



CHEMICAL UPDATE WORKSHEET

Chemical Name:	Zinc
CAS #:	7440-66-6
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)	65.39	65.37	EPI	EXP
Physical State at ambient temp	Inorganic	Inorganic	MDEQ	
Melting Point (°C)	---	419.50	Phys Prop	EXP
Boiling Point (°C)	908	908.00	Phys Prop	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)	62	6.2E+01	SSG	EST

	Part 201 Value	Updated Value	Reference Source	Comments
Flash Point (°C)	NA	NA	NA	NA
Lower Explosivity Level (LEL; unitless)	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)	3.3E-1	3.0E-1	IRIS, 2005	
RfD details	Human diet supplement; No NOAEL; LOAEL = 59.72 mg/kg; Adjustment = 1.0 mg/kg based on 50 mg Zn supplement + 9.72 mg/d Zn from diet/ 60 kg (avg female body weight from study); UF = 3; Critical effect = 47% decreased in erythrocyte superoxide dismutase (Yadrick et al., 1989). CCD/RRD date: ??	<p>Tier 1 Source: IRIS: Basis: IRIS is a Tier 1 source. The ATSDR intermediate MRL is the same as the IRIS chronic RfD and based on the same data. Both assessments are dated 2005. IRIS RfD = 3.0E-1 mg/kg-day. Critical Studies: (Yadrick et al., 1989; Fischer et al., 1984; Davis et al., 2000; Milne et al., 2001) 1) Milne, DB; Davis, CD; Nielsen, FH. (2001) Low dietary zinc alters indices of copper function and status in postmenopausal women. Nutrition 17:701-708. 2) Davis, CD; Milne, DB; Nielsen, FH. (2000) Changes in dietary zinc and copper affect zinc-status indicators of postmenopausal women, notably, extracellular superoxide dismutase and amyloid precursor proteins. Am J Clin Nutr 71:781-788. 3) Yadrick, MK; Kenney, MA; Winterfeldt, EA. (1989) Iron, copper, and zinc status: response to supplementation with zinc or zinc and iron in adult females. Am J Clin Nutr 49:145-150. 4) Fischer, PW; Giroux, A; L'Abbe, MR. (1984) Effect of zinc supplementation on copper status in adult man. Am J Clin Nutr 40:743-746. Method(s): The RfD is based on human clinical studies to establish daily nutritional requirements. Insufficient as well as excessive oral intake can cause toxicity and disease and a quantitative RA must take essentiality into account. The dose conversion factor was based on reference adult body weights for the appropriate gender. Total dose was derived from estimations from the FDA Total Diet Study for 1982-1986 (Pennington et al., 1989), plus reported supplemental dose. The principal studies identified effect levels of 0.81 mg Zn/kg-day (Davis et al., 2000; Milne et al., 2001), 0.94 mg Zn/kg-day (Fischer et al., 1984), and 0.99 mg Zn/kg-day (Yadrick et al., 1989). Since the four studies have similar methodologies and outcomes with regard to effects, they were averaged together to obtain the LOAEL (0.81+0.94+0.99=2.74/3=0.91 mg/kg-day). Critical effect: decreased erythrocyte Cu, Zn-superoxide dismutase (ESOD)</p>		Complete.



	Part 201 Value	Updated Value	Source/Reference/ Date	Comments/Notes /Issues
		<p>activity in healthy adult male and female volunteers</p> <p>End point or Point of Departure (POD): LOAEL = 0.91 mg/kg-day. A NOAEL could not be determined.</p> <p>Uncertainty Factors: UF = 3 for intraspecies variability.</p> <p>Source and date: IRIS, Last revision date - 8/3/2005. An IRIS Toxicological Review is available.</p> <p>Tier 1 and 2 Sources:</p> <p>OPP March 4, 2009: Per OPP document "Summary of Human Health Effects Data for Zinc, Zinc Salts, and Zeolites Registration Review Decision Document": Zinc is ubiquitous in the environment including soil, plants and animals. Zinc is an essential nutrient in the body. For toxicological concerns, there are adequate toxicology studies in the zinc database to evaluate incidental oral exposures. At high levels, oral exposure to zinc in animal studies may result in toxic effects such as pancreatic and renal lesions as well as histological alterations in the pituitary and adrenal glands. In general, the levels of zinc causing these toxicological effects occur at much higher dose levels than the level recommended for nutritional use and that is naturally available in food. Zinc is widely distributed in plants and animals, and is normally present in food. Zinc is also a normal part of metabolism in all living organisms.</p> <p>Based on this information, no toxicological endpoints were selected.</p> <p>PPRTV: No PPRTV record available at this time.</p> <p>MRL: Per ATSDR (9/2005), chronic and intermediate oral MRL = 3.0E-1 mg/kg-day:</p> <p>Critical Study(ies): Yadrick, MK; Kenney, MA; Winterfeldt, EA. (1989) Iron, copper, and zinc status: response to supplementation with zinc or zinc and iron in adult females. Am J Clin Nutr 49:145-150.</p> <p>Method(s): Eighteen healthy women, ages 25–40 years, were given zinc gluconate supplements twice daily (50 mg supplemental zinc/day, or 0.83 mg supplemental zinc/kg/day assuming a 60-kg mean body weight for healthy women) for a 10-week period</p>		

	Part 201 Value	Updated Value	Source/Reference/Date	Comments/Notes/Issues
		<p>Critical effect: decreases in erythrocyte superoxide dismutase (SOD) and serum ferritin levels</p> <p>End point or Point of Departure (POD): NOAEL = 50 mg/day; NOAEL_{ADJ} = 0.83 mg/kg-day (assumes 60 kg female body weight). The observed effect is considered to be a precursor event to the more severe symptoms seen with zinc-induced copper deficiency, rather than a toxic effect of itself, therefore, the 50 mg supplemental zinc/day value was the NOAEL.</p> <p>Uncertainty Factors: UF = 3 for interspecies variability.</p> <p>Source and date: ATSDR, 9/2005. A Toxicological Profile is available.</p> <p>Tier 3 Source: MDEQ: Per DEQ-CCD/RRD, RfD = 3.3E-1 mg/kg-day. See Part 201 Value RfD details.</p>		
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 carcinogenic potential of zinc</p> <p>IRIS WOE Basis: studies of humans occupationally-exposed to zinc are inadequate or inconclusive, adequate animal bioassays of the possible carcinogenicity of zinc are not available, and results of genotoxic tests of zinc have been equivocal.</p> <p>Source and Date: IRIS, Last revision date - 8/3/2005</p> <p>Tier 1 and 2 Sources: IRIS: Per IRIS (8/3/2005), 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>		Complete
Reference Concentration (RfC) or Initial	--	NA	MDEQ, 2015	



	Part 201 Value	Updated Value	Source/Reference/ Date	Comments/Notes /Issues
Threshold Screening Level (ITSL) ($\mu\text{g}/\text{m}^3$)				
RfC/ITSL details	NA	Tier 1 and 2 Sources: IRIS: Per IRIS (8/3/2005), no value at this time. PPRTV: No PPRTV record available at this time. MRL: Per ATSDR, no inhalation MRL value at this time. Tier 3 Source: MDEQ: Per DEQ-CCD, no value at this time.		Complete
Inhalation Unit Risk Factor (IURF) ($(\mu\text{g}/\text{m}^3)^{-1}$)	--	NA	MDEQ, 2015	
IURF details	NA	Carcinogen Weight-of-Evidence (WOE) Class: inadequate information to assess carcinogenic potential of zinc IRIS WOE Basis: studies of humans occupationally-exposed to zinc are inadequate or inconclusive, adequate animal bioassays of the possible carcinogenicity of zinc are not available, and results of genotoxic tests of zinc have been equivocal. Source and Date: IRIS, Last revision date - 8/3/2005 Tier 1 and 2 Sources: IRIS: Per IRIS (8/3/2005), no value at this time. PPRTV: No PPRTV record available 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
Mutagenic Mode of Action (MMOA)? (Y/N)	--	NO	USEPA, 2014	
MMOA Details	--	Not listed as a carcinogen with mutagenic MOA in the USEPA OSWER List.		
Developmental or Reproductive	No	No, the RfD is 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	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)	5.0E+3	5.0E+3	USEPA SMCL List, 2015	
SMCL details		Based on 40 CFR 143, National Secondary Drinking Water Regulations.		
Is there an aesthetic value for drinking water? (Y/N)	NO	YES	NA	
Aesthetic value (ug/L)	5.0E+3	5.0E+3	USEPA SMCL List, 2015	
Aesthetic Value details		Based on 40 CFR 143, National Secondary Drinking Water Regulations.		
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 (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/USEPA RAGS-E, 2004	
AE _d details		RAGS E (USEPA, 2004): There is no default value assigned for inorganics because the speciation of the compound is critical to the dermal absorption and there are too little data to extrapolate a reasonable default value.		
Ingestion Absorption Efficiency (AE _i)		0.5	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)	(G)
Updated GSI value (µg/L)	(G)
Rule 57 Drinking Water Value (µg/L)	3,300

	Rule 57 Value (µg/L)	Verification Date
Human Non-cancer Values- Drinking water source (HNV-drink)	3,300	10/2005
Human Non-Cancer Values- Non-drinking water sources (HNV-Non-drink)	16,000	10/2005
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)	$(EXP(0.8473*(LnH)+0.884))*0.986^D$ D = value is expressed as dissolved	7/1997
Aquatic maximum value (AMV)	$(EXP(0.8473*(LnH)+0.884))*0.978^D$ D = value is expressed as dissolved	7/1997
Final Acute Value (FAV)	$(EXP(0.8473*(LnH)+0.884))*0.978*2^D$ D = value is expressed as dissolved	7/1997

Sources:

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

(E) Analytical Information

	Value	Source
Target Detection Limit – Soil ($\mu\text{g}/\text{kg}$)	1,000	MDEQ, 2015
Target Detection Limit – Water ($\mu\text{g}/\text{L}$)	50	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 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