



## CHEMICAL UPDATE WORKSHEET

<b>Chemical Name:</b>	<b>Cobalt</b>
<b>CAS #:</b>	<b>7440-48-4</b>
<b>Revised By:</b>	RRD Toxicology Unit
<b>Revision Date:</b>	August 17, 2015

### (A) Chemical-Physical Properties

	Part 201 Value	Updated Value	Reference Source	Comments
<b>Molecular Weight (g/mol)</b>	58.933	58.93	EPI	EXP
<b>Physical State at ambient temp</b>	Inorganic	Inorganic	MDEQ	
<b>Melting Point (°C)</b>	---	1495	HSDB	EXP
<b>Boiling Point (°C)</b>	3100	2927	HSDB	EXP
<b>Solubility (ug/L)</b>	NA	NA	NA	NA
<b>Vapor Pressure (mmHg at 25°C)</b>	NA	NR	NA	NA
<b>HLC (atm-m<sup>3</sup>/mol at 25°C)</b>	NR	NR	NA	NA
<b>Log Kow (log P; octanol-water)</b>	NR	NR	NA	NA
<b>Koc (organic carbon; L/Kg)</b>	NR	NR	NA	NA
<b>Ionizing Koc (L/kg)</b>		NR	NA	NA
<b>Diffusivity in Air (Di; cm<sup>2</sup>/s)</b>	NR	NR	NA	NA
<b>Diffusivity in Water (Dw; cm<sup>2</sup>/s)</b>	NR	NR	NA	NA
<b>Soil Water Partition Coefficient (Kd; inorganics)</b>	NA	NA	NA	NA

	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 <sup>3</sup> )		NR	NA	NA
EMSOFT Flux Residential 2 m (mg/day/cm <sup>2</sup> )	NA	NR	EMSOFT	NA
EMSOFT Flux Residential 5 m (mg/day/cm <sup>2</sup> )	NA	NR	EMSOFT	NA
EMSOFT Flux Nonresidential 2 m (mg/day/cm <sup>2</sup> )	NA	NR	EMSOFT	NA
EMSOFT Flux Nonresidential 5 m (mg/day/cm <sup>2</sup> )	NA	NR	EMSOFT	NA

**(B) Toxicity Values/Benchmarks**

	Part 201 Value	Updated Value	Source/Reference/Date	Comments/Notes/Issues
<b>Reference Dose (RfD) (mg/kg/day)</b>	5.0E-3	3.0E-4	PPRTV, 2008/MDEQ 2015	
<b>RfD details</b>	<p>16-week, in-feed rat study, NOAEL=5 mg/kg-day, UF=1000; Critical effect = testicular atrophy (Nation et al., 1983).</p> <p>CCD/ERD date: 7/27/1994</p>	<p><b>Tier 2 Source:</b>  <b>PPRTV:</b>  <b>Basis:</b> No tier 1 value available. PPRTV p-RfD = 3.0E-4 mg/kg-day.  <b>Critical Study:</b> Roche, M. and M. Layrisse. 1956. Effect of cobalt on thyroidal uptake of I131. J. Clin. Endocrinol. Metab. 16:831-833.  <b>Method(s):</b> Twelve euthyroid (normal thyroid) patients were treated with 150 mg cobalt chloride/day (equivalent to 1 mg cobalt/kg-day, assuming a body weight of 70 kg) for 2 weeks resulted in a greatly reduced uptake of 48-hour radioactive iodine by the thyroid when measured after 1 week of exposure to cobalt, with uptake nearly abolished completely by the second week of exposure to cobalt. When cobalt treatment was discontinued, iodine uptake returned to pre-treatment reported values.  <b>Critical effect:</b> decreased iodine uptake in human thyroid  <b>End point or Point of Departure (POD):</b> LOAEL = 1 mg/kg-day  <b>Uncertainty Factors:</b> PPRTV UF = 300; MDEQ added additional 10-fold factor for use of a subchronic study: MDEQ UF = 3,000 (10 each for interspecies variability, use of a LOAEL, use of a subchronic study, and 3 for database deficiencies)  <b>Source and date:</b> PPRTV, 8/25/2008</p> <p><b>Tier 1 and 2 Sources:</b>  <b>IRIS:</b> No IRIS file available at this time.  <b>MRL:</b> Per ATSDR (10/2004), no oral chronic MRL at this time. An oral intermediate MRL = 0.01 mg/kg-day is available:  <b>Critical Study:</b> Davis, J.E. and Fields, J.P. 1958. Experimental production of polycythemia in humans by administration of cobalt chloride. Proc Soc Exp Biol Med 99:493-495.  <b>Method(s):</b> Six apparently normal men, ages 20–47, were administered a daily dose of cobalt chloride, administered as a 2% solution diluted in either water or milk, for up to 22 days. Five of the six received 150 mg cobalt chloride per day for</p>		Complete

	Part 201 Value	Updated Value	Source/Reference/ Date	Comments/Notes /Issues
		<p>the entire exposure period, while the sixth was started on 120 mg/day and later increased to 150 mg/day.</p> <p><b>Critical effect:</b> hematological effects (increased levels of erythrocytes)</p> <p><b>End point or Point of Departure (POD):</b> LOAEL = 150 mg cobalt chloride per day (available animal studies support the LOAEL).</p> <p><b>Uncertainty Factors:</b> UF = 100 (10 each for interspecies variability and use of a LOAEL)</p> <p><b>Source and date:</b> ATSDR, 10/2004</p> <p><b>Tier 3 Source:</b>  <b>MDEQ:</b> Per DEQ-CCD/RRD (7/27/1994), RfD = 5.0E-3 mg/kg-day. See Part 201 Value RfD details.</p>		
<b>Oral Cancer Slope Factor (CSF) (mg/kg-day)<sup>-1</sup></b>	--	NA	MDEQ, 2015	
<b>CSF details</b>	NA	<p><b>Carcinogen Weight-of-Evidence (WOE) Class:</b> "likely to be carcinogenic to humans by the inhalation route,"</p> <p><b>IRIS WOE Basis:</b> limited evidence of carcinogenicity in humans and sufficient evidence of carcinogenicity in animals as shown by a statistically significant increased incidence of alveolar/bronchiolar tumors in both sexes of rats and mice, pheochromocytomas in female rats, and hemangiosarcomas in male mice (Bucher et al., 1999).</p> <p><b>Source and Date:</b> PPRTV, 8/25/2008</p> <p><b>Tier 1 and 2 Sources:</b>  <b>IRIS:</b> No IRIS file available at this time.  <b>PPRTV:</b> Per PPRTV (8/25/2008), no value at this time.  <b>MRL:</b> NA; MRLs are for non-cancer effects only.</p> <p><b>Tier 3 Source:</b>  <b>MDEQ:</b> Per DEQ-CCD, no value at this time.</p>		Complete
<b>Reference Concentration</b>	2.0E-1	6.0E-3	PPRTV, 2008	

	Part 201 Value	Updated Value	Source/Reference/ Date	Comments/Notes /Issues
<b>(RfC) or Initial Threshold Screening Level (ITSL) (<math>\mu\text{g}/\text{m}^3</math>)</b>				
<b>RfC/ITSL details</b>	<p>ITSL based on 1% of the 1994-1995 ACGIH TLV per R230 (8) (b) and R232 (1) (c) (UF=100); critical effects are respiratory [specifically, asthma in exposed workers] (Kusaka et al., 1986).                      CCD/AQD date: 5/15/1995</p>	<p><b>Tier 2 Source:</b>  <b>PPRTV:</b>  <b>Basis:</b> PPRTV is a tier 2 source, no tier 1 value available. PPRTV Chronic p-RfC = <math>6.0\text{E}-6 \text{ mg}/\text{m}^3</math>.  <b>Critical Study:</b> Nemery, B., P. Casier, D. Roosels et al. 1992. Survey of cobalt exposure and respiratory health in diamond polishers. Am. Rev. Resp. Disease 145:610-616.  <b>Method(s):</b> Cross-sectional study of cobalt exposure and respiratory effects in diamond polishers who were primarily exposed to metallic cobalt-containing dust; species of cobalt in the dust samples were not identified. The study group was composed of 194 polishers working in 10 different workshops. In two of these workshops (#1, 2), the workers used cast iron polishing disks almost exclusively, and in the others, they primarily used cobalt-containing disks. The number of subjects from each workshop varied from 6 to 28 and the participation rate varied from 56 to 100%. The low participation in some workshops reflects the fact that only workers who used cobalt disks were initially asked to be in the study; low participation is not due to a high refusal rate (only eight refusals were documented). More than a year after the polishing workshops were studied, an additional three workshops with workers engaged in sawing diamonds, cleaving diamonds or drawing jewelry were studied as an unexposed control group (n=59 workers).  <b>Critical effect:</b> decreased pulmonary function and respiratory tract irritation  <b>End point or Point of Departure (POD):</b> NOAEL = <math>5.3 \mu\text{g}/\text{m}^3</math>; NOAEL<sub>ADJ</sub> = <math>1.9 \mu\text{g}/\text{m}^3</math>  <b>Uncertainty Factors:</b> UF = 300 (10 each for interspecies variability and database deficiencies, and 3 for sub chronic to chronic exposure extrapolation)  <b>Source and date:</b> PPRTV, 8/25/2008</p> <p><b>Tier 1 and 2 Sources:</b></p>		Complete



	Part 201 Value	Updated Value	Source/Reference/Date	Comments/Notes/Issues
		<p><b>IRIS:</b> No IRIS file available at this time.</p> <p><b>MRL:</b> Per ATSDR List (10/2004), inhalation chronic MRL = 1.0E-4 mg/m<sup>3</sup> or 1.0E-1 µg/m<sup>3</sup>:</p> <p><b>Critical Study:</b> Nemery B, Casier P, Roosels D, et al. 1992. Survey of cobalt exposure and respiratory health in diamond polishers. Am Rev Respir Dis 145:610-616.</p> <p><b>Method(s):</b> A cross-sectional study of cobalt exposure and respiratory effects in diamond polishers. The study group was composed of 194 polishers working in 10 different workshops. In two of these workshops (#1, 2), the workers used cast iron polishing disks almost exclusively, and in the others, they used cobalt-containing disks primarily. The number of subjects from each workshop varied from 6 to 28 and the participation rate varied from 56 to 100%. The low participation in some workshops reflects the fact that only workers who used cobalt disks were initially asked to be in the study, rather than a high refusal rate (only eight refusals were documented). More than a year after the polishing workshops were studied, an additional three workshops with workers engaged in sawing diamonds, cleaving diamonds, or drawing jewelry were studied as an unexposed control group (n=59 workers).</p> <p><b>Critical effect:</b> pulmonary function effects (decreased values upon spirometric examination).</p> <p><b>End point or Point of Departure (POD):</b> NOAEL = 0.0053 mg cobalt/m<sup>3</sup>; adjusted NOAEL = 0.0013 mg cobalt/m<sup>3</sup></p> <p><b>Uncertainty Factors:</b> UF = 10 for interspecies variability.</p> <p><b>Source and date:</b> ATSDR, 10/2004.</p> <p><b>Tier 3 Source:</b>  <b>MDEQ:</b> Per DEQ-CCD/AQD (date), RfC = 2.0E-1 µg/m<sup>3</sup>. See Part 201 Value RfC details.</p>		
Inhalation Unit Risk Factor (IURF) ((µg/m <sup>3</sup> ) <sup>-1</sup> )	--	9.0E-3	PPRTV, 2008	
IURF details	NA	<p><b>Tier 2 Source:</b>  <b>PPRTV:</b></p>		



	Part 201 Value	Updated Value	Source/Reference/ Date	Comments/Notes /Issues
		<p><b>Basis:</b> PPRTV is a tier 2 source, no tier 1 value available. PPRTV provisional IUR = 9.0 (mg/m<sup>3</sup>)<sup>-1</sup></p> <p><b>Critical Study(ies):</b></p> <p>1) NTP (National Toxicology Program). 1998. Toxicology and Carcinogenicity Studies of Cobalt Sulfate Heptahydrate (CAS No. 10026-24-1) in F344/N Rats and B6C3F1 Mice (Inhalation studies). U.S. Dept. of Health and Human Services, Public Health Service, National Institutes of Health. NTP Technical Report Series, No. 471.</p> <p>2) Bucher, J.R., J.R. Hailey, J.R. Roycroft et al. 1999. Inhalation toxicity and carcinogenicity studies of cobalt sulfate. Toxicol. Sci. 49:56-67.</p> <p><b>Method(s):</b> BMR = 0.1; BMDL = 0.011</p> <p>1) <i>Dose response data: Tumor Type – lung tumors; Test Species – rats, female; Route - inhalation</i></p> <p>2) <i>Extrapolation method: linear extrapolation of the BMDL to zero exposure level (in the absence of mode of action data to inform the low dose extrapolation for cobalt)</i></p> <p><b>Carcinogen Weight-of-Evidence (WOE) Class:</b> “likely to be carcinogenic to humans by the inhalation route,”</p> <p><b>IRIS WOE Basis:</b> limited evidence of carcinogenicity in humans and sufficient evidence of carcinogenicity in animals as shown by a statistically significant increased incidence of alveolar/bronchiolar tumors in both sexes of rats and mice, pheochromocytomas in female rats, and hemangiosarcomas in male mice (Bucher et al., 1999).</p> <p><b>Source and Date:</b> PPRTV, 8/25/2008</p> <p><b>Tier 1 and 2 Sources:</b></p> <p><b>IRIS:</b> No IRIS file available at this time.</p> <p><b>MRL:</b> NA; MRLs are for non-cancer effects only.</p> <p><b>Tier 3 Source:</b></p> <p><b>MDEQ:</b> Per DEQ-CCD, no value at this time.</p>		Complete
<b>Mutagenic Mode of Action</b>	--	NO	USEPA, 2015	



	Part 201 Value	Updated Value	Source/Reference/ Date	Comments/Notes /Issues
(MMAO)? (Y/N)				
<b>MMAO Details</b>	--	NA Not listed as a carcinogen with mutagenic MOA in the USEPA OSWER List.		
<b>Developmental or Reproductive Effector? (Y/N)</b>	No	No. The RfD and ITSL are not based on a reproductive-developmental effect.	MDEQ, 2015	
<b>Developmental or Reproductive Toxicity Details</b>	NA	NA		
<b>State Drinking Water Standard (SDWS) (ug/L)</b>	--	NO	SDWA, 1976	
<b>SDWS details</b>	NA	MI Safe Drinking Water Act (SDWA) 1976 PA 399		
<b>Secondary Maximum Contaminant Level (SMCL) (ug/L)</b>	--	NO	SDWA, 1976 and USEPA SMCL List, 2015	
<b>SMCL details</b>	NA	SDWA, 1976 and USEPA SMCL List, 2015		
<b>Is there an aesthetic value for drinking water? (Y/N)</b>	NO	Not evaluated.	NA	
<b>Aesthetic value (ug/L)</b>	NA	NA	NA	
<b>Aesthetic Value details</b>	NA	NA		
<b>Phytotoxicity Value? (Y/N)</b>	NO	Not evaluated.	NA	
<b>Phytotoxicity details</b>	NA	NA	NA	
<b>Others</b>				

**(C) Chemical-specific Absorption Factors**

	Part 201 Value	Update	Source/Reference/ Dates	Comments/Notes /Issues
Gastrointestinal absorption efficiency value (ABS <sub>gi</sub> )	---	1.0	MDEQ, 2015/USEPA RAGS-E, 2004	
ABS <sub>gi</sub> details		RAGS E (USEPA, 2004) Default Value		
Skin absorption efficiency value (AE <sub>d</sub> )	---	0.01	MDEQ, 2015	
AE <sub>d</sub> details				
Ingestion Absorption Efficiency (AE <sub>i</sub> )		0.5	MDEQ, 2015	
AE <sub>i</sub> Details				
Relative Source Contribution for Water (RSC <sub>w</sub> )		0.2	MDEQ, 2015	
Relative Source Contribution for Soil (RSC <sub>s</sub> )		1.0	MDEQ, 2015	
Relative Source Contribution for Air (RSC <sub>A</sub> )		1.0	MDEQ, 2015	
Others				

**(D) Rule 57 Water Quality Values and GSI Criteria**

<b>Current GSI value (µg/L)</b>	100
<b>Updated GSI value (µg/L)</b>	100
<b>Rule 57 Drinking Water Value (µg/L)</b>	100

	<b>Rule 57 Value (µg/L)</b>	<b>Verification Date</b>
<b>Human Non-cancer Values- Drinking water source (HNV-drink)</b>	ID* (100)	7/1998
<b>Human Non-Cancer Values- Non-drinking water sources (HNV-Non-drink)</b>	ID* (100)	7/1998
<b>Wildlife Value (WV)</b>	NA	NA
<b>Human Cancer Values for Drinking Water Source (HCV-drink)</b>	NA	NA
<b>Human Cancer values for non-drinking water source (HCV-Non-drink)</b>	NA	NA
<b>Final Chronic Value (FCV)</b>	100	4/1998
<b>Aquatic maximum value (AMV)</b>	370	4/1998
<b>Final Acute Value (FAV)</b>	740	4/1998

Sources:

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

**(E) Target Detection Limits (TDL)**

	<b>Value</b>	<b>Source</b>
<b>Target Detection Limit – Soil (<math>\mu\text{g}/\text{kg}</math>)</b>	500	MDEQ, 2015
<b>Target Detection Limit – Water (<math>\mu\text{g}/\text{L}</math>)</b>	20	MDEQ, 2015
<b>Target Detection Limit – Air (ppbv)</b>	NA	MDEQ, 2015
<b>Target Detection Limit – Soil Gas (ppbv)</b>	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