



CHEMICAL UPDATE WORKSHEET

Chemical Name:	Benzidine
CAS #:	92-87-5
Revised By:	RRD Toxicology Unit
Revision Date:	August 12, 2105

(A) Chemical-Physical Properties

	Part 201 Value	Updated Value	Reference Source	Comments
Molecular Weight (g/mol)	184.24	184.24	EPI	EXP
Physical State at ambient temp	Solid	Solid	MDEQ	
Melting Point (°C)	396	120.00	EPI	EXP
Boiling Point (°C)	401	401.00	EPI	EXP
Solubility (ug/L)	5.20E+5	3.22E+05	EPI	EXP
Vapor Pressure (mmHg at 25°C)	0.0000000836	8.98E-07	PP	EST
HLC (atm-m³/mol at 25°C)	3.90E-11	5.17E-11	PP	EST
Log Kow (log P; octanol-water)	1.66	1.34	EPI	EXP
Koc (organic carbon; L/Kg)	42.9	1190	EPI	EST
Ionizing Koc (L/kg)		NR	NA	NA
Diffusivity in Air (Di; cm²/s)	0.08	3.55E-02	W9	EST
Diffusivity in Water (Dw; cm²/s)	1.5E-5	7.5891E-06	W9	EST
Soil Water Partition Coefficient (Kd; inorganics)	NR	NR	NA	NA

	Part 201 Value	Updated Value	Reference Source	Comments
Flash Point (°F)	NA	NA	NA	NA
Lower Explosivity Level (LEL; unit less)	NA	NA	NA	NA
Critical Temperature (K)		NA	NA	NA
Enthalpy of Vaporization (cal/mol)		NA	NA	NA
Density (g/mL, g/cm ³)		1.25	PC	EXP
EMSOFT Flux Residential 2 m (mg/day/cm ²)	3.34E-08	2.65E-09	EMSOFT	EST
EMSOFT Flux Residential 5 m (mg/day/cm ²)	3.34E-08	2.65E-09	EMSOFT	EST
EMSOFT Flux Nonresidential 2 m (mg/day/cm ²)	3.35E-08	2.66E-09	EMSOFT	EST
EMSOFT Flux Nonresidential 5 m (mg/day/cm ²)	3.35E-08	2.66E-09	EMSOFT	EST

(B) Toxicity Values/Benchmarks

	Part 201 Value	Updated Value	Source*/Reference /Date	Comments/Notes /Issues
Reference Dose (RfD) (mg/kg/day)	2.7E-3	3.0E-3	IRIS, 1995	
RfD details	<p>Chronic Oral (drinking water) bioassay in mice (Littlefield et al, 1983) NOAEL=none; LOAEL=2.7 mg/kg/day; UF=1000; Critical effect = brain cell vacuolization, liver cell alterations in females. Source: IRIS CCD/RRD date: 7/16/1987</p>	<p>Tier 1 Source: IRIS: Basis: IRIS is tier 1 source. IRIS (2/01/1995), RfD = 3.0E-3 mg/kg/day. Critical Study: Littlefield, N.A., C.J. Nelson and C.H. Frith. 1983. Benzidine dihydrochloride: Toxicological assessments in mice during chronic exposures. J. Toxicol. Environ. Health. 12: 671-685. Method(s): Balb/C males and C57B1/65 females), 72 to 120/sex/strain, were exposed to benzidine dihydrochloride in the drinking water at 0 to 160 ppm (0 to 27.2 mg/kg/day) for 33 months. Critical effect: Liver cell changes and brain vacuolization in female mice. End point or Point of Departure (POD): LOAEL = 2.7 mg/kg/day (as corrected for the free base concentration) Uncertainty Factors: UF = 1,000 (10 each for intra-species variability and interspecies and LOAEL to NOAEL extrapolation) Source and date: IRIS, Last revision date = 2/01/1995. EPA screening-level review in 2001 did not identify any critical new studies</p> <p>Tier 1 and 2 Sources: PPRTV: No PPRTV record available at this time. MRL: No MRL record available at this time.</p> <p>MDEQ: Per DEQ-CCD/RRD, RfD = 2.7E-3 mg/kg/day. See Part 201 Value RfD details. WRD RfD = 0.0027 mg/kg/day (3/29/2010).</p>		Complete
Oral Cancer Slope Factor (CSF) (mg/kg-day)⁻¹	2.3E+2	2.3E+2	IRIS, 1993	
CSF details	Bladder tumors occurred in men exposed	<p>Tier 1 Source: IRIS: Basis: IRIS is a tier 1 source.</p>		Complete



	Part 201 Value	Updated Value	Source*/Reference /Date	Comments/Notes /Issues
	<p>occupationally to benzidine via the air. Of 25 men, 11 had bladder tumors and 2 had papilloma (Zavon, 1973). The one-hit model was used per the IRIS Database. Human data - no species scaling factor. Source: IRIS Entry date: 12/17/1986</p>	<p>Critical Study (ies): Zavon, M.R. 1973. Benzidine exposure as a cause of bladder tumors. Arch. Environ. Health. 27: 1-7 Method(s): Epidemiological study. 1) <i>Dose response data: Tumor Type</i> - Human, bladder tumors; <i>Test Species</i> - Human; <i>Route</i> - occupational exposure (inhalation) 2) <i>Extrapolation method:</i> One-hit with time factor, extra risk Carcinogen Weight-of-Evidence (WOE) Class: A = human carcinogen. IRIS WOE Basis: Increased incidence of bladder cancer and bladder cancer-related deaths in exposed workers Source and Date: IRIS, Last revision date - 7/01/1993. EPA screening-level review in 2001 identified significant new studies. Other Sources: PPRTV: No PPRTV record available at this time. MRL: NA; MRLs are for non-cancer effects only. MDEQ: Per DEQ-CCD/RRD, RfD = 2.3E+2 (mg/kg/day)⁻¹(2/17/1986). See Part 201 Value CSF details. Per CCD/ Water Resources Division (3/29/2010) established an RfD = 234 (mg/kg/day)⁻¹ value that differs from the IRIS RfD as three significant figures are presented.</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: IRIS: Per IRIS (7/01/1991), no value at this time. PPRTV: No PPRTV record available at this time. MRL: No MRL record available at this time. Tier 3 Source: MDEQ: Per DEQ-CCD, no value at this time.</p>		Complete



	Part 201 Value	Updated Value	Source*/Reference /Date	Comments/Notes /Issues
Inhalation Unit Risk Factor (IURF) (($\mu\text{g}/\text{m}^3$)⁻¹)	6.7E-2	6.7E-2	IRIS, 1993	
IURF details	Human bladder tumors reported by Zavon 1973 provided basis for IRSL, calc'd by EPA in IRIS AQD calculation date = 10/15/92.	<p>Tier 1 Source: IRIS: Basis: IRIS is the only available data. Critical Study (ies): Zavon, M.R. 1973. Benzidine exposure as a cause of bladder tumors. Arch. Environ. Health. 27: 1-7 Method(s): Epidemiological study.</p> <p>3) <i>Dose response data: Tumor Type</i> - Human, bladder tumors; <i>Test Species</i> - Human; <i>Route</i> - occupational exposure (inhalation) 4) <i>Extrapolation method:</i> One-hit with time factor, extra risk</p> <p>Carcinogen Weight-of-Evidence (WOE) Class: A = human carcinogen. IRIS WOE Basis: Increased incidence of bladder cancer and bladder cancer-related deaths in exposed workers Source and Date: IRIS, Last revision date - 7/01/1993.</p> <p>Tier 2 Sources: PPRTV: No PPRTV record available at this time. MRL: NA; MRLs are for non-cancer effects only.</p> <p>Tier 3 Source: MDEQ: Per DEQ-CCD, AQD adopted IRIS value for IURF.</p>		Complete
Mutagenic Mode of Action (MMOA)? (Y/N)	--	YES	USEPA, 2015	
MMOA Details	--	Chemical is 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		



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

(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		MDEQ, 2015/USEPA RAGS-E, 2004		
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)		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)	0.3 (M); 0.073
Updated GSI value (µg/L)	0.3 (M,X); 0.073
Rule 57 Drinking Water Value (µg/L)	0.3 (M); 0.0015

	Rule 57 Value (µg/L)	Verification Date
Human Non-cancer Values- Drinking water source (HNV-drink)	74	3/2010
Human Non-Cancer Values- Non-drinking water sources (HNV-Non-drink)	3,700	3/2010
Wildlife Value (WV)	NA	NA
Human Cancer Values for Drinking Water Source (HCV-drink)	0.0015	3/2010
Human Cancer values for non-drinking water source (HCV-Non-drink)	0.073	3/2010
Final Chronic Value (FCV)	2.7	2/2009
Aquatic maximum value (AMV)	25	2/2009
Final Acute Value (FAV)	49	2/2009

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 ($\mu\text{g}/\text{kg}$)	1,000	MDEQ, 2015
Target Detection Limit – Water ($\mu\text{g}/\text{L}$)	0.3	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

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