer values for non-drinking water source (HCV-Non-drink)	NA	NA
Final Chronic Value (FCV)	3	5/1999
Aquatic maximum value (AMV)	23	5/1999
Final Acute Value (FAV)	46	5/1999

Sources:

1. MDEQ Surface Water Assessment Section Rule 57 website
2. MDEQ Rule 57 table

(E) Analytical Information

	Value	Source
Target Detection Limit – Soil (μg/kg)	330	MDEQ, 2015
Target Detection Limit – Water (μg/L)	2	MDEQ, 2015
Target Detection Limit – Air (ppbv)	1.10E-01	MDEQ, 2015
Target Detection Limit – Soil Gas (ppbv)	3.80E+00	MDEQ, 2015

CHEMICAL UPDATE WORKSHEET ABBREVIATIONS:

CAS # - Chemical Abstract Service Number.

Section (A) Chemical-Physical Properties

Reference Source(s):

CRC	Chemical Rubber Company Handbook of Chemistry and Physics, 95th edition, 2014-2015
EMSOFT	USEPA Exposure Model for Soil-Organic Fate and Transport (EMSOFT) (EPA, 2002)
EPA2001	USEPA (2001) Fact Sheet, Correcting the Henry's Law Constant for Soil Temperature. Office of Solid Waste and Emergency Response, Washington, D.C.
EPA4	USEPA (2004) User's Guide for Evaluating Subsurface Vapor Intrusion into Buildings. February 22, 2004.
EPI	USEPA's Estimation Programs Interface SUITE 4.1, Copyright 2000-2012
HSDB	Hazardous Substances Data Bank
MDEQ	Michigan Department of Environmental Quality
NPG	National Institute for Occupational Safety and Health Pocket Guide to Chemical Hazards
PC	National Center for Biotechnology Information's PubChem database
PP	Syracuse Research Corporation's PhysProp database
SCDM	USEPA's Superfund Chemical Data Matrix
SSG	USEPA's Soil Screening Guidance: Technical Background Document, Second Edition, 1996
USEPA/EPA	United States environmental protection agency's Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment). July, 2004.
W9	USEPA's User Guide for Water9 Software, Version 2.0.0, 2001

Basis/Comments:

EST	estimated
EXP	experimental
EXT	extrapolated
NA	not available or not applicable
NR	not relevant

Section (B) Toxicity Values/Benchmarks

Sources/References:

ATSDR	Agency for Toxic Substances and Disease Registry
CALEPA	California Environmental Protection Agency
CAL DTSC	California Department of Toxic Substances Control
CAL OEHHA	CAEPA Office of Environmental Health Hazard Assessment
CCD	MDEQ Chemical Criteria Database
ECHA	European Chemicals Agency (REACH)
OECD HPV	Organization for Economic Cooperation and Development HPV Database
HEAST	USEPA's Health Effects Assessment Summary Tables
IRIS	USEPA's Integrated Risk Information System
MADEP	Massachusetts Department of Environmental Protection
MDEQ/DEQ	Michigan Department of Environmental Quality
DEQ-CCD/AQD	MDEQ Air Quality Division
DEQ-CCD/RRD	MDEQ Remediation and Redevelopment Division
DEQ-CCD/WRD	MDEQ Water Resources Division
MNDOH	Minnesota Department of Health
NJDEP	New Jersey Department of Environmental Protection

NYDEC	New York State Department of Environmental Conservation
OPP/OPPT	USEPA's Office of Pesticide Programs
PPRTV	USEPA's Provisional Peer Reviewed Toxicity Values
RIVM	The Netherlands National Institute of Public Health and the Environment
TCEQ	Texas Commission on Environmental Quality
USEPA	United States Environmental Protection Agency
USEPA OSWER	USEPA Office of Solid Waste and Emergency Response
USEPA MCL	USEPA Maximum Contaminant Level
WHO	World Health Organization
WHO IPCS	International Programme on Chemical Safety (IPCS/INCHEM)
WHO IARC	International Agency for Research on Cancers
NA	Not Available.
NR	Not Relevant.

Toxicity terms:

BMC	Benchmark concentration
BMCL	Lower bound confidence limit on the BMC
BMD	benchmark dose
BMDL	Lower bound confidence limit on the BMD
CSF	Cancer slope Factor
CNS	Central nervous system
IURF or IUR	Inhalation unit risk factor
LOAEL	Lowest observed adverse effect level
LOEL	Lowest observed effect level
MRL	Minimal risk level (ATSDR)
NOAEL	No observed adverse effect level
NOEL	No observed effect level
RfC	Reference concentration
RfD	Reference dose
p-RfD	Provisional RfD
aRfD	Acute RfD
UF	Uncertainty factor
WOE	Weight of evidence

Section (C) Chemical-specific Absorption Factors

MDEQ	Michigan Department of Environmental Quality
USEPA RAGS-E	United States Environmental Protection Agency's Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment). July, 2004.

Section (D) Rule 57 Water Quality Values and GSI Criteria

GSI	Groundwater-surface water interface
NA	A value is not available or not applicable.
ID	Insufficient data to derive value
NLS	No literature search has been conducted