# CHEMICAL UPDATE WORKSHEET

| | |
|---|---|
| **Chemical Name:** | **Chromium VI** |
| **CAS #:** | **18540-29-9** |
| **Revised By:** | RRD Toxicology Unit |
| **Revision Date:** | August 18, 2015 |

## (A) Chemical-Physical Properties

| | Part 201 Value | Updated Value | Reference Source | Comments |
|---|---|---|---|---|
| **Molecular Weight (g/mol)** | 51.996 | 51.996 | PP | EXP |
| **Physical State at ambient temp** | Inorganic | Inorganic | MDEQ | |
| **Melting Point (˚C)** | --- | 1900 | PP | EXP |
| **Boiling Point (˚C)** | --- | 2642 | 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; $cm^2/s$)** | NR | NR | NA | NA |
| **Diffusivity in Water (Dw; $cm^2/s$)** | NR | NR | NA | NA |
| **Soil Water Partition Coefficient (Kd; inorganics)** | 19 | 1.9E+01 | SSG | 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)** | 4.8E-3 | 9.0E-4 | ATSDR, 2012 | |
| **RfD details** | Rat 1-year drinking water study, no effects reported (Mackenzie et al, 1958). NOAEL = 2.4 mg/kg/d, UF = 500. IRIS RfD = 5E-3 due to rounding to 1 significant figure. CCD/RRD date: 9/27/1993 | **Tier 2 Source:**<br>**ATSDR:**<br>**Basis:** ATSDR is more current than IRIS.<br>**ATSDR** (9/2012) RfD **=** 9.0E-4 mg/kg-day.<br>**Critical Study**: NTP. 2008a. NTP technical report on the toxicology and carcinogenesis studies of sodium dichromate dihydrate (CAS No. 7789-12-0) in F344/N rats and B6C3F1 mice (drinking water studies). Washington, DC: National Toxicology Program. NTP TR 546. http://ntp.niehs.nih.gov/files/546_web_FINAL.pdf. August 13, 2008.<br>**Methods**: F344/N rats (50/sex/group) and B6C3F1 mice (50/sex/group) were exposed to sodium dichromate dihydrate in drinking water for 2 years. Rats and female mice were exposed to drinking water concentrations of 0, 14.3, 57.3, 172, or 516 mg/L. Calculated equivalent mean daily doses in male rats were 0, 0.21, 0.77, 2.1, or 5.9 mg chromium(VI)/kg/day, in female rats: 0, 0.24, 0.94, 2.4, and 7.0 mg chromium(VI)/kg/day, respectively, and in female mice: 0, 0.38, 1.4, 3.1, or 8.7 mg chromium(VI)/kg/day, respectively. Male mice were exposed to 0, 14.3, 28.6, 85.7, or 257.4 mg sodium dichromate dihydrate/L. Equivalent doses were 0, 0.38, 0.91, 2.4, and 5.9 mg chromium(VI)/kg/day, respectively.<br>**Critical effect**: diffuse epithelial hyperplasia of the duodenum (in female mice)<br>**End point or Point of Departure (POD):** $BMDL_{10}$ = 0.09 mg/kg-day<br>**Uncertainty Factors**: UF = 100 (10 each for interspecies variability and interspecies extrapolation)<br>**Source and date:** ATSDR, 09/2012. A Toxicological Profile is available.<br><br>**Tier 1 and 2 Sources**:<br>**IRIS:** Per IRIS (9/03/1998), RfD = 3.0E-3 mg/kg-day.<br>**Critical Study***:* MacKenzie, RD; Byerrum, RU; Decker, CF, et al. (1958) Chronic toxicity studies. II. Hexavalent and trivalent chromium administered in drinking water to rats. Am Med Assoc Arch Ind Health 18:232-234. | | Complete |

| | Part 201 Value | Updated Value | Source/Reference/Date | Comments/Notes/Issues |
|---|---|---|---|---|
| | | **Method(s):** Sprague-Dawley rats (12 males, 8 female) were administered K2CrO4 in drinking water at doses of 0 or 25 mg/L for 1 year.<br>**Critical effect:** none reported<br>**End point or Point of Departure (POD):** NOAEL = 25 mg K2CrO4/L. Adjusted NOAEL = 2.5 mg/kg/day (assumes 0.35 kg body weight and 0.035 L drinking water consumption per day).<br>**Uncertainty Factors:** UF = 1,000 (10 each for interspecies variability and interspecies extrapolation, and 3 each for use of a sub chronic study and undefined concerns)<br>Per **IRIS Toxicological Review - External Draft (9/30/2010),** RfD = 9.0E-4 mg/kg-day. As of 2/2015, the new draft has not been released and per IRIS Track, the projected final date is 2016.<br>**Critical Study***:* NTP. 2008a. NTP technical report on the toxicology and carcinogenesis studies of sodium dichromate dihydrate (CAS No. 7789-12-0) in F344/N rats and B6C3F1 mice (drinking water studies). Washington, DC: National Toxicology Program. NTP TR 546.<br>**Method(s):** 2-year drinking water study in F344/N rats and B6C3F1 mice<br>**Critical effect:** diffuse epithelial hyperplasia in the duodenum of female mice<br>**End point or Point of Departure (POD):** $BMDL_{10}$ = 0.09 mg/kg-day<br>**Uncertainty Factors:** UF = 100 (10 each for interspecies variability and interspecies extrapolation)<br><br>**PPRTV:** No PPRTV record available at this time.<br><br>**Tier 3 Source:**<br>**MDEQ:** Per DEQ-CCD/RRD (9/27/1993), RfD = 4.8E-3 mg/kg-day. See Part 201 Value RfD details. | | |
| **Oral Cancer Slope Factor (CSF) ((mg/kg-day)$^{-1}$)** | NA | 5.0E-1 | IRIS, 2010 | |
| **CSF details** | NA | **Tier 1 Source:**<br>**IRIS:**<br>**Basis:** IRIS is the only available value and a Tier 1 source. | | Complete |

| | Part 201 Value | Updated Value | Source/Reference/Date | Comments/Notes/Issues |
|---|---|---|---|---|
| | | Per IRIS Toxicological Review - External Draft (9/30/2010), CSF = 5.0E-1 (mg/kg-day)$^{-1}$.<br>**Critical Study**: NTP. 2008a. NTP technical report on the toxicology and carcinogenesis studies of sodium dichromate dihydrate (CAS No. 7789-12-0) in F344/N rats and B6C3F1 mice (drinking water studies). Washington, DC: National Toxicology Program. NTP TR 546.<br>**Method(s)**: 2-year drinking water study in F344/N rats and B6C3F1 mice<br>1. *Dose response data*: *Tumor Type* - small intestine tumors; *Test Species* - mice, male; *Route* - oral<br>2. *Extrapolation method*: two-stage multistage model<br>**Carcinogen Weight-of-Evidence (WOE) Class**: "likely to be carcinogenic to humans" via the oral route of exposure<br>**IRIS WOE Basis**: Statistically significant increase in the incidence of tumors of the oral mucosa and tongue of rats and of the small intestine of mice; and evidence of an association between oral exposure to hexavalent chromium and stomach cancer in humans. Additionally, available evidence indicates that chromium interacts with DNA, resulting in DNA damage and mutagenesis. Thus, hexavalent chromium is proposed to induce carcinogenicity via a mutagenic mode of action. (IRIS, 2010)<br>**Source and Date**: IRIS Toxicological Review - External Draft, 9/30/2010<br><br>**Tier 1 and 2 Sources**:<br>**IRIS:** Per IRIS record (9/03/1998), no value at this time.<br>**PPRTV:** No PPRTV record available at this time.<br>**MRL:** NA; MRLs are for non-cancer effects only.<br><br>**Tier 3 Source:**<br>**MDEQ:** Per DEQ-CCD, no value at this time. | | |
| **Reference Concentration (RfC) or Initial Threshold Screening Level (ITSL) (µg/m³)** | 8.0E-3 | 5.0E-3 | ATSDR, 2012 | |

| | Part 201 Value | Updated Value | Source/Reference/Date | Comments/Notes/Issues |
|---|---|---|---|---|
| **RfC/ITSL details** | EPA RfC based on nasal septum pathology from occupational exposure reported by Lindberg and Hedenstierna (1983). LOAEL of 2 ug/m3 for chromium VI acid mist and dissolved aerosols resulted in RfC of 0.008 ug/$m^3$. There is also an RfC for particulate chromium VI of 0.1 ug/$m^3$ based on rat lavage fluid changes reported by Malsch et al (1994). NOTE: there is another/different ITSL for chromium VI particulate under this same CAS number. CCD/AQD date: 9/03/1998. | **Tier 2 Source:**<br>**ATSDR:**<br>**Basis:** ATSDR is a more current evaluation than IRIS.<br>**ATSDR** chronic (and intermediate) inhalation MRL for aerosol mists = 5.0E-6 mg/$m^3$<br>**Critical Study**: Lindberg E, Hedenstierna G. 1983. Chrome plating: Symptoms, findings in the upper airways, and effects on lung function. Arch Environ Health 38:367-374.<br>**Methods**: Eighty-five male and 19 female chrome-plating workers exposed to chromic acid were assessed for nose, throat, and chest symptoms, were inspected for effects in nasal passages, and were given pulmonary function tests. The reference group consisted of 119 auto mechanics that were not exposed to chromium. The length of worker exposures ranged from 0.1 to 36 years. Chromium exposures were measured using personal air samplers and stationary equipment positioned close to the baths containing chromic acid. The exposure categories were defined as high (average daily concentrations >0.002 mg chromium (VI)/$m^3$), low (average daily concentrations <0.002 mg chromium (VI)/m3), and mixed category (chromium (VI) was <0.002 mg chromium(VI)/m3, with exposure to other acids and metallic salts).<br>**Critical effect**: nasal irritation, mucosal atrophy, and ulceration, and decreased spirometric parameters (forced vital capacity, forced expired volume in 1 second, and forced mid-expiratory flow)<br>**End point or Point of Departure (POD):** LOAEL = 0.002 mg/$m^3$; $LOAEL_{ADJ}$ for continuous exposure = 0.0005 mg/$m^3$<br>**Uncertainty Factors**: UF = 100 (10 each for interspecies variability and use of a LOAEL)<br>**Source and date:** ATSDR, 9/2012. A Toxicological Profile is available.<br><br>**Tie 1 and 2 Sources:**<br>**IRIS:** Per IRIS (9/03/1998), RfC for chromic acid mists and dissolved CR(VI) aerosols = 8.0E-6 mg/$m^3$<br>**Critical Study***:* Lindberg E, Hedenstierna G. 1983. Chrome plating: Symptoms, findings in the upper airways, and effects on lung function. Arch Environ Health | | Complete |

| | Part 201 Value | Updated Value | Source/Reference/Date | Comments/Notes/Issues |
|---|---|---|---|---|
| | | 38:367-374.<br>**Methods:** occupational exposures to chromic acid mists. Workers (85 males, 19 females) exposed in chrome plating plants were interviewed using a standard questionnaire for the assessment of nose, throat, and chest symptoms. Nasal inspections and pulmonary function testing were performed as part of the study. The median exposure time for the entire group of exposed subjects (104) in the study was 4.5 years (0.1-36 years).<br>**Critical effect:** nasal septum atrophy<br>**End point or Point of Departure (POD):** LOAEL = 2.0E-3 mg/m$^3$; adjusted LOAEL = 7.14E-4 mg/m$^3$<br>**Uncertainty Factors:** UF = 90 (10 for interspecies variability and interspecies extrapolation, and 3 each for use of a sub chronic study and undefined concerns)<br>**Source and Date:** IRIS, Last revision date - 9/03/1998. An RfC for CR(VI) particulates = 1.0E-4 mg/m$^3$ is available based on a sub chronic study of rats (Glaser et al., 1990 and Malsh et al., 1994). Critical effects = lactate dehydrogenase in bronchioalveolar lavage fluid observed, and UF = 300 (10 each for interspecies variability and use of a sub chronic study and 3 for pharmacodynamic differences)<br><br>**PPRTV:** No PPRTV record available at this time.<br>**MRL:** Per ATSDR (9/2012), an intermediate inhalation MRL **for Cr(VI) particulates** = 3.0E-4 mg/m$^3$ is available and the same as the chronic MRL.<br>**Critical Study:** Glaser U, Hochrainer D, Steinholf D. 1990. Investigation of irritating properties of inhaled CrVI with possible influence on its carcinogenic action. Environ Hyg 2:235-245.<br>**Methods:** Eight-week-old male Wistar rats (30 animals in each group) were exposed 22 hours/day, 7 days/week to 0, 0.05, 0.1, 0.2, or 0.4 mg/m$^3$ chromium(VI) as sodium dichromate aerosol particulates.<br>**Critical effect***:* alterations in lactate dehydrogenase levels in bronchoalveolar lavage<br>**End point or Point of Departure (POD):** $BMCL_{HEC}$ = 0.01 mg/m$^3$<br>**Uncertainty Factors:** UF = 30 (10 for interspecies variability and 3 for interspecies extrapolation. | | |

| | Part 201 Value | Updated Value | Source/Reference/Date | Comments/Notes/Issues |
|---|---|---|---|---|
| | | **Tier 3 Source:**<br>**MDEQ:** Per DEQ-CCD (9/03/1998), AQD adopted IRIS RfC for chromium VI acid mist and dissolved aerosols = 0.008 µg/m³. See Part 201 Value RfC details. AQD adopted the EPA RfC for chromium VI particulates of 1.0E-1 µg/m³. | | |
| **Inhalation Unit Risk Factor (IURF) ((µg/m$^3$)$^{-1}$)** | 1.2E-2 | 1.2E-2 | IRIS, 1998 | |
| **IURF details** | Potency based on epidemiology studies, as calculated by EPA and listed on IRIS on 3/1/1991.<br>CCD/AQD date: 4/28/1998 | **Tier 1 Source:**<br>**IRIS:**<br>**Basis:** IRIS is a Tier 1 source and the only IURF available.<br>**Critical Study**: Mancuso, TF. (1975) Consideration of chromium as an industrial carcinogen. International Conference on Heavy Metals in the Environment, Toronto, Ontario, Canada, October 27-31. pp. 343-356.<br>**Method(s)**:<br>*1. Dose response data*: *Tumor Type* – lung cancer; *Test Species* - human; *Route* – inhalation, occupational exposure<br>*2. Extrapolation method*: multistage, extra risk<br>**Carcinogen Weight-of-Evidence (WOE) Class**: known human carcinogen by the inhalation route of exposure<br>**IRIS WOE Basis**: Hexavalent chromium is known to be carcinogenic in humans by the inhalation route of exposure. Animal data are consistent with the human carcinogenicity data on hexavalent chromium. Per IRIS*, in vitro data suggest that hexavalent chromium carcinogenesis may result from the formation of mutagenic oxidative DNA lesions* following intracellular reduction to the trivalent form. Cr(VI) readily passes through cell membranes and is rapidly reduced intracellularly to generate reactive Cr(V) and Cr(IV) intermediates and reactive oxygen species. A number of *potentially mutagenic DNA lesions are formed during the reduction of Cr(VI)*. Hexavalent chromium is *mutagenic in bacterial assays, yeasts, and V79 cells*, and Cr(VI) compounds decrease the fidelity of DNA synthesis in vitro and produce unscheduled DNA synthesis as a consequence of DNA damage.<br>**Source and Date**: IRIS, Last revision date – 9/03/1998 | | . |

| | Part 201 Value | Updated Value | Source/Reference/Date | Comments/Notes/Issues |
|---|---|---|---|---|
| | | **Tier 2 values**:<br>**PPRTV:** No PPRTV record available at this time.<br>**MRL:** NA; MRLs are for non-cancer effects only.<br><br>**Tier 3 sources:**<br>**MDEQ:** Per DEQ-CCD (4/28/1998), AQD adopted 1998 IRIS IURF. See Part 201 Value IURF details. | | |
| **Mutagenic Mode of Action (MMOA)? (Y/N)** | -- | **YES** | USEPA, 2015 | |
| **MMOA Details** | -- | Justification: Cr(VI) is not listed as a carcinogen with mutagenic MOA in theUS EPA OSWER List (2005). However, this list may change as new data become available, including recently completed (IRIS) assessments or reassessments; and recently completed Superfund Technical Support Center assessments.<br><u>MDEQ considers Cr(VI) as a carcinogen with mutagenic MOA on the following basis:</u><br>1. The IRIS Toxicological Review - External Draft, 9/30/2010 indicates that "available evidence indicates that chromium interacts with DNA, resulting in DNA damage and mutagenesis. Thus, hexavalent chromium is proposed to induce carcinogenicity via a mutagenic mode of action.<br>2. The 1998 IRIS assessment indicate that Cr(VI) "carcinogenesis may result from the formation of mutagenic oxidative DNA lesions following intracellular reduction to the trivalent form. Cr(VI) is rapidly reduced intracellularly to generate reactive Cr(V) and Cr(IV) intermediates and reactive oxygen species. A number of potentially mutagenic DNA lesions are formed during the reduction of Cr(VI). Hexavalent chromium is mutagenic in bacterial assays, yeasts, and V79 cells.<br>3. EPA's Office of Pesticide Programs (OPP) determined that Cr(VI) has a mutagenic mode of action for carcinogenesis in all cells regardless of type, following administration via drinking water OPP recommended that Age-Dependent Adjustment Factors (ADAFs) be applied when assessing cancer risks from early-life exposure (< 16 years of age).<br>4. McCarroll, et al. (2009) in "An Evaluation of the Mode of Action | | |

| | Part 201 Value | Updated Value | Source/Reference/Date | Comments/Notes/Issues |
|---|---|---|---|---|
| | | Framework for Mutagenic Carcinogens Case Study II: Cr(VI). Environ and Molecular Mutagenesis.2009." concluded that "despite the uncertainty that have been identified in the database, there is plausible evidence that Cr (VI), administered via drinking water, may act via a mutagenic MOA for carcinogenicity." | | |
| **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)** | 100 | 100 | SDWA, 1976 | |
| **SDWS details** | SDWA, 1976 | MI Safe Drinking Water Act (SDWA) 1976 PA 399 | | |
| **Secondary Maximum Contaminant Level (SMCL) (ug/L)** | -- | NA | SDWA, 1976 and USEPA SMCL List, 2015 | |
| **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 | |
| **Aesthetic Value details** | | 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 (ABSgi)** | --- | 1.0 | MDEQ, 2015/USEPA RAGS-E, 2004 | |
| **ABSgi details** | | RAGS E (USEPA, 2004) Default Value | | |
| **Skin absorption efficiency value (AEd)** | --- | 0.01 | MDEQ, 2015 | |
| **AEd details** | | | | |
| **Ingestion Absorption Efficiency (AEi)** | | 0.5 | MDEQ, 2015 | |
| **AEi Details** | | | | |
| **Relative Source Contribution for Water ($RSC_W$)** | | 0.7 | 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)** | 11 |
| **Updated GSI value (µg/L)** | 11 |
| **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 | 9/1997 |
| **Human Non-Cancer Values- Non-drinking water sources (HNV-Non-drink)** | 9,400 | 6/1997 |
| **Wildlife Value (WV)** | NA | |
| **Human Cancer Values for Drinking Water Source (HCV-drink)** | NA | |
| **Human Cancer values for non-drinking water source (HCV-Non-drink)** | NA | |
| **Final Chronic Value (FCV)** | $11^{D}$<br>D = value is expressed as dissolved | 7/1997 |
| **Aquatic maximum value (AMV)** | $16^{D}$<br>D = value is expressed as dissolved | 7/1997 |
| **Final Acute Value (FAV)** | $32^{D}$<br>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 (μg/kg)** | 2,000 | MDEQ, 2015 |
| **Target Detection Limit – Water (μg/L)** | 10 | 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 |