



## CHEMICAL UPDATE WORKSHEET

<b>Chemical Name:</b>	<b>Acrylamide</b>
<b>CAS #:</b>	<b>79-06-1</b>
<b>Revised By:</b>	RRD Toxicology Unit
<b>Revision Date:</b>	August 12, 2105

### (A) Chemical-Physical Properties

	Part 201 Value	Updated Value	Reference Source	Comments
<b>Molecular Weight (g/mol)</b>	71.08	71.08	EPI	EXP
<b>Physical State at ambient temp</b>	Solid	Solid	MDEQ	
<b>Melting Point (°C)</b>	358	84.50	EPI	EXP
<b>Boiling Point (°C)</b>	192.6	192.60	EPI	EXP
<b>Solubility (ug/L)</b>	2.20E+9	3.90E+08	EPI	EXP
<b>Vapor Pressure (mmHg at 25°C)</b>	0.006992	7.00E-03	EPI	EXP
<b>HLC (atm-m<sup>3</sup>/mol at 25°C)</b>	3.22E-10	1.70E-09	PP	EST
<b>Log Kow (log P; octanol-water)</b>	-0.96	-0.67	EPI	EXP
<b>Koc (organic carbon; L/Kg)</b>	0.114	5.694	EPI	EST
<b>Ionizing Koc (L/kg)</b>		NR	NA	NA
<b>Diffusivity in Air (Di; cm<sup>2</sup>/s)</b>	0.097	1.07E-01	W9	EST
<b>Diffusivity in Water (Dw; cm<sup>2</sup>/s)</b>	1.1E-4	1.2649E-05	W9	EST
<b>Soil Water Partition Coefficient (Kd; inorganics)</b>	NR	NR	NA	NA

	Part 201 Value	Updated Value	Reference Source	Comments
Flash Point (°C)	280 F	138	NPG	EXP
Lower Explosivity Level (LEL; unit less)	NA	NA	NA	NA
Critical Temperature (K)		NA	NA	NA
Enthalpy of Vaporization (cal/mol)		NA	NA	NA
Density (g/mL, g/cm <sup>3</sup> )		1.13	PC	EXP
EMSOFT Flux Residential 2 m (mg/day/cm <sup>2</sup> )	1.03E-06	1.35E-06	EMSOFT	EST
EMSOFT Flux Residential 5 m (mg/day/cm <sup>2</sup> )	1.03E-06	1.35E-06	EMSOFT	EST
EMSOFT Flux Nonresidential 2 m (mg/day/cm <sup>2</sup> )	1.10E-06	1.68E-06	EMSOFT	EST
EMSOFT Flux Nonresidential 5 m (mg/day/cm <sup>2</sup> )	1.10E-06	1.68E-06	EMSOFT	EST

**(B) Toxicity Values/Benchmarks**

	Part 201 Value	Updated Value	Source/Reference/ Date	Comments/Notes /Issues
<b>Reference Dose (RfD) (mg/kg/day)</b>	2.0E-4	2.0E-3	IRIS, 2010	
<b>RfD details</b>	Rat subchronic drinking water study (Burek et al, 1980) UF=1000; NOAEL = 0.2 mg/kg/day; Critical Effect = nerve damage. Acrylamide is teratogenic in rats, but at maternal doses higher than shown to produce nerve damage in adult rats.	<p><b>Tier 1 Source:</b>  <b>Basis:</b> IRIS is a Tier 1 source.  <b>IRIS:</b>  <b>Critical Study(ies):</b>            1) Johnson KA; Gorzinski SJ; Bodner KM; Campbell RA; Wolf CH; Friedman MA; Mast RW (1986). Chronic toxicity and oncogenicity study on acrylamide incorporated in the drinking water of Fischer 344 rats. Toxicol Appl Pharmacol, 85: 154-168. 061340.            2) Friedman MA; Dulak LH; Stedham MA (1995). A lifetime oncogenicity study in rats with acrylamide. Fundam Appl Toxicol, 27: 95-105. 224307  <b>Method(s):</b>            1) F344 rats (90/grp) were given 0, 0.01, 0.1, 0.5, or 2.0 mg/kg-day acrylamide in drinking water for up to 2 years (Johnson et al., 1986).            2) F344 male rats exposed to 0, 0.1., 0.5, and 2.0 mg/kg-day, and female rats to 0, 1, and 3 mg/kg-day (Friedman et al. ,1995)  <b>Critical effect:</b> nerve degenerative changes  <b>End point or Point of Departure (POD):</b> BMDL5 = 0.27 mg/kg-day; Human equivalent dose BMDL = 0.053 mg/kg-day.  <b>Uncertainty Factors:</b> UF = 30 (interspecies TD and TK = 3 and 1, and 10 for intra-species variability)  <b>Source and date:</b> IRIS; Last revision date - 3/22/2010. An IRIS Toxicological Review is available.</p> <p><b>Tier 2 Sources:</b>  <b>PPRTV:</b> No PPRTV record available at this time.  <b>MRL:</b> Per ATSDR (12/2012), chronic oral MRL = 0.001 mg/kg-day (1.0E-3 mg/kg-day) – from 12/2014 MRL list  <b>Critical Study (ies):</b> Friedman MA; Dulak LH; Stedham MA (1995). A lifetime oncogenicity study in rats with acrylamide. Fundam Appl Toxicol, 27: 95-105.</p>		Complete

	Part 201 Value	Updated Value	Source/Reference/Date	Comments/Notes/Issues
		<p>224307</p> <p><b>Method(s):</b> F344 rats (≥50/sex/group) were exposed to acrylamide in the drinking water for 2 years at concentrations resulting in calculated doses of 0, 0.1, 0.5, or 2.0 mg/kg/day for the males and 0, 0.5, or 3.0 mg/kg/day for the females. The study included two control groups for each sex to assess variability in background tumor responses and 204 male rats in the 0.1 mg/kg/day group to increase the statistical power sufficient to detect a 5% increase in incidence of scrotal sac mesotheliomas over an expected background incidence of this tumor for F344 rats of about 1%.</p> <p><b>Critical effect:</b> degenerative sciatic nerve changes in male rats</p> <p><b>End point or Point of Departure (POD):</b> BMDL5 = 2.4E-4 mM rat blood TWA acrylamide; Human equivalent dose BMDL = 0.042 mg/kg-day.</p> <p><b>Uncertainty Factors:</b> UF = 30 (3 for interspecies extrapolation and 10 for intraspecies variability)</p> <p><b>Tier 3 Source:</b></p> <p><b>MDEQ:</b> Per CCD/RRD, RfD = 2.0E-4 mg/kg-day. See Part 201 value RfD details.</p>		
<b>Oral Cancer Slope Factor (CSF) (mg/kg-day)<sup>-1</sup></b>	2.8E+0	5.1E-1	IRIS, 2010	
<b>CSF details</b>	2-year drinking water study in rats (Rao et al., 1988). SF is based on incidence in females of CNS, mammary and thyroid glands, uterus, and oral cavity tumors combined. SF adjusted with revised species	<p><b>Tier 1 Source:</b></p> <p><b>Basis:</b> IRIS is a Tier 1 source.</p> <p><b>IRIS:</b></p> <p><b>Critical Study:</b> Johnson et al. (1986) and Friedman et al. (1995). Refer to RfD Details.</p> <p><b>Method(s):</b></p> <ol style="list-style-type: none"> <li>1) <i>Dose response data: Tumor Type</i> - thyroid tumors and tunica vaginalis mesotheliomas; <i>Test Species</i> - Rat/Fischer 344, males; <i>Route</i> - oral, drinking water</li> <li>2) <i>Extrapolation method:</i> See IRIS record.</li> </ol> <p><b>Carcinogen Weight-of-Evidence (WOE) Class:</b> likely to be carcinogenic to humans; carcinogenic by a mutagenic mode of action</p> <p><b>IRIS WOE Basis:</b> 1) chronic oral exposure of F344 rats to AA in drinking water</p>		Complete



	Part 201 Value	Updated Value	Source/Reference/Date	Comments/Notes/Issues
	scaling factor = (BWh/BWa) rose to the 0.25 power.	<p>induced thyroid follicular cell tumors, scrotal sac mesotheliomas (males), and mammary gland fibroadenomas (females) in two bioassays;</p> <p>(2) oral, i.p., or dermal exposure to AA initiated skin tumors that were promoted by TPA in SENCAR and Swiss-ICR mice;</p> <p>(3) i.p. injections of AA induced lung adenomas in strain A/J mice. CNS tumors were found in both of the chronic F344 rat bioassays; and</p> <p>(4) ample evidence for the ability of AA (associated with its metabolite GA) to induce a variety of genotoxic effects in mammalian cells.</p> <p><b>Source and Date:</b> IRIS; Last revision date - 3/22/2010. An IRIS Toxicological Review is available.</p> <p><b>Tier 2 Sources:</b>  <b>PPRTV:</b> No PPRTV record available 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 CCD/RRD, RfD = 2.8E+0 (mg/kg-day)<sup>-1</sup>. See Part 201 value and CSF details</p>		
<b>Reference Concentration (RfC) or Initial Threshold Screening Level (ITSL) (µg/m³)</b>	--	6.0E+0	IRIS, 2010	
<b>RfC/ITSL details</b>	NA	<p><b>Tier 1 Source:</b>  <b>Basis:</b> IRIS is the only available value.  <b>IRIS:</b>  <b>Critical Study:</b> Johnson KA; Gorzinski SJ; Bodner KM; Campbell RA; Wolf CH; Friedman MA; Mast RW (1986). Chronic toxicity and oncogenicity study on acrylamide incorporated in the drinking water of Fischer 344 rats. Toxicol Appl Pharmacol, 85: 154-168. 061340.  <b>Method(s):</b> F344 rats (90/grp) were exposed to 0, 0.01, 0.1, 0.5, or 2.0 mg/kg-day acrylamide in drinking water for up to 2 years.</p>		Complete



	Part 201 Value	Updated Value	Source/Reference/Date	Comments/Notes/Issues
		<p><b>Critical effect:</b> Degenerative nerve changes  <b>End point or Point of Departure (POD):</b> route-to-route extrapolation estimate of the human equivalent HECBMDL = 0.18 mg/m<sup>3</sup>  <b>Uncertainty Factors:</b> UF = 30 (interspecies TD and TK = 3 and 1, and 10 for intra-species variability)  <b>Source and date:</b> IRIS; Last revision date - 3/22/2010</p> <p><b>Tier 2 Sources:</b>  <b>PPRTV:</b> No PPRTV record available at this time.  <b>MRL:</b> Per ATSDR (12/2012), no inhalation value at this time.</p> <p><b>Tier 3 Source:</b>  <b>MDEQ:</b> AQD adopted 2010 IRIS RfC value. AQD, 3/22/10.</p>		
<b>Inhalation Unit Risk Factor (IURF) ((µg/m<sup>3</sup>)<sup>-1</sup>)</b>	1.3E-3	1.0E-4	IRIS, 2010	
<b>IURF details</b>	Per AQD: Potency based on EPA's 1988 risk assessment (see IRIS). Total tumors in female rats administered acrylamide in drinking water, as reported by Johnson et al., (1986). Oral potency of 4.5 (mg/kg)-1 convert to air value of 1.3E-3 (ug/m3)-1. IRIS revision date:	<p><b>Tier 1 Source:</b>  <b>Basis:</b> IRIS is the only available value.  <b>IRIS:</b>  <b>Critical Study:</b> Johnson KA; Gorzinski SJ; Bodner KM; Campbell RA; Wolf CH; Friedman MA; Mast RW (1986). Chronic toxicity and oncogenicity study on acrylamide incorporated in the drinking water of Fischer 344 rats. Toxicol Appl Pharmacol, 85: 154-168. 061340.  <b>Method(s):</b> F344 rats (90/grp) were exposed to 0, 0.01, 0.1, 0.5, or 2.0 mg/kg-day acrylamide in drinking water for up to 2 years. Route-to-route extrapolation estimate of the oral cancer potency of 0.51 (mg/kg)<sup>-1</sup> converted to air value of 1.47 E-4 (ug/m3)<sup>-1</sup>, which is rounded to 1E-4 (µg/m3)<sup>-1</sup>. Multistage model with linear extrapolation from the point of departure (BMDL), summed risk  <b>Carcinogen Weight-of-Evidence (WOE) Class:</b> likely to be carcinogenic to humans; carcinogenic by a mutagenic mode of action  <b>IRIS WOE Basis:</b> Refer to CSF details.  <b>Source and Date:</b> IRIS; Last revision date - 3/22/2010. An IRIS Toxicological Review is available.</p>		Complete



	Part 201 Value	Updated Value	Source/Reference/Date	Comments/Notes/Issues
	07/01/93.	<p><b>Tier 2 Sources:</b>  <b>PPRTV:</b> No PPRTV record available 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 CCD/AQD (3/22/2010), AQD adopted the IRIS RfC.</p>		
<b>Mutagenic Mode of Action (MMOA)? (Y/N)</b>	--	YES	USEPA, 2015	
<b>MMOA Details</b>	--	<p>Listed as a carcinogen with mutagenic MOA in the USEPA OSWER List                      USEPA has concluded that acrylamide is carcinogenic by a mutagenic mode of action (MOA). Those exposed to carcinogens with a mutagenic MOA are assumed to have increased early-life susceptibility. For MMOA details of this carcinogen, refer to the IRIS record.</p> <p>The oral slope factor of 5E-1 per mg/kg-day, calculated from data from adult exposure, does not reflect presumed early-life susceptibility for this chemical; therefore, age dependent adjustment factors (ADAFs) should be applied to the acrylamide oral CSF when assessing cancer risks.</p> <p>Application of ADAFs for exposures to individuals less than 16 years old yields an IURF of 1.7x10<sup>-4</sup> (ug/m<sup>3</sup>)<sup>-1</sup>.</p>		
<b>Developmental or Reproductive Effector? (Y/N)</b>	No	No, the RfD nor RfC/ITSL is 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>	--	TT <sup>2</sup>	SDWA, 1976	
<b>SDWS details</b>	NA	MI Safe Drinking Water Act (SDWA) 1976 PA 399.		



	Part 201 Value	Updated Value	Source/Reference/ Date	Comments/Notes /Issues
		<sup>2</sup> When acrylamide is used in drinking water systems, the combination (or product) of dose and monomer levels shall not exceed that equivalent to a polyacrylamide polymer containing 0.05% monomer dosed at 1 mg/L.		
<b>Secondary Maximum Contaminant Level (SMCL) (ug/L)</b>	--	NO	SDWA, 1976 and USEPA SMCL List	
<b>SMCL details</b>	NA	MI Safe Drinking Water Act (SDWA) 1976 PA 399 and USEPA SMCL List		
<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	
ABS <sub>gi</sub> details				
Skin absorption efficiency value (AE <sub>d</sub> )	---	0.1	MDEQ, 2015	
AE <sub>d</sub> details				
Ingestion Absorption Efficiency (AE <sub>i</sub> )		1.0	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>	10 (X)
<b>Updated GSI value (µg/L)</b>	10 (X)
<b>Rule 57 Drinking Water Value (µg/L)</b>	0.5 (M); 0.12

	<b>Rule 57 Value (µg/L)</b>	<b>Verification Date</b>
<b>Human Non-cancer Values- Drinking water source (HNV-drink)</b>	28	6/2005
<b>Human Non-Cancer Values- Non-drinking water sources (HNV-Non-drink)</b>	2,200	6/2005
<b>Wildlife Value (WV)</b>	NA	NA
<b>Human Cancer Values for Drinking Water Source (HCV-drink)</b>	0.12	6/2005
<b>Human Cancer values for non-drinking water source (HCV-Non-drink)</b>	10	6/2005
<b>Final Chronic Value (FCV)</b>	590	8/2008
<b>Aquatic maximum value (AMV)</b>	5,300	8/2008
<b>Final Acute Value (FAV)</b>	11,000	8/2008

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>	10	MDEQ, 2015
<b>Target Detection Limit – Water (<math>\mu\text{g}/\text{L}</math>)</b>	0.5	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