



CHEMICAL UPDATE WORKSHEET

Chemical Name:	Fluorene
CAS #:	86-73-7
Revised By:	RRD Toxicology Unit
Revision Date:	November 23, 2015

(A) Chemical-Physical Properties

	Part 201 Value	Updated Value	Reference Source	Comments
Molecular Weight (g/mol)	166.23	166.22	EPI	EXP
Physical State at ambient temp	Solid	Solid	MDEQ	
Melting Point (°C)	390	114.80	EPI	EXP
Boiling Point (°C)	295	295.00	EPI	EXP
Solubility (ug/L)	1980	1690	EPI	EXP
Vapor Pressure (mmHg at 25°C)	0.0006232	6.00E-04	EPI	EXP
HLC (atm-m³/mol at 25°C)	6.36E-5	9.62E-05	EPI	EXP
Log Kow (log P; octanol-water)	4.21	4.18	EPI	EXP
Koc (organic carbon; L/Kg)	13800	9160	EPI	EST
Ionizing Koc (L/kg)		NR	NA	NA
Diffusivity in Air (Di; cm²/s)	0.0363	6.28E-02	W9	EST
Diffusivity in Water (Dw; cm²/s)	7.88E-6	7.34E-06	W9	EST
Soil Water Partition Coefficient (Kd; inorganics)	NR	NR	NA	NA

	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)		8.70E+02	EPA2004	EXP
Enthalpy of Vaporization (cal/mol)		1.27E+04	EPA2004	EXP
Density (g/mL, g/cm ³)		NA	NA	NA
EMSOFT Flux Residential 2 m (mg/day/cm ²)	1.07E-06	4.11E-06	EMSOFT	EST
EMSOFT Flux Residential 5 m (mg/day/cm ²)	1.07E-06	4.11E-06	EMSOFT	EST
EMSOFT Flux Nonresidential 2 m (mg/day/cm ²)	1.27E-06	5.20E-06	EMSOFT	EST
EMSOFT Flux Nonresidential 5 m (mg/day/cm ²)	1.27E-06	5.20E-06	EMSOFT	EST

(B) Toxicity Values/Benchmarks

	Part 201 Value	Updated Value	Source/Reference/Date	Comments/Notes/Issues
Reference Dose (RfD) (mg/kg/day)	1.2E-1	4.0E-2	ATSDR, 1995/MDEQ, 2015	
RfD details	<p>Mouse sub chronic gavage bioassay (US EPA, 1989); NOAEL = 125 mg/kg/day; UF = 1000; Critical effects = decreased RBC, packed cell volume & hemoglobin. *IRIS oral RfD changed. IRIS UF of 3,000 changed to 1,000 per MDNR policy. RfD presented as two significant figures. CCD/RRD date: 1/15/1989</p>	<p>Tier 2 Source: ATSDR: Basis: ATSDR (1995) intermediate MRL = 0.4 mg/kg-day. MDEQ applied an additional UF of 10 for sub chronic to chronic exposure extrapolation to derive the final RfD = 4.0E-2 mg/kg-day. This value is the same as the IRIS (1990) value. ATSDR is a more recent evaluation than IRIS. MRL: Per ATSDR, no chronic oral MRL at this time. Intermediate oral MRL = 0.4 mg/kg-day. Critical Study: U.S. EPA. 1989. Mouse oral sub chronic toxicity study. Prepared by Toxicity Research Laboratories, LTD., Muskegon, MI for the Office of Solid Waste, Washington, DC. Method(s): CD-1 mice (25/sex/group) were exposed to 0, 125, 250, or 500 mg/kg/day fluorene in corn oil by gavage for 13 weeks Critical effect: increased relative liver weight End point or Point of Departure (POD): LOAEL = 125 mg/kg-day Uncertainty Factors: UF = 300 (10 each for intraspecies variability and interspecies extrapolation, and 3 for use of a minimal LOAEL) plus an additional 10 for use of a sub chronic study. Source and date: ATSDR, 8/1995. A Toxicological Review of PAH is available</p> <p>Tier 1 and 2 Sources: IRIS: IRIS (1990) RfD = 4.0E-2 mg/kg-day: Critical Study (ies): U.S. EPA. 1989. Mouse oral sub chronic toxicity study. Prepared by Toxicity Research Laboratories, LTD., Muskegon, MI for the Office of Solid Waste, Washington, DC. Method(s): CD-1 mice (25/sex/group) were exposed to 0, 125, 250, or 500 mg/kg/day fluorene in corn oil by gavage for 13 weeks Critical effect: Decreased RBC, packed cell volume and hemoglobin End point or Point of Departure (POD): NOAEL = 125 mg/kg-day</p>		Complete



	Part 201 Value	Updated Value	Source/Reference/Date	Comments/Notes/Issues
		<p>Uncertainty Factors: UF = 3000 (10 each for intraspecies variability, interspecies extrapolation and use of a sub chronic study and 3 for database deficiencies)</p> <p>Source and date: IRIS, Last revision date – 11/01/1990</p> <p>PPRTV: PPRTV (5/31/2002) evaluated the oral slope factor only.</p> <p>Tier 3 Source: MDEQ: Per DEQ-CCD/RRD (1/15/1989), RfD = 1.2E-1 mg/kg-day based on a modified IRIS RfD. See Part 201 Value RfD details. DEQ-CCD-WRD (1/28/1999) RfD = 4E-2 mg/kg/day.</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 human carcinogenicity)</p> <p>IRIS WOE Basis: based on no human data and insufficient data from animal bioassays</p> <p>Source and Date: IRIS, 11/01/1990; PPRTV, 5/31/2002</p> <p>Tier 1 and 2 Sources: IRIS: Per IRIS (11/01/1990), no value at this time. PPRTV: Per PPRTV (5/31/2002), no value at this time. MRL: NA; MRLs are for non-cancer effects only.</p> <p>Tier 3 Source: MDEQ: Per DEQ-CCD, no value at this time.</p>		Complete
Reference Concentration (RfC) or Initial Threshold Screening Level (ITSL) (µg/m³)	1.4E+2	1.4E+2	MDEQ, 1993	
RfC/ITSL details	ITSL based on	Tier 3 Source:		



	Part 201 Value	Updated Value	Source/Reference/ Date	Comments/Notes /Issues
	<p>EPA's RfD of 40 ug/kg from 13 wk. mouse gavage NOAEL of 125 mg/kg. CCD/AQD date: 7/19/1993.</p>	<p>MDEQ: Basis: The MDEQ (1993) value is selected because the justification provides more detail. DEQ and NY values are the same. Both were derived by extrapolating the IRIS RfD to an inhalation value. See details below.</p> <p>Tier 1 and 2 Sources: IRIS: Per IRIS (11/01/1990), no value at this time. PPRTV: Per PPRTV (5/31/2002), no value at this time. MRL: Per ATSDR, no inhalation MRL is available at this time.</p> <p>Tier 3 Sources: MDEQ: AQD (1993) ITSL = 1.4E+2 µg/m³ (24 hour averaging time). Basis: Extrapolated ITSL from EPA's RfD value. Critical Study (ies): U.S. EPA. 1989. Mouse oral sub chronic toxicity study. Prepared by Toxicity Research Laboratories, LTD., Muskegon, MI for the Office of Solid Waste, Washington, DC. Method(s): CD-1 mice (25/sex/group) were exposed to 0, 125, 250, or 500 mg/kg/day fluorene in corn oil by gavage for 13 weeks Critical effect: Decreased RBC, packed cell volume and hemoglobin End point or Point of Departure (POD): NOAEL = 125 mg/kg-day Uncertainty Factors: UF = 3000 (10 each for intraspecies variability, interspecies extrapolation and use of a sub chronic study and 3 for database deficiencies) Source and date: MDEQ-CCD/AQD, 7/19/1993</p> <p>New York DEC: RfC= 1.4E+2 µg/m³ is based on a route to route extrapolation; The IRIS (1990) RfD (0.04 mg/kg/day) is the toxicity value used in the derivation of an oral non-cancer-based soil cleanup objective for fluorene. Source: New York State Brownfield Cleanup Program, Development of Soil Cleanup Objectives: Technical Support Document, 2006, Appendix A, 4/2004</p> <p>Other Tier 3: No value is available at this time from these Tier 3</p>		<p>Complete</p>



	Part 201 Value	Updated Value	Source/Reference/ Date	Comments/Notes /Issues
		sources/databases: HEAST, NTP ROC, health and environmental agencies of California, Massachusetts, Minnesota, New Jersey and Texas, WHO (IARC), WHO (IPCS/INCHEM), Canada, The Netherlands (RIVM), ECHA (REACH) and OECD HPV.		
Inhalation Unit Risk Factor (IURF) (($\mu\text{g}/\text{m}^3$)⁻¹)	--	NA	MDEQ, 2015	
IURF details	NA	<p>Carcinogen Weight-of-Evidence (WOE) Class: D (not classifiable as to human carcinogenicity) IRIS WOE Basis: based on no human data and insufficient data from animal bioassays Source and Date: IRIS, 11/01/1990; PPRTV, 5/31/2002</p> <p>Tier 1 and 2 Sources: IRIS: Per IRIS (11/01/1990), no value at this time. PPRTV: Per PPRTV (5/31/2002), no value at this time. MRL: NA; MRLs are for non-cancer effects only.</p> <p>Tier 3 Source: MDEQ: Per DEQ-CCD, no value at this time.</p>		Complete
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	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)	--	NO	SDWA, 1976	

	Part 201 Value	Updated Value	Source/Reference/ Date	Comments/Notes /Issues
SDWS details	NA	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		
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)	---	0.1	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)	12
Updated GSI value (µg/L)	12
Rule 57 Drinking Water Value (µg/L)	140

	Rule 57 Value (µg/L)	Verification Date
Human Non-cancer Values- Drinking water source (HNV-drink)	140	1/1999
Human Non-Cancer Values- Non-drinking water sources (HNV-Non-drink)	160	1/1999
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)	12	9/1998
Aquatic maximum value (AMV)	110	9/1998
Final Acute Value (FAV)	220	9/1998

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 ($\mu\text{g}/\text{kg}$)	330	MDEQ, 2015
Target Detection Limit – Water ($\mu\text{g}/\text{L}$)	5	MDEQ, 2015
Target Detection Limit – Air (ppbv)	2.00E+01	MDEQ, 2015
Target Detection Limit – Soil Gas (ppbv)	6.80E+02	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