



CHEMICAL UPDATE WORKSHEET

Chemical Name:	Cyanide (DD)
CAS #:	57-12-5
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)	26.02	26.018	PP	EXP
Physical State at ambient temp	Inorganic	Inorganic	MDEQ	
Melting Point (°C)	---	NA	NA	
Boiling Point (°C)	---	NA	NA	
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)	NA	NR	NA	NA
Koc (organic carbon; L/Kg)	NA	NR	NA	NA
Ionizing Koc (L/kg)		NR	NA	NA
Diffusivity in Air (Di; cm²/s)	0.08	2.16E-01	W9	EST
Diffusivity in Water (Dw; cm²/s)	8.0E-6	2.5283E-05	W9	EST
Soil Water Partition Coefficient (Kd; inorganics)	NR	9.9E+00	SSG	EST

	Part 201 Value	Updated Value	Reference Source	Comments
Flash Point (°C)	NA	NA	NA	NA
Lower Explosivity Level (LEL; unit less)	NA	0.06	CRC	EXP
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)	5.4E-3	6.3E-4	IRIS, 2010	
RfD details	<p>2-year dietary ** study in rats (Howard & Hamzal, 1955) NOAEL=10.8 mg/kg-day; UF=100; MF=5 (Accounts for tolerance to CN when ingested w/food than when administered by gavage or drinking water. CCD/RRD date: 10/18/1999</p>	<p>Tier 1 Source: IRIS: Basis: IRIS is a tier 1 source. IRIS RfD = 6.3E-4 mg/kg-day. Critical Study: NTP. 1993. NTP Technical Report on toxicity studies of sodium cyanide (CAS No. 143-33-9) administered in drinking water to F344/N rats and B6C3F1 mice. Research Triangle Park, NC: National Toxicology Program, U.S. Department of Health and Human Services, Public Health Service, National Institutes of Health. NIH Publication 94-3386. Method(s): Rats and mice (10/sex/group) were exposed to sodium cyanide (NaCN) in drinking water for 13 weeks at doses 0, 0.16, 0.48, 1.4, 4.5, and 12.5 mg/kg-day CN⁻ in male rats; 0, 0.16, 0.53, 1.7, 4.9, and 12.5 mg/kg-day in female rats; 0, 0.26, 0.96, 2.7, 8.6, and 24.4 mg/kg-day CN⁻ in male mice; and 0, 0.32, 1.1, 3.3, 10.1, and 28.8 mg/kg-day in female mice. Critical effect: decreased cauda epididymis weight End point or Point of Departure (POD): BMD_{1SD} = 3.5 mg/kg-day; BMDL_{1SD} = 1.9 mg/kg-day (used to derive the RfD). Uncertainty Factors: UF = 3,000 (10 each for intraspecies variability, interspecies extrapolation and use of a sub chronic study, and 3 for database deficiencies) Source and date: IRIS, Last revision date - 9/28/2010. A Toxicological Review is available.</p> <p>NOTE: The IRIS RfD is for Hydrogen Cyanide and Cyanide Salts (CAS Nos:— 74-90-8; 143-33-9; 151-50-8; 506-61-6; 460-19-5)</p> <p>The RfDs for simple cyanide salts like NaCN and KCN, which freely dissociate into cyanide, are calculated from the RfD for CN⁻ by adjusting for molecular weight (i.e., the RfD is multiplied by the ratio of the total molecular weight of the compound to the molecular weight of the CN⁻):</p> <p>RfD for aqueous HCN [HCN(aq)] = $6.3 \times 10^{-4} \times 27/26 = 7 \times 10^{-4}$ mg/kg-day</p>		Complete



	Part 201 Value	Updated Value	Source/Reference/ Date	Comments/Notes /Issues
		<p>RfD for NaCN = $6.3 \times 10^{-4} \times 49/26 = 1 \times 10^{-3}$ mg/kg-day RfD for KCN = $6.3 \times 10^{-4} \times 65/26 = 2 \times 10^{-3}$ mg/kg-day RfD for calcium cyanide¹ [Ca(CN)₂] = $6.3 \times 10^{-4} \times 92/(2 \times 26) = 1 \times 10^{-3}$ mg/kg-day RfD for potassium silver cyanide² [KAg(CN)₂] = $6.3 \times 10^{-4} \times 199/26 = 5 \times 10^{-3}$ mg/kg-day RfD for cyanogen² (CN)₂ = $6.3 \times 10^{-4} \times 52/26 = 1 \times 10^{-3}$ mg/kg-day</p> <p>Use of the RfD for free cyanide to calculate RfDs of other cyanide compounds may be merited, but the ability of the individual cyanogenic species to dissociate and release free cyanide in aqueous solution (and at physiological pHs) should be taken into consideration. If dissociation of the compound is expected, then liberated cations should be considered for potential toxicity independent of CN⁻.</p> <p>Tier 2 Sources: PPRTV: No PPRTV record is available at this time. MRL: Per ATSDR (7/2006), no oral chronic MRL value at this time. Oral intermediate MRL for sodium cyanide = 0.05 mg/kg-day (5.0E-2 mg/kg-day): Critical Study: NTP. 1993. NTP technical report on toxicity studies of sodium cyanide administered in drinking water to F344/N rats and B6C3F1 mice. Toxicity Report No. 37. National Toxicology Program, U.S. Department of Health and Human Services, Public Health Service, National Institutes of Health. NIH Publication 94-3386. Method(s): Rats (10/sex/group) were given drinking water containing sodium cyanide at concentrations of 0, 3, 10, 30, 100, or 300 ppm for 13 weeks. A supplemental set of 10 males/group was assigned for interim examinations of hematology, clinical chemistry, and urinalysis examinations. The intakes of cyanide during that period averaged 0, 0.2, 0.5, 1.4 (males) or 1.7 (females), 4.5 (males) or 4.9 (females), or 12.5 mg/kg/day, respectively. Critical effect: mild adverse effect on the male reproductive system End point or Point of Departure (POD): NOAEL = 4.5 mg/kg-day Uncertainty Factors: UF = 100 (10 each for intraspecies variability and interspecies extrapolation) Source and date: ATSDR, 7/2006.</p>		



	Part 201 Value	Updated Value	Source/Reference/Date	Comments/Notes/Issues
		<p>Tier 3 Source: MDEQ: Per DEQ-CCD/RRD (10/18/1999), RfD = 5.4E-3 mg/kg-day. See Part 201 Value RfD details.</p> <p>MDEQ: An acute RfD and scenario was used to calculate the residential soil direct contact value (DCV) for cyanide. See 1999 toxicological assessment and 2016 addendum for basis of the acute RfD = 5.4E-3 mg/kg and calculation of the soil DCC.</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 the carcinogenic potential”.</p> <p>IRIS WOE Basis: Studies examining cancer incidence in occupationally exposed cyanide workers are not available. Studies of cancer in populations exposed to thiocyanate via diet were limited to examinations of thyroid cancer and results are generally not positive (Bosetti et al., 2002; Kolonel et al., 1990), although one recent case control study has associated high consumption of goitrogenic food and low iodine intake with increased incidence of thyroid cancer in women (Truong et al., 2010). The only available chronic animal study of cyanide that analyzed a wide variety of tissues is an oral study in rats (Howard and Hanzal, 1955), in which tumors or lesions were not associated with either dose group following dietary administration of cyanide at doses up to 10.8 mg/kg-day for 2 years.</p> <p>Source and Date: IRIS, Last revision date - 9/28/2010. A Toxicological Review is available.</p> <p>Tier 1 and 2 Sources: IRIS: Per IRIS (9/28/2010), no value at this time. 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) ($\mu\text{g}/\text{m}^3$)	50	8.0E-1	IRIS, 2010	
RfC/ITSL details	ITSL is based on 1 % of NIOSH REL of $5 \text{ mg}/\text{m}^3$. CCD/AQD date: 5/05/1993	<p>Tier 1 Source: IRIS: Basis: IRIS is a tier 1 value. IRIS RfC = $8\text{E}-1 \mu\text{g}/\text{m}^3$: Critical Study: El Ghawabi SH, Gaafar MA, El-Saharti AA, et al. 1975. Chronic cyanide exposure: A clinical, radioisotope, and laboratory study. Br J Ind Med 32:215-219. Method(s): occupational epidemiology study; self-reported increased incidence of headache, weakness, and sensory changes for taste and smell in workers (n = 36) exposed to HCN for 5–15 years in three electroplating factories. Individual breathing zone measurements of HCN were collected from each worker. The mean concentrations across factories ranged from 7.07 to 11.5 mg/m^3 HCN and the values for individual workers ranged from 4.6 to 13.7 mg/m^3 HCN. The exposure durations used for exposed workers assumed an 8-hour/day, 5-day/week exposure scenario. The LOAEL of 7.07 $\text{mg HCN}/\text{m}^3$ was adjusted for daily exposure duration using a default occupational ventilation rate of $10 \text{ m}^3/8\text{-hour day}$ and a default ventilation rate for continuous ambient exposure of $20 \text{ m}^3/24\text{-hour day}$. Critical effect: thyroid enlargement and altered iodide uptake End point or Point of Departure (POD): LOAEL = $7.07 \text{ mg}/\text{m}^3$; LOAEL_{ADJ} = $2.5 \text{ mg}/\text{m}^3$ (used to derive the RfD). Uncertainty Factors: UF = 3,000 (10 each for intraspecies variability, LOAEL to NOAEL extrapolation, and database deficiencies use, and 3 for sub chronic to chronic exposure.) Source and date: IRIS, Last revision date - 9/28/2010. A Toxicological Review is available.</p>		Complete



	Part 201 Value	Updated Value	Source/Reference/Date	Comments/Notes/Issues
		<p>Tier 1 and 2 Sources: PPRTV: No PPRTV record is available at this time. MRL: Per ATSDR (12/2014), no inhalation MRLs at this time.</p> <p>Tier 3 Source: MDEQ: Per DEQ-CCD/AQD (5/05/1993), RfC = 5.0E+1 µg/m³. See Part 201 Value RfC/ITSL details.</p>		
Inhalation Unit Risk Factor (IURF) ((µg/m³)⁻¹)	--	NA	MDEQ,2015	
IURF details	NA	<p>Carcinogen Weight-of-Evidence (WOE) Class: “inadequate information to assess the carcinogenic potential” IRIS WOE Basis: Studies examining cancer incidence in occupationally exposed cyanide workers are not available. Studies of cancer in populations exposed to thiocyanate via diet were limited to examinations of thyroid cancer and results are generally not positive (Bosetti et al., 2002; Kolonel et al., 1990), although one recent case control study has associated high consumption of goitrogenic food and low iodine intake with increased incidence of thyroid cancer in women (Truong et al., 2010). The only available chronic animal study of cyanide that analyzed a wide variety of tissues is an oral study in rats (Howard and Hanzal, 1955), in which tumors or lesions were not associated with either dose group following dietary administration of cyanide at doses up to 10.8 mg/kg-day for 2 years. Source and Date: IRIS, Last revision date - 9/28/2010. A Toxicological Review is available.</p> <p>Tier 1 and 2 Sources: IRIS: Per IRIS (9/28/2010), 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:</p>		Complete



	Part 201 Value	Updated Value	Source/Reference/ Date	Comments/Notes /Issues
		MDEQ: Per DEQ-CCD, no value at this time.		
Mutagenic Mode of Action (MMOA)? (Y/N)	--	NO	USEPA, 2015	
MMOA Details	--	NA Not listed as a carcinogen with mutagenic MOA in the USEPA OSWER List.		
Developmental or Reproductive Effector? (Y/N)	No	YES - oral; the RfD is based on a reproductive-developmental effect. Oral Exposure Pathways- Full Term Exposure No for inhalation exposure. The RfC is not based on a reproductive-developmental effect.	MDEQ, 2015	
Developmental or Reproductive Toxicity Details	NA	<p>Critical effect: decreased cauda epididymis weight</p> <p>Critical Study: NTP. 1993. NTP Technical Report on toxicity studies of sodium cyanide (CAS No. 143-33-9) administered in drinking water to F344/N rats and B6C3F1 mice. Research Triangle Park, NC: National Toxicology Program, U.S. Department of Health and Human Services, Public Health Service, National Institutes of Health. NIH Publication 94-3386.</p> <p>Method(s): Rats and mice (10/sex/group) were exposed to sodium cyanide (NaCN) in drinking water for 13 weeks at doses 0, 0.16, 0.48, 1.4, 4.5, and 12.5 mg/kg-day CN⁻ in male rats; 0, 0.16, 0.53, 1.7, 4.9, and 12.5 mg/kg-day in female rats; 0, 0.26, 0.96, 2.7, 8.6, and 24.4 mg/kg-day CN⁻ in male mice; and 0, 0.32, 1.1, 3.3, 10.1, and 28.8 mg/kg-day in female mice.</p> <p>An acute RfD of 5.4E-3 was used generate an acute soil DCC for a young child. See 1999 toxicological assessment and 2016 addendum.</p>		
State Drinking Water Standard (SDWS) (ug/L)	2.0E+2	2.0E+2	SDWA, 1976	
SDWS details	SDWA, 1976	MI Safe Drinking Water Act (SDWA) 1976 PA 399		
Secondary Maximum Contaminant Level	--	NO	SDWA, 1976 and USEPA SMCL List, 2015	

	Part 201 Value	Updated Value	Source/Reference/ Date	Comments/Notes /Issues
(SMCL) (ug/L)				
SMCL details	NA	SDWA, 1976 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)		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)	5.2
Updated GSI value (µg/L)	5.2
Rule 57 Drinking Water Value (µg/L)	600

	Rule 57 Value (µg/L)	Verification Date
Human Non-cancer Values- Drinking water source (HNV-drink)	600	7/1997
Human Non-Cancer Values- Non-drinking water sources (HNV-Non-drink)	48,000	7/1997
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)	5.2	7/1997
Aquatic maximum value (AMV)	22	7/1997
Final Acute Value (FAV)	44	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 ($\mu\text{g}/\text{kg}$)	100	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