



CHEMICAL UPDATE WORKSHEET

Chemical Name:	Carbazole
CAS #:	86-74-8
Revised By:	RRD Toxicology Unit
Revision Date:	September 16, 2015

(A) Chemical-Physical Properties

	Part 201 Value	Updated Value	Reference Source	Comments
Molecular Weight (g/mol)	167.21	167.21	EPI	EXP
Physical State at ambient temp	Solid	Solid	MDEQ	
Melting Point (°C)	245	346.20	EPI	EXP
Boiling Point (°C)	354.7	354.70	EPI	EXP
Solubility (ug/L)	7480	7.5E-04	EPI	EXP
Vapor Pressure (mmHg at 25°C)	400	1.37E-06	HSDB	EST
HLC (atm-m³/mol at 25°C)	1.53E-8	1.16E-07	EPI	EXP
Log Kow (log P; octanol-water)	3.59	3.72	EPI	EXP
Koc (organic carbon; L/Kg)	3380	9161	EPI	EST
Ionizing Koc (L/kg)		NR	NA	NA
Diffusivity in Air (Di; cm²/s)	0.039	4.50E-02	W9	EST
Diffusivity in Water (Dw; cm²/s)	7.03E-6	8.2239E-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	NA	NA	NA
Lower Explosivity Level (LEL; unit less)	NA	NA	NA	NA
Critical Temperature (K)		899.00	EPA2001	EXP
Enthalpy of Vaporization (cal/mol)		1.40E+04	EPA2001	EXP
Density (g/mL, g/cm ³)		1.297	CRC	EXP
EMSOFT Flux Residential 2 m (mg/day/cm ²)	NA	1.20E-07	EMSOFT	EST
EMSOFT Flux Residential 5 m (mg/day/cm ²)	NA	1.20E-07	EMSOFT	EST
EMSOFT Flux Nonresidential 2 m (mg/day/cm ²)	NA	1.48E-07	EMSOFT	EST
EMSOFT Flux Nonresidential 5 m (mg/day/cm ²)	NA	1.48E-07	EMSOFT	EST

(B) Toxicity Values/Benchmarks

	Part 201 Value	Updated Value	Source/Reference/Date	Comments/Notes/Issues
Reference Dose (RfD) (mg/kg/day)	--	5.0E-3	MDEQ, 2000	
RfD details	NA	<p>Tier 3 Source: MDEQ: Basis: MDEQ (2000) value based on Eagle and Carlson (1950) acute study. No value is available from other Tier 3 sources. See details below.</p> <p>Tier 1 and 2 Sources: IRIS: No IRIS file available at this time. PPRTV: Per PPRTV (7/23/2008), no value at this time. The data are inadequate to derive a p-RfD MRL: No MRL record available at this time.</p> <p>Tier 3 Sources: MDEQ: RfD = 5.0E-3 mg/kg-day Critical Study(ies): Eagle & Carlson, 1950 Method(s): Critical effect: End point or Point of Departure (POD): LD50 = 5,000 mg/kg in the rat with an acute to chronic application factor of 0.0001 Uncertainty Factors: UF = 100 (10 each for intra-species variability and interspecies extrapolation) Source and date: MDEQ Water Resources Division (former SWB), 2/01/2000</p> <p>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, Canada, The Netherlands (RIVM), WHO (IARC), WHO (IPCS/INCHEM), OECD HPV, and ECHA (REACH).</p>		Complete
Oral Cancer Slope Factor (CSF) (mg/kg-day) ⁻¹	1.0E-2	9.8E-2	MDEQ, 2009	



	Part 201 Value	Updated Value	Source/Reference/Date	Comments/Notes/Issues	
CSF details	<p>Tsuda et al (1982) fed male and female B6C3F mice a basal diet of 0, 0.15%, 0.3%, or 0.6% carbazole for 96 weeks followed by an 8 week recovery period. This study reported a significant increase in the induction of neoplastic lesions of the liver (neoplastic nodules and hepatocellular carcinomas). Only hepatocellular carcinomas were used to calculate the SF. Revised species scaling factor of (BWh/BWa) to the 0.25.</p> <p>WB/CCD date: 2/1/2000</p>	<p>Tier 3 Source: MDEQ-AQD: Basis: MDEQ (2009) AQD value based on Tsuda et al. (1982) study. AQD used a more current model (BMDS v2.1) and body weight scaling factor. HEAST (1997), California (2001) and MDEQ-WRD (2000) values are based on the same study but used an older model to calculate the CSF. New Jersey and Texas adopted the HEAST value.</p> <p>Tier 1 and 2 Sources: IRIS: No IRIS file available at this time. PPRTV: Per PPRTV (7/23/2008), no value at this time. PPRTV classifies carbazole as having "Inadequate Information to Assess Carcinogenic Potential." MRL: NA; MRLs are for non-cancer effects only.</p> <p>Tier 3 Sources:</p> <p>MDEQ: AQD derived an oral CSF of $9.8E-2 \text{ (mg/kg)}^{-1}$. This value was used as basis for the MDEQ IUR: Critical Study: Tsuda, H., A. Hagiwara, M. Shibata et al. 1982. Carcinogenic effect of carbazole in the liver of (C57BL/6N x C3H/HeN) F1 mice. J. Natl. Cancer Inst. 69: 1383-1389. Method(s): Basal diet of 0, 0.15%, 0.3%, or 0.6% carbazole for 96 weeks followed by an 8 week recovery period. 1) Dose response data: Tumor Type - neoplastic nodules and hepatocellular; Test Species - male and female B6C3F mice; Route – diet 2) Calculation method: BMDS v2.1 multistage model with 90% BMD CI give mice SF of $1.487 \text{ (mg/kg)}^{-1}$. This value is further refined using the new body weight scaling ratio to the $\frac{3}{4}$ power, i.e. $(70\text{kg}/0.037 \text{ kg})^{1/4}$ to derive the oral slope factor of $0.0098 \text{ (mg/kg)}^{-1}$.</p> <p>Source and Date: MDEQ-AQD, 9/03/2009.</p> <p>MDEQ: WRD (2000) CSF = $1.0E-2 \text{ (mg/kg-day)}^{-1}$.</p>			Complete

	Part 201 Value	Updated Value	Source/Reference/ Date	Comments/Notes /Issues
		<p>Critical Study: Tsuda, H., A. Hagiwara, M. Shibata et al. 1982. Carcinogenic effect of carbazole in the liver of (C57BL/6N x C3H/HeN) F1 mice. J. Natl. Cancer Inst. 69: 1383-1389.</p> <p>Method(s): Basal diet of 0, 0.15%, 0.3%, or 0.6% carbazole for 96 weeks followed by an 8 week recovery period.</p> <p>3) <i>Dose response data: Tumor Type</i> - hepatocellular carcinomas; <i>Test Species</i> - male B6C3F mice; <i>Route</i> - diet</p> <p>4) <i>Extrapolation method:</i> Global 82 linearized multistage model with species scaling factor of (BWh/BWa) to the 0.25.</p> <p>Source and Date: MDEQ Water Resources Division (former SWB), 2/01/2000</p> <p>HEAST: CSF = 2.0E-2 (mg/kg-day)⁻¹: Critical Study: (10096) Tsuda, H., A. Hagiwara, M. Shibata et al. 1982. Carcinogenic effect of carbazole in the liver of (C57BL/6N x C3H/HeN) F1 mice. J. Natl. Cancer Inst. 69: 1383-1389. Method(s): Basal diet of 0, 0.15%, 0.3%, or 0.6% carbazole for 96 weeks followed by an 8 week recovery period. Tumor type: liver tumors in mice Source: Heast Summary 1997, p 3-7</p> <p>CALIFORNIA DTSC/OEHHA: CSF = 1.7E-1 per mg/kg-day: Study: Tsuda H, Hagiwara A, Shibata M, Ohshima M, Ito N (1982). Carcinogenic effect of carbazole in the liver of (C57BL/6N x C3H/HeN) F1 mice. J Natl Cancer Inst 69:13831387. Methods: Tsuda et al. exposed male and female B6C3F1 mice to carbazole via diet for 22 months. The animals were sacrificed at 24 months. Female mice were exposed to 180, 360, or 739 mg/kg-day. Males were exposed to 166, 332 or 665 mg/kg-day. The most sensitive sex/species/site is female mouse liver. The final potency estimate was derived based on data for both tumor sites, liver and forestomach, in female mouse. The multistage model fit adequately to the forestomach tumor data in female mice, and all dose groups were retained. CSF: The upper 95 percent confidence bound on q1 was determined based on the</p>		

	Part 201 Value	Updated Value	Source/Reference/Date	Comments/Notes/Issues
		<p>distribution of the sum of potencies from the carbazole-affected sites. The human cancer potency is estimated to be 0.17 (mg/kg-day)⁻¹ and the associated NSRL 4.1 mg/day.</p> <p>Source: OEHHA 2001. Expedited Cancer Potency Values and No Significant Risk Levels (NSRLs) for Six Proposition 65 Carcinogens p.5</p> <p>NEW JERSEY DEP: CSF = 2.0E-2 (mg/kg-day)⁻¹ based on HEAST.</p> <p>TEXAS CEQ: CSF = 2.0E-2 (mg/kg-day)⁻¹ based on HEAST.</p> <p>Other Tier 3: No value is available at this time from these Tier 3 sources/databases: NTP ROC, health and environmental agencies of Massachusetts, Minnesota, and New York, Canada, The Netherlands (RIVM), WHO (IARC), WHO (IPCS/INCHEM), OECD HPV, and ECHA (REACH).</p>		
Reference Concentration (RfC) or Initial Threshold Screening Level (ITSL) (µg/m³)	--	NA	MDEQ, 2015	
RfC/ITSL details	NA	<p>Tier 1 and 2 Sources:</p> <p>IRIS: No IRIS file available at this time.</p> <p>PPRTV: Per PPRTV (7/23/2008), no value at this time.</p> <p>MRL: No MRL record available at this time.</p> <p>Tier 3 source:</p> <p>MDEQ: Per DEQ-CCD, no value at this time.</p>		Complete
Inhalation Unit Risk Factor (IURF) ((µg/m³)⁻¹)	--	2.8E-6	MDEQ, 2009	
IURF details	NA	<p>Tier 3 Source:</p> <p>MDEQ:</p> <p>Basis: MDEQ (2009) value is extrapolated from an oral CSF. No value is available</p>		Complete



	Part 201 Value	Updated Value	Source/Reference/ Date	Comments/Notes /Issues
		<p>from other Tier 3 sources. See details below.</p> <p>Tier 1 and 2 Sources: IRIS: No IRIS file available at this time. PPRTV: Per PPRTV (7/23/2008), no value at this time. MRL: NA; MRLs are for non-cancer effects only.</p> <p>Tier 3 Sources: MDEQ: IURF = $2.8E-6 (\mu\text{g}/\text{m}^3)^{-1}$ extrapolated from human oral SF of <u>$9.8E-2 (\text{mg}/\text{kg})^{-1}$</u> derived by AQD as follows: Critical Study: Tsuda, H., A. Hagiwara, M. Shibata et al. 1982. Carcinogenic effect of carbazole in the liver of (C57BL/6N x C3H/HeN) F1 mice. J. Natl. Cancer Inst. 69: 1383-1389. Method(s): Basal diet of 0, 0.15%, 0.3%, or 0.6% carbazole for 96 weeks followed by an 8 week recovery period.</p> <ol style="list-style-type: none"> 1. <i>Dose response data: Tumor Type</i> - neoplastic nodules and hepatocellular; <i>Test Species</i> - male and female B6C3F mice; <i>Route</i> - diet 2. <i>Calculation method:</i> BMDS v2.1 multistage model with 90% BMD CI give mice SF of $1.487 (\text{mg}/\text{kg})^{-1}$. This value is further refined using the new body weight scaling ratio to the $\frac{3}{4}$ power, i.e. $(70\text{kg}/0.037 \text{ kg})^{1/4}$ to derive the oral SF = $0.0098 (\text{mg}/\text{kg})^{-1}$. <p>Inhalation SF: The <u>human CSF</u> converted to inhalation SF (IUR) = $2.8E-6 (\mu\text{g}/\text{m}^3)^{-1}$. Source and Date: MDEQ-AQD, 9/03/2009.</p> <p>NEW JERSEY DEP: IURF = $5.7E-7 (\text{mg}/\text{kg}\text{-day})^{-1}$ based on HEAST. Per HEAST (1997) this oral Unit Risk is $5.7E-7$ per $\mu\text{g}/\text{L}$ which is not an air concentration unit. No HEAST values are presented for IURF and inhalation slope factor values for carbazole. Source: NJDEP Toxicity factors for Carbazole, New Jersey Dept. of Environmental Protection - Toxicity Factors 9/23/2008</p>		

	Part 201 Value	Updated Value	Source/Reference/ Date	Comments/Notes /Issues
		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 York, and Texas, Canada, The Netherlands (RIVM), WHO (IARC), WHO (IPCS/INCHEM), ECHA (REACH), and OECD HPV.		
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	No, the RfD is not based on a reproductive-developmental effect.	MDEQ, 2015	
Developmental or Reproductive Toxicity Details	NA	NA		
State Drinking Water Standard (SDWS) (ug/L)	--	NA	SDWA, 1976	
SDWS details	NA	MI Safe Drinking Water Act (SDWA) 1976 PA 399		
Secondary Maximum Contaminant Level (SMCL) (ug/L)	--	NA	SDWA, 1976 and USEPA SMCL List, 2015	
SMCL details	NA	SDWA, 1976 and USEPA SMCL List, 2015		
Is there an aesthetic value for drinking water? (Y/N)	NO	Not evaluated.	NA	
Aesthetic value (ug/L)	NA	NA	NA	
Aesthetic Value details	NA	NA		

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

(C) Chemical-specific Absorption Factors

	Part 201 Value	Update	Source/Reference/ Dates	Comments/Notes /Issues
Gastrointestinal absorption efficiency value (ABS_{gi})	---	1.0	MDEQ, 2015	MDEQ, 2015/USEPA RAGS-E, 2004
ABS_{gi} details		RAGS E (USEPA, 2004) Default Value		
Skin absorption efficiency value (A_{Ed})	---	0.1	MDEQ, 2015	
A_{Ed} details				
Ingestion Absorption Efficiency (A_{Ei})		1.0	MDEQ, 2015	
A_{Ei} 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)	10 (M); 4
Updated GSI value (µg/L)	10 (M); 4
Rule 57 Drinking Water Value (µg/L)	10 (M); 4

	Rule 57 Value (µg/L)	Verification Date
Human Non-cancer Values- Drinking water source (HNV-drink)	ID* (4)	9/1998
Human Non-Cancer Values- Non-drinking water sources (HNV-Non-drink)	ID* (4)	9/1998
Wildlife Value (WV)	NA	NA
Human Cancer Values for Drinking Water Source (HCV-drink)	19	1/2000
Human Cancer values for non-drinking water source (HCV-Non-drink)	41	1/2000
Final Chronic Value (FCV)	4	5/1999
Aquatic maximum value (AMV)	36	5/1999
Final Acute Value (FAV)	72	5/1999

Sources:

1. MDEQ Surface Water Assessment Section Rule 57 [website](#)
2. MDEQ Rule 57 [table](#)

(E) Target Detection Limits (TDL)

	Value	Source
Target Detection Limit – Soil ($\mu\text{g}/\text{kg}$)	330	MDEQ, 2015
Target Detection Limit – Water ($\mu\text{g}/\text{L}$)	10	MDEQ, 2015
Target Detection Limit – Air (ppbv)	NA	MDEQ, 2015
Target Detection Limit – Soil Gas (ppbv)	NA	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
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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 OEHHHA	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