



CHEMICAL UPDATE WORKSHEET

Chemical Name:	Cyclohexane(DD)
CAS #:	110-82-7
Revised By:	RRD Toxicology Unit
Revision Date:	August 17, 2015

(A) Chemical-Physical Properties

	Part 201 Value	Updated Value	Reference Source	Comments
Molecular Weight (g/mol)	84.18	84.16	EPI	EXP
Physical State at ambient temp	Liquid	Liquid	MDEQ	
Melting Point (°C)	6.47	6.60	EPI	EXP
Boiling Point (°C)	177.26	80.70	EPI	EXP
Solubility (ug/L)	5.5E+4	5.5E+04	EPI	EXP
Vapor Pressure (mmHg at 25°C)	96.9	9.69E+01	EPI	EXP
HLC (atm-m³/mol at 25°C)	0.195	1.50E-01	EPI	EXP
Log Kow (log P; octanol-water)	3.44	3.44	EPI	EXP
Koc (organic carbon; L/Kg)	2400	145.8	EPI	EST
Ionizing Koc (L/kg)		NR	NA	NA
Diffusivity in Air (Di; cm²/s)	0.08	8.00E-02	W9	EST
Diffusivity in Water (Dw; cm²/s)	8.0E-6	9.1079E-06	W9	EST
Soil Water Partition Coefficient (Kd; inorganics)	NR	NR	NA	NA

	Part 201 Value	Updated Value	Reference Source	Comments
Flash Point (°C)	-0.4 F	-20	CRC	EXP
Lower Explosivity Level (LEL; unit less)	0.013	0.013	CRC	EXP
Critical Temperature (K)		553.4	CRC	EXP
Enthalpy of Vaporization (cal/mol)		7.16E+03	CRC	EXP
Density (g/mL, g/cm ³)		0.7739	CRC	EXP
EMSOFT Flux Residential 2 m (mg/day/cm ²)	2.62E-05	2.81E-05	EMSOFT	EST
EMSOFT Flux Residential 5 m (mg/day/cm ²)	6.12E-05	6.91E-05	EMSOFT	EST
EMSOFT Flux Nonresidential 2 m (mg/day/cm ²)	3.71E-05	4.48E-05	EMSOFT	EST
EMSOFT Flux Nonresidential 5 m (mg/day/cm ²)	8.55E-05	1.10E-04	EMSOFT	EST

(B) Toxicity Values/Benchmarks

	Part 201 Value	Updated Value	Source/Reference/ Date	Comments/Notes /Issues
Reference Dose (RfD) (mg/kg/day)	--	NA	MDEQ, 2015	
RfD details	NA	<p>Tier 1 and 2 Sources: IRIS: Per IRIS (9/11/2003), no value at this time. PPRTV: Per PPRTV (9/29/2010), no value at this time. MRL: No MRL record available at this time.</p> <p>Tier 3 Source: MDEQ: Per DEQ-CCD/RRD Toxicology Assessment (11/2008), no value at this time. Available data do not support development of an RfD value. Literature searches were conducted in 2006 and 2010.</p>		Complete
Oral Cancer Slope Factor (CSF) (mg/kg-day) ⁻¹	--	NA	MDEQ, 2015	
CSF details	NA	<p>Carcinogen Weight-of-Evidence (WOE) Class: "Inadequate Information to Assess [the] Carcinogenic Potential" of cyclohexane (PPRTV, 2010); "Data are inadequate for an assessment of human carcinogenic potential" (IRIS, 2003) IRIS WOE Basis: Per PPRTT (9/29/2010), no information was located on the carcinogenicity of cyclohexane in humans or animals. Genotoxicity data provide little evidence to suggest that cyclohexane is mutagenic.</p> <p>Tier 1 and 2 Sources: IRIS: Per IRIS (9/11/2003), no value at this time. PPRTV: Per PPRTV (9/29/2010), no value at this time. MRL: NA; MRLs are for non-cancer effects only.</p> <p>Tier 3 Source: MDEQ: Per DEQ-CCD, no value at this time.</p>		Complete
Reference Concentration (RfC) or Initial Threshold	--	6.0E+3	IRIS, 2003	

	Part 201 Value	Updated Value	Source/Reference/ Date	Comments/Notes /Issues
Screening Level (ITSL) ($\mu\text{g}/\text{m}^3$)				
RfC/ITSL details	NA	<p>Tier 1 Source: IRIS: Basis: IRIS is the only available value. IRIS RfC = 6.0E+3 $\mu\text{g}/\text{m}^3$: Critical Study: 1) Kreckmann, KH; Baldwin, JK; Roberts, LG; et al. (2000) Inhalation developmental toxicity and reproduction studies with cyclohexane. Drug Chem Toxicol 23(4):555-73. 2) DuPont HLR. (1997) Reproductive and fertility effects with cyclohexane inhalation multigeneration reproduction study in rats, with cover letter dated 4/18/97. Submitted by Chemical Manufacturers Association, Cyclohexane Panel; E.I. du Pont de Nemours and Company, Haskell Laboratory for Toxicology and Industrial Medicine to U.S. EPA under TSCA Section 4. U.S. EPA Document No. 44640. Fiche No. OTS0558881. Methods: CrI: CD BR rats (Sprague-Dawley strain; 30/sex/concentration) were exposed by whole body inhalation to cyclohexane vapor at 0, 500, 2,000 or 7,000 ppm (0, 1,721, 6,886, or 24,101 mg/m^3). After 10 weeks of exposure (6 hrs. /day and 5 days/wk., excluding holidays), the animals were bred within their respective treatment groups and allowed to deliver and rear their offspring until weaning. With the exception of gestation day 21 until day 4 of lactation, when they were not exposed, females were exposed daily after breeding throughout pregnancy and lactation. Neonate rats were not directly exposed to cyclohexane. At weaning, F1 rats were randomly selected to produce the next generation and were treated to the same exposure schedule as the P1 generation. At least 11 weeks after weaning, the F1 rats were bred to produce the F2 litters. Critical effect: decreased pup body weight End point or Point of Departure (POD): $\text{BMCL}_{1\text{SDHEC}} = 1,822 \text{ mg}/\text{m}^3$ Uncertainty Factors: UF = 300 (10 each for interspecies variability and database deficiencies, and 3 for interspecies extrapolation) Source and date: IRIS, Last revision date - 9/11/2003</p> <p>Tier 2 Sources:</p>		Complete



	Part 201 Value	Updated Value	Source/Reference/Date	Comments/Notes/Issues
		<p>PPRTV: Per PPRTV (9/29/2010), 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 (9/11/2003), AQD adopted the IRIS RfC.</p>		
Inhalation Unit Risk Factor (IURF) (($\mu\text{g}/\text{m}^3$)⁻¹)	--	NA	MDEQ, 2015	
IURF details	NA	<p>Carcinogen Weight-of-Evidence (WOE) Class: "Inadequate Information to Assess [the] Carcinogenic Potential" of cyclohexane (PPRTV, 2010); "Data are inadequate for an assessment of human carcinogenic potential" (IRIS, 2003)</p> <p>IRIS WOE Basis: Per PPRTT (9/29/2010), no information was located on the carcinogenicity of cyclohexane in humans or animals. Genotoxicity data provide little evidence to suggest that cyclohexane is mutagenic.</p> <p>Tier 1 and 2 Sources:</p> <p>IRIS: Per IRIS (9/11/2003), no value at this time.</p> <p>PPRTV: Per PPRTV (9/29/2010), no value at this time.</p> <p>MRL: NA; MRLs are for non-cancer effects only.</p> <p>Tier 3 Source:</p> <p>MDEQ: Per DEQ-CCD, no value at this time.</p>		Complete
Mutagenic Mode of Action (MMOA)? (Y/N)	--	NO	USEPA, 2015	
MMOA Details	--	<p>NA</p> <p>Not listed as a carcinogen with mutagenic MOA in the USEPA OSWER List.</p>		
Developmental or Reproductive Effector? (Y/N)	No	<p>YES – inhalation; the RfC is based on a reproductive-developmental effect. Inhalation Exposure Pathways- Full Term Exposure</p> <p>No for oral exposure. The RfD is not based on a reproductive-developmental effect.</p>	MDEQ, 2015	
Developmental or Reproductive	NA	<p>Critical effect: decreased pup body weight</p> <p>Critical Study:</p>		



	Part 201 Value	Updated Value	Source/Reference/ Date	Comments/Notes /Issues
Toxicity Details		<p>1) Kreckmann, KH; Baldwin, JK; Roberts, LG; et al. (2000) Inhalation developmental toxicity and reproduction studies with cyclohexane. Drug Chem Toxicol 23(4):555-73.</p> <p>2) DuPont HLR. (1997) Reproductive and fertility effects with cyclohexane inhalation multigeneration reproduction study in rats, with cover letter dated 4/18/97. Submitted by Chemical Manufacturers Association, Cyclohexane Panel; E.I. du Pont de Nemours and Company, Haskell Laboratory for Toxicology and Industrial Medicine to U.S. EPA under TSCA Section 4. U.S. EPA Document No. 44640. Fiche No. OTS0558881.</p> <p>Method(s): Crl: CD BR rats (Sprague-Dawley strain; 30/sex/concentration) were exposed by whole body inhalation to cyclohexane vapor at 0, 500, 2,000 or 7,000 ppm (0, 1,721, 6,886, or 24,101 mg/m³). After 10 weeks of exposure (6 hrs. /day and 5 days/wk., excluding holidays), the animals were bred within their respective treatment groups and allowed to deliver and rear their offspring until weaning. With the exception of gestation day 21 until day 4 of lactation, when they were not exposed, females were exposed daily after breeding throughout pregnancy and lactation. Neonate rats were not directly exposed to cyclohexane. At weaning, F1 rats were randomly selected to produce the next generation and were treated to the same exposure schedule as the P1 generation. At least 11 weeks after weaning, the F1 rats were bred to produce the F2 litters.</p>		
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	
SMCL details	NA	SDWA, 1976 and USEPA SMCL List, 2015		
Is there an aesthetic value for drinking water?	NO	Not evaluated.	NA	

	Part 201 Value	Updated Value	Source/Reference/ Date	Comments/Notes /Issues
(Y/N)				
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 Absorption Factors

	Part 201 Value	Update	Source/Reference/ Dates	Comments/Notes /Issues
Gastrointestinal absorption efficiency value (ABS _{gi})	---	1.0	MDEQ, 2015/USEPA RAGS-E, 2004	
ABS _{gi} details		RAGS E (USEPA, 2004) Default Value		
Skin absorption efficiency value (AE _d)	---	0.1	MDEQ, 2015	
AE _d details				
Ingestion Absorption Efficiency (AE _i)		1.0	MDEQ, 2015	
AE _i Details				
Relative Source Contribution for Water (RSC _w)		1.0	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)	ID
Updated GSI value (µg/L)	ID
Rule 57 Drinking Water Value (µg/L)	ID

	Rule 57 Value (µg/L)	Verification Date
Human Non-cancer Values- Drinking water source (HNV-drink)	ID	7/2006
Human Non-Cancer Values- Non-drinking water sources (HNV-Non-drink)	ID	7/2006
Wildlife Value (WV)	NA	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)	ID	7/2006
Aquatic maximum value (AMV)	ID	7/2006
Final Acute Value (FAV)	ID	7/2006

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 ($\mu\text{g}/\text{kg}$)	500	MDEQ, 2015
Target Detection Limit – Water ($\mu\text{g}/\text{L}$)	10	MDEQ, 2015
Target Detection Limit – Air (ppbv)	1.70E+03	MDEQ, 2015
Target Detection Limit – Soil Gas (ppbv)	5.80E+04	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