



CHEMICAL UPDATE WORKSHEET

Chemical Name:	Copper
CAS #:	7440-50-8
Revised By:	RRD Toxicology Unit
Revision Date:	September 25, 2015

(A) Chemical-Physical Properties

	Part 201 Value	Updated Value	Reference Source	Comments
Molecular Weight (g/mol)	63.546	63.55	EPI	EXP
Physical State at ambient temp	Inorganic	Inorganic	MDEQ	
Melting Point (°C)	---	1083	PP	EXP
Boiling Point (°C)	2595	2595	PP	EXP
Solubility (ug/L)	NA	NA	NA	NA
Vapor Pressure (mmHg at 25°C)	NA	NR	NA	NA
HLC (atm-m³/mol at 25°C)	NR	NR	NA	NA
Log Kow (log P; octanol-water)	NR	NR	NA	NA
Koc (organic carbon; L/Kg)	NR	NR	NA	NA
Ionizing Koc (L/kg)		NR	NA	NA
Diffusivity in Air (Di; cm²/s)	NR	NR	NA	NA
Diffusivity in Water (Dw; cm²/s)	NR	NR	NA	NA
Soil Water Partition Coefficient (Kd; inorganics)	360	3.6E+02	MDEQ	EST

	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)		NR	NA	NA
Enthalpy of Vaporization (cal/mol)		NR	NA	NA
Density (g/mL, g/cm ³)		NR	NA	NA
EMSOFT Flux Residential 2 m (mg/day/cm ²)	NA	NR	EMSOFT	NA
EMSOFT Flux Residential 5 m (mg/day/cm ²)	NA	NR	EMSOFT	NA
EMSOFT Flux Nonresidential 2 m (mg/day/cm ²)	NA	NR	EMSOFT	NA
EMSOFT Flux Nonresidential 5 m (mg/day/cm ²)	NA	NR	EMSOFT	NA

(B) Toxicity Values/Benchmarks

	Part 201 Value	Updated Value	Source/Reference/Date	Comments/Notes/Issues
Reference Dose (RfD) (mg/kg/day)	3.8E-2	1.0E-3	ATSDR, 2004	
RfD details	<p>Toxicity data inadequate to derive RfD. Type B groundwater value based on MCLG (See equation below). [5.3 mg/day]/ [2x2 l/day] = 1.3mg/l. -----> Corresponds to RfD of 3.8E-2 = [5.3mg/d/ (2 x70 Kg)]. LOAEL = 5.3mg/day (Human clinical case studies; (Chuttani, et al., 1965) Critical effects = gastrointestinal effects. Source: MDEQ/ERD CCD date: 6/24/1991</p>	<p>Tier 2 Source: ATSDR: Basis: ATSDR is a Tier 2 source, no Tier 1 available. An additional uncertainty factor of 10 is applied to the ATSDR intermediate oral MRL = 0.01 mg/kg-day to account for subchronic to chronic exposure extrapolation. Critical Study: Araya M, Olivares M, Pizarro F, et al. 2003b. Gastrointestinal symptoms and blood indicators of copper load in apparently healthy adults undergoing controlled copper exposure. Am J Clin Nutr 77:646-650. Method(s): Groups of 327–340 men and women (mean age 32.9 years) were exposed to 0, 2, 4, or 6 mg Cu/L in drinking water for 2 months. The subjects prepared the copper sulfate solution daily using tap water and a stock copper sulfate solution. The copper solution was used for drinking and preparation of beverages and soups. Calculated doses using a reference body weight of 65 kg were 0, 0.042, 0.091, and 0.17 mg Cu/kg-day, respectively. Critical effect: gastrointestinal effects End point or Point of Departure (POD): NOAEL = 0.042 mg/kg-day Uncertainty Factors: UF = 3 (3 interspecies variability) Source and date: ATSDR, 10/2004</p> <p>Tier 1 Sources: IRIS: Per IRIS (8/1/1991), no value at this time. EPA-OPP: Copper is a natural trace element required for the homeostasis of life with humans having a unique ability to maintain appropriate copper stores in the body. As such, it is inappropriate to compare the toxicity of copper in laboratory animals for extrapolation to human toxicity. Humans are exposed primarily through the food that is consumed with RDAs established for adults, infants, and children. The irritating properties of copper to the gastrointestinal tract are a mechanism by which excess orally absorbed copper is prevented. Copper may be irritating, however, to the skin, eyes, and lungs and should therefore be avoided</p>		Complete



	Part 201 Value	Updated Value	Source/Reference/Date	Comments/Notes/Issues
		<p>by these routes of exposure. Copper residues from the use as a pesticidal active ingredient are not expected to significantly contribute to the naturally occurring levels of copper in foods; therefore, toxicological endpoints have not been established for copper.</p> <p>Source: June 29, 2006 Memo. Revised Human Health Chapter of the RED Document. From Elissa Reaves et al.:</p> <p>Tier 2 Sources: PPRTV: No PPRTV record available at this time. MRL: An oral acute MRL of 0.01 mg/kg/day is also available.</p> <p>Tier 3 Source: MDEQ: 1) Per DEQ-CCD/RRD (6/24/1991), RfD = 3.8E-2 mg/kg-day. See Part 201 Value RfD details. 2) Per MDEQ-WRD (4/14/1997), RfD = 4.5E-2 mg/kg-day <i>Critical Study:</i> Wyllie J. 1957. Copper poisoning at a cocktail party. Am J Public Health 47:617. <i>Method(s):</i> acute exposure <i>Critical effect:</i> nausea, vomiting, diarrhea and headache <i>End point or Point of Departure (POD):</i> LOAEL = 5.3 mg copper (0.09 mg/kg) <i>Uncertainty Factors:</i> UF = 2 (10 each for interspecies variability, interspecies extrapolation and use of a sub chronic study, and 3 for database deficiencies) <i>Source and date:</i> MDEQ-CCD/WRD, 4/14/1997</p>		
Oral Cancer Slope Factor (CSF) (mg/kg-day)⁻¹	--	NA	MDEQ, 2015	
CSF details	NA	<p>Carcinogen Weight-of-Evidence (WOE) Class: D; not classified IRIS WOE Basis: no human data, inadequate animal data from assays of copper compounds, and equivocal mutagenicity data Source and Date: IRIS, Last revision date - 8/01/1991</p> <p>Tier 1 and 2 Sources:</p>		Complete



	Part 201 Value	Updated Value	Source/Reference/Date	Comments/Notes/Issues
		<p>IRIS: Per IRIS (8/1/1991), no value at this time. 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, no value at this time.</p>		
Reference Concentration (RfC) or Initial Threshold Screening Level (ITSL) ($\mu\text{g}/\text{m}^3$)	2.0E+0	2.0E+0	MDEQ, 2009	
RfC/ITSL details	<p>ITSL based on TLV for copper fume which was set by ACGIH in 2001, under R232(1)(c). CCD/AQD date: 12/02/2009</p>	<p>Tier 3 Source: MDEQ: Basis: MDEQ is selected as it is a more recent source, based on human 8-hour exposure. See details below.</p> <p>Tier 1 and 2 Sources: IRIS: Per IRIS (8/1/1991), no value at this time. RED/Pesticide Docs: See the note in the oral RfD section. No value available. PPRTV: No PPRTV record available at this time. MRL: Per ATSDR (10/2004), no inhalation MRL value at this time.</p> <p>Tier 3 Sources: MDEQ: Per DEQ-CCD, ITSL = 2.0E+0 $\mu\text{g}/\text{m}^3$. Critical Studies: ACGIH. 1991. Documentation of the Threshold Limit Values and Biological Exposure Index. ACGIH. 2001. Documentation of the Threshold Limit Values and Biological Exposure Index. Basis: based on TLV for copper fume = 0.2 mg/m^3, which was set by ACGIH in 2001. Averaging time = 8 hours. Source and date: MDEQ/AQD, 12/02/2009</p> <p>California OEHHA 2008: Reference Exposure Level (REL) = 100 $\mu\text{g}/\text{m}^3$. This is 1</p>		Complete



	Part 201 Value	Updated Value	Source/Reference/ Date	Comments/Notes /Issues
		<p>hour exposure. Per Cal TSD for copper “Because of the limitations of the existing data, reevaluation of the REL for copper is recommended when better methods or data are available.”</p> <p>Critical Study: ACGIH, 1991; Gleason, 1968; Whitman, 1957, 1962</p> <p>Methods: worker inhalation exposure to 1 - 3 mg/m³ copper fume for “short periods”</p> <p>Critical effect: metal fume fever</p> <p>Point of Departure: NOAEL = 1 mg Cu/m³</p> <p>Uncertainty factors: UF = 10; interspecies variability</p> <p>Source and date: Cal OEHHA TSD for Noncancerous RELs; June 2008</p> <p>Massachusetts DEP 2015: Threshold Effects Limit (TEL) = 0.54 µg/m³ – 24-hour averaging time; Allowable Ambient Limit (ALL) = 0.54 µg/m³ – annual averaging time. Last updated 1990. No further details available.</p> <p>Minnesota 2015: RfC = 100 µg/m³. Based on California 2008 short term value.</p> <p>New Jersey DEP 2011: RfC = 100 µg/m³. Based on California 2008 short term value.</p> <p>New York DEP 2006: 490 µg/m³. Based on oral to inhalation extrapolation from IOM (2001) RfD of 0.14 mg/kg/day and 70 kg / 20 m³. IOM reference: IOM (Institute of Medicine). 2001. Dietary Reference Intakes for Vitamin A, Vitamin K, Arsenic, Boron, Chromium, Copper, Iodine, Iron, Manganese, Molybdenum, Nickel, Silicon, Vanadium, and Zinc. Washington, DC: National Academy Press.</p> <p>RIVM 2001: Tolerable Concentration in Air (TCA) = 1.0E+0 µg/m³. Based a tolerable daily intake study by Vermeire et al 1990. The NOAEC of 0.6 mg/m³ from the Vermeire paper was used from the sub chronic exposure with rabbits and UF = 100 (10 for inter- and interspecies extrapolation) corrected for a continuous exposure (5/7 x 6/24) = 1 µg/m³. Source: RIVM report 711701 025 Re-evaluation of human-toxicological maximum permissible risk levels March 2001.</p>		

	Part 201 Value	Updated Value	Source/Reference/Date	Comments/Notes/Issues
		<p>ECHA (REACH): no long term systemic effects value; short term systemic effects Derived No Effects Level (DNEL) = 2.0E+4 µg/m³. Long term exposure with local effects DNEL = 1.0E+3 µg/m³. Based on a 2010 (reference not given) subacute 28-day, 6 hours/day, 5 days/week inhalation exposure with Sprague-Dawley male and female rats (20 males/20 females per concentration). Nominal concentrations were 0.2, 0.4, 0.8 and 2.0 mg/m³. NOAEL ≥ 2 mg/m³ air. Source: ECHA REACH Dossier on Copper. Last modified 9/10/2015.</p> <p>Other Tier 3: No value is available from these sources/databases: HEAST 1997, NTP ROC, Texas CEQ 2014, WHO (IARC and IPCS/INCHEM), Canada, OECD HPV</p>		
Inhalation Unit Risk Factor (IURF) ((µg/m ³) ⁻¹)	--	NA	MDEQ, 2015	
IURF details	NA	<p>Carcinogen Weight-of-Evidence (WOE) Class: D; not classified</p> <p>IRIS WOE Basis: no human data, inadequate animal data from assays of copper compounds, and equivocal mutagenicity data</p> <p>Source and Date: IRIS, Last revision date - 8/01/1991</p> <p>Tier 1 and 2 Sources:</p> <p>IRIS: Per IRIS (8/1/1991), no value at this time.</p> <p>PPRTV: No PPRTV record available 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	No	No. The RfD and ITSL are not based on a reproductive-developmental effect.	MDEQ, 2015	

	Part 201 Value	Updated Value	Source/Reference/ Date	Comments/Notes /Issues
Effector? (Y/N)				
Developmental or Reproductive Toxicity Details	NA	NO		
State Drinking Water Standard (SDWS) (ug/L)	--	NA	SDWA, 1976 and USEPA SMCL List, 2015	
SDWS details	NA	MI Safe Drinking Water Act (SDWA) 1976 PA 399		
Secondary Maximum Contaminant Level (SMCL) (ug/L)	1,000	1,300	USEPA SMCL list, 2015	
SMCL details	SDWA, 1976	Drinking water standard, EPA 2002c; 40CFR264, Appendix IX Action level (Cu) - 1.3 mg/L; MCLG (Cu) - 1.3 mg/L Secondary MCL for public water systems - 1.0 mg/L (EPA 2002e 40CFR143.3)		
Is there an aesthetic value for drinking water? (Y/N)	YES	YES	USEPA SMCL list, 2015	
Aesthetic value (ug/L)	1,000	1,000	USEPA SMCL list, 2015	
Aesthetic Value details		USEPA SMCL list, 2015		
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)	---	0.01	MDEQ, 2015	
AE _d details				
Ingestion Absorption Efficiency (AE _i)		0.5	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	MDEQ, 2015	
Others				

(D) Rule 57 Water Quality Values and GSI Criteria

Current GSI value (µg/L)	(G)
Updated GSI value (µg/L)	(G)
Rule 57 Drinking Water Value (µg/L)	470

	Rule 57 Value (µg/L)	Verification Date
Human Non-cancer Values- Drinking water source (HNV-drink)	470	12/2005
Human Non-Cancer Values- Non-drinking water sources (HNV-Non-drink)	38,000	12/2005
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)	$(EXP(0.8545*(LnH)-1.7))*0.96^D$ D = value is expressed as dissolved	7/1997
Aquatic maximum value (AMV)	$(EXP(0.9422*(LnH)-1.7))*0.96^D$ D = value is expressed as dissolved	7/1997
Final Acute Value (FAV)	$(EXP(0.9422*(LnH)-1.7))*0.96*2^D$ D = value is expressed as dissolved	7/1997

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 ($\mu\text{g}/\text{L}$)	4	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