



CHEMICAL UPDATE WORKSHEET

Chemical Name:	Selenium (and inorganic selenium compounds)
CAS #:	7782-49-2
Revised By:	RRD Toxicology Unit
Revision Date:	November 30, 2015

(A) Chemical-Physical Properties

	Part 201 Value	Updated Value	Reference Source	Comments
Molecular Weight (g/mol)	78.96	78.96	CRC	EXP
Physical State at ambient temp	Inorganic	Inorganic	MDEQ	
Melting Point (°C)	---	221.00	Phys Prop	EXP
Boiling Point (°C)	684	685.00	CRC	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	9.74E-03	PP	EST
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)	5	5.0E+00	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	NR	NA
EMSOFT Flux Residential 5 m (mg/day/cm ²)	NA	NR	NR	NA
EMSOFT Flux Nonresidential 2 m (mg/day/cm ²)	NA	NR	NR	NA
EMSOFT Flux Nonresidential 5 m (mg/day/cm ²)	NA	NR	NR	NA

(B) Toxicity Values/Benchmarks

	Part 201 Value	Updated Value	Source/Reference/Date	Comments/Notes/Issues
Reference Dose (RfD) (mg/kg/day)	5.0E-3	5.0E-3	IRIS, 1991	
RfD details	Human epid. study; NOAEL = 0.015 mg/kg; LOAEL = 0.023mg/kg; Critical effect = clinical selenosis. UF = 3 to protect sensitive individuals. CCD/RRD date: 3/27/1991	<p>Tier 1 Source: IRIS: Basis: Selenium IRIS, RfD= 5.0E-3 mg/kg/day is a Tier 1 source. The MRL is the same although the evaluation was conducted in 2003. The same study was used for both. Critical Study: Yang, G., S. Yin, R. Zhou, et al. 1989b. Studies of safe maximal daily dietary Se-intake in a seleniferous area in China. II. Relation between Se- intake and the manifestation of clinical signs and certain biochemical alterations in blood and urine. J. Trace Elem. Electrolytes Health Dis. 3(2): 123-130. Method(s): A population of approximately 400 individuals living in an area of China with unusually high environmental concentrations of selenium (Se) was evaluated for clinical and biochemical signs of Se intoxication. Three geographical areas with low, medium and high selenium levels in the soil and food supply were chosen for comparison in the studies. Critical effect: clinical selenosis (characteristic "garlic odor" of excess selenium excretion in the breath and urine, thickened and brittle nails, hair and nail loss, lowered hemoglobin levels, mottled teeth, skin lesions and CNS abnormalities) End point or Point of Departure (POD): NOAEL = 0.015 mg/kg-day; LOAEL = 1.26 mg Se/day. Uncertainty Factors: UF = 3 for intraspecies variability Source and date: IRIS, Last revision date - 9/01/1991. An EPA screening level in review in 2002 identified one or more significant new studies</p> <p>Tier 2 Sources: PPRTV: No PPRTV record is available at this time. MRL: Per ATSDR List, an oral chronic MRL = 5.0E-3 mg/kg-day was derived as follows: Critical Study: Yang G, Zhou R. 1994. Further observations on the human maximum safe dietary selenium intake in a seleniferous area of China. J Trace</p>		Complete



	Part 201 Value	Updated Value	Source/Reference/Date	Comments/Notes/Issues
		<p>Elem Electrolytes Health Dis 8:159-165.</p> <p>Method(s): This study was an examination of a group of five individuals who were recovering from selenosis, and who had been drawn from a larger population studied by the same authors (Yang et al. 1989a, 1989b). Yang et al. (1989a, 1989b) examined a population in an area of China where selenosis occurred. Data were collected on selenium levels in the diet, blood, nails, hair, urine, and milk of residents, and the incidence of clinical symptoms of selenosis (morphological changes in fingernails) was compared with dietary intake of selenium and selenium levels in blood.</p> <p>Critical effect: nail disease (selenosis)</p> <p>End point or Point of Departure (POD): NOAEL = NOAEL of 0.015 mg/kg/day for nail disease based on recovery from symptoms of selenosis</p> <p>Uncertainty Factors: UF = 3 for intraspecies variability</p> <p>Source and date: ATSDR, 9/2003</p> <p>Tier 3 Source: MDEQ: Per DEQ-CCD (3/27/1991), RRD adopted IRIS RfD. See Part 201 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: D; not classifiable as to carcinogenicity in humans</p> <p>IRIS WOE Basis: inadequate human data and inadequate evidence of carcinogenicity in animals</p> <p>Source and Date: IRIS, 7/01/1993</p> <p>Tier 1 and 2 Sources: IRIS: Per IRIS (7/01/1993), no value at this time. An EPA screening-level review in 2002 did not identify any critical new studies pertinent to the cancer assessment. PPRTV: No PPRTV record is available at this time. MRL: NA; MRLs are for non-cancer effects only.</p>		Complete



	Part 201 Value	Updated Value	Source/Reference/Date	Comments/Notes/Issues
		Tier 3 Source: MDEQ: Per DEQ-CCD, no value at this time.		
Reference Concentration (RfC) or Initial Threshold Screening Level (ITSL) ($\mu\text{g}/\text{m}^3$)	2.0E+0	2.0E+1	CALEPA, 1999	
RfC/ITSL details	Screening level was derived using the ACGIH TLV. CCD/AQD date: 3/24/1998	Tier 3 Source: CALEPA: Basis: CALEPA value is chosen as it is based on a published study. See details below. Tier 1 and 2 Sources: IRIS: Per IRIS (9/01/1991), no value at this time. PPRTV: No PPRTV record is available at this time. MRL: Per ATSDR List (12/2014), no inhalation MRL value at this time. Tier 3 Sources: MDEQ-QQD 3/24/1998: Screening level was derived using the ACGIH TLV. Updated file to include inorganic selenium compounds, which have the same TLV according to ACGIH. 8 hour averaging time noted. HEAST 1997: No available value. California EPA 1999: inhalation reference exposure level (REL) = $20 \mu\text{g}/\text{m}^3$. The inhalation chronic REL is based on the oral chronic REL, which is the same as the USEPA's oral reference dose (RfD) (U.S. EPA, 1996) Critical Study: Yang G, Zhou R, Yin S, and Gu L. 1989. Studies of safe maximal daily dietary selenium intake in a seleniferous area in China. I. Selenium intake and tissue selenium levels of the inhabitants. J. Trace Elem. Electrolytes Health Dis. 3:77-87. Methods: 400 people in China Average experimental exposure 70, 195, and 1438		Complete



	Part 201 Value	Updated Value	Source/Reference/ Date	Comments/Notes /Issues
		<p>µg/day for adult males; 62, 198, and 1238 µg/day for adult females; lifetime exposure</p> <p>Critical effect: clinical selenosis (liver, blood, skin. CNS)</p> <p>Point of Departure (POD): NOAEL 0.015 mg/kg/day (0.853 mg/kg / 55kg)</p> <p>Uncertainty factors: UF = 3; 3 for intraspecies variability</p> <p>Source and date: Appendix D.3 Chronic RELs and toxicity summaries using the previous version of the Hot Spots Risk Assessment guidelines (OEHHA 1999) page 476</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 and Texas, WHO (IARC), WHO (IPCS/INCHEM), Canada, The Netherlands (RIVM), and OECD HPV.</p>		
Inhalation Unit Risk Factor (IURF) ((µg/m³)⁻¹)	--	NA	MDEQ, 2015	
IURF details	NA	<p>Carcinogen Weight-of-Evidence (WOE) Class: D; not classifiable as to carcinogenicity in humans</p> <p>IRIS WOE Basis: inadequate human data and inadequate evidence of carcinogenicity in animals</p> <p>Source and Date: IRIS, 7/01/1993</p> <p>Tier 1 and 2 Sources:</p> <p>IRIS: Per IRIS (7/01/1993), no value at this time. An EPA screening-level review in 2002 did not identify any critical new studies pertinent to the cancer assessment.</p> <p>PPRTV: No PPRTV record is 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, 2014	



	Part 201 Value	Updated Value	Source/Reference/ Date	Comments/Notes /Issues
MMOA Details	--	Not listed as a carcinogen with mutagenic MOA in the USEPA OSWER List.		
Developmental or Reproductive Effector? (Y/N)	No	No, the RfD or RfC/ITSL is not based on a reproductive-developmental effect.	MDEQ, 2015	
Developmental or Reproductive Toxicity Details	NA	NA		
State Drinking Water Standard (SDWS) (ug/L)	50	50	SDWA, 1976	
SDWS details	SDWA, 1976	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	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)	---	0.01	MDEQ, 2015	
AE _d details				
Ingestion Absorption Efficiency (AE _i)		0.5	MDEQ, 2015	
AE _i Details				
Relative Source Contribution for Water (RSC _w)		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)	5
Updated GSI value (µg/L)	5
Rule 57 Drinking Water Value (µg/L)	120

	Rule 57 Value (µg/L)	Verification Date
Human Non-cancer Values- Drinking water source (HNV-drink)	120	4/1997
Human Non-Cancer Values- Non-drinking water sources (HNV-Non-drink)	2,700	4/1997
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)	5	7/1997
Aquatic maximum value (AMV)	62	8/1998
Final Acute Value (FAV)	120	8/1998

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 ($\mu\text{g}/\text{kg}$)	200	MDEQ, 2015
Target Detection Limit – Water ($\mu\text{g}/\text{L}$)	5	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