CHEMICAL UPDATE WORKSHEET

Chemical Name:	**Indeno(1,2,3-cd)pyrene**
CAS #:	**193-39-5**
Revised By:	RRD Toxicology Unit
Revision Date:	March 2, 2016

(A) Chemical-Physical Properties

	Part 201 Value	Updated Value	Reference Source	Comments
Molecular Weight (g/mol)	276.34	276.34	EPI	EXP
Physical State at ambient temp	Solid	Solid	MDEQ	
Melting Point (˚C)	435	163.60	EPI	EXP
Boiling Point (˚C)	536	536.00	EPI	EXP
Solubility (ug/L)	0.022	0.19	EPI	EXP
Vapor Pressure (mmHg at 25˚C)	0.0000000001444	1.25E-10	PP	EST
HLC (atm-m^3/mol at 25˚C)	1.60E-6	3.48E-07	EPI	EXP
Log Kow (log P; octanol-water)	6.65	6.54	SSG	EXP
Koc (organic carbon; L/Kg)	3.45E+6	1.951E+06	EPI	EST
Ionizing Koc (L/kg)		NR	NA	NA
Diffusivity in Air (Di; cm^2/s)	0.019	4.48E-02	W9	EST
Diffusivity in Water (Dw; cm^2/s)	5.66E-6	5.23E-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)		1078.24	EPA2001	EXP
Enthalpy of Vaporization (cal/mol)		1.90E+04	EPA2001	EST
Density (g/mL, g/cm^3)		NA	NA	NA
EMSOFT Flux Residential 2 m (mg/day/cm^2)	NA	7.53E-09	EMSOFT	EST
EMSOFT Flux Residential 5 m (mg/day/cm^2)	NA	7.53E-09	EMSOFT	EST
EMSOFT Flux Nonresidential 2 m (mg/day/cm^2)	NA	8.39E-09	EMSOFT	EST
EMSOFT Flux Nonresidential 5 m (mg/day/cm^2)	NA	8.39E-09	EMSOFT	EST

(B) Toxicity Values/Benchmarks

	Part 201 Value	Updated Value	Source/Reference/Date	Comments/Notes/Issues
Reference Dose (RfD) (mg/kg/day)	NA	NA	MDEQ, 2015	
RfD details		**Tier 1 and 2 Sources:** **RIS:** Per IRIS, 03/01/1994, no value at this time. **PPRTV:** Per PPRTV, 01/31/2002, no value at this time. **MRL:** No MRL record available at this time. **Tier 3 Source:** **MDEQ:** Per DEQ-CCD, no value at this time.		Complete
Oral Cancer Slope Factor (CSF) (mg/kg-day)$^{-1}$)	4.1E-1	1.0E-1	IRIS, 2014	
CSF details	Based on the oral slope factor for benzo (a) pyrene and a relative potency of 0.1.	**Tier 1 Source:** **IRIS:** **Basis:** IRIS is a Tier 1 source. Classification – B2, probable human carcinogen, based on no human data and sufficient data from animal bioassays. Indeno [1, 2, 3-cd] pyrene produced tumors in mice following lung implants, subcutaneous injection and dermal exposure. Indeno [1, 2, 3-cd] pyrene tested positive in bacterial gene mutation assays. **IRIS (03/01/1994):** Per IRIS, no value at this time. The IRIS Toxicological Review Draft 9/2014 reports a benzo(a)pyrene (BaP) CSF = 1.0 mg/kg/day. BaP CSF adjusted for a relative potency of 0.1 for indeno (1, 2, 3-cd) pyrene CSF = 0.1 (mg/kg/day)$^{-1}$. **Critical Study:** Beland, F; Culp, S. 1998. Chronic bioassay of two composite samples from selected manufactured gas plant waste sites [unpublished report]. National Center for Toxicological Research. Technical Report 6722.02 **Methods:** chronic dietary exposure (2-year) in Wistar rats and B6C3F1 mice (~50/sex/group) *Tumor type: tumor response in the alimentary tract (forestomach, esophagus, tongue, and larynx) of female B6C3F1 mice* **Source and Date:** Toxicological Review of Benzo[a]pyrene (CASRN 50-32-8) In Support of Summary Information on the Integrated Risk Information System (IRIS). External Draft Review 9/2014.		Complete

	Part 201 Value	Updated Value	Source/Reference/Date	Comments/Notes/Issues
		Tier 2 Sources: **PPRTV (01/31/2002):** Per PPRTV, a provisional oral slope factor cannot be derived because human and animal oral cancer data are lacking. **MRL:** NA; MRLs are for non-cancer effects only. **Tier 3 Sources:** **MDEQ/RRD (03/21/2000):** Per DEQ-CCD, CSF = 0.41 $(mg/kg/day)^{-1}$, the oral slope factor for indeno (1, 2, 3-cd) pyrene is based on the oral slope factor of benzo (a) pyrene which has been adjusted using the relative potency value of 0.1. **California OEHHA 2011:** CSF = 1.2 $(mg/kg/day)^{-1}$. OEHHA PEF weighting scheme for Indeno [1, 2, 3-cd] pyrene = 0.1 (based on BaP = 1.0). Indeno [1, 2, 3-cd] pyrene was assigned a PEF of 0.1. Clement Associates (1988) used the mouse skin carcinogenesis data obtained by Habs et al. (1980) and by Hoffman and Wynder (1966) and the lung tumor data obtained by Deutsch-Wenzel et al. (1983) after intrapulmonary administration to estimate cancer potencies relative to BaP of 0.0302, 0.0292, and 0.246, respectively. These were averaged and rounded to obtain a potency equivalency factor (PEF) of 0.1. CSF for BaP = 11.5 $(mg/kg/day)^{-1}$ 11.5 x 0.1 = 1.15 = 1.2 $(mg/kg/day)^{-1}$. Cal OEHHA Appendix B. Chemical-specific summaries of the information used to derive unit risk and cancer potency values page B91-95 **New Jersey DEP 2008:** 0.73 $(mg/kg/day)^{-1}$. Based on NCEA/EPA provisional value. No further information provided. **New York 2006:** Per NY DOH, 0.903 $(mg/kg/day)^{-1}$. The cancer potency values for indeno[1,2,3-cd]pyrene are based on benzo(a)pyrene and the application of relative potency factors. The recommended cancer potency value for benzo (a) pyrene is 9.03 per mg/kg/day (see Oral Cancer Toxicity Value Documentation for benzo (a) pyrene). Application of the recommended relative potency factor (0.1) yields a cancer potency factor 0.903 per mg/kg/day, which		

	Part 201 Value	Updated Value	Source/Reference/Date	Comments/Notes/Issues
		is the toxicity value recommended for use in the derivation of an oral cancer-based soil cleanup objective for indeno [1, 2, 3-cd] pyrene. **Texas CEQ 2014:** 0.73 $(mg/kg/day)^{-1}$. Cited as EPA-93. No further information available. **Other Tier 3:** No value available from these sources: HEAST 1997, NTP ROC, Massachusetts DEP 2015, Minnesota DOH 2015, WHO (IARC and IPCS/CHEM 1999), Canada 2010, RIVM, ECHA (REACH), OECD HPV		
Reference Concentration (RfC) or Initial Threshold Screening Level (ITSL) ($\mu g/m^3$)	NA	NA	MDEQ, 2015	
RfC/ITSL details		**Tier 1 and 2 Sources:** **IRIS (03/01/1994):** Per IRIS, no value at this time. **PPRTV (01/31/2002):** Per PPRTV, no value at this time. **MRL:** No MRL record available at this time. **Tier 3 Source:** **MDEQ:** Per DEQ-CCD, AQD does not report a value at this time.		Complete
Inhalation Unit Risk Factor (IURF) ($(\mu g/m^3)^{-1}$)	NA	6.0E-5	IRIS, 2014	
IURF details		**Tier 1 Source**: **IRIS:** **Basis:** IRIS is a Tier 1 source. **IRIS:** Per IRIS, no value at this time. Per IRIS Toxicological Review Draft 9/2014 recommends an IURF for BaP of 6.0E-4 $(\mu g/m^3)^{-1}$. Adjusted for a relative potency of 0.1 for indeno (1, 2, 3-cd) pyrene IURF = 6.0E-5 $\mu g/m^3)^{-1}$. **Critical Study:** Thyssen, J; Althoff, J; Kimmerle, G; Mohr, U. 1981. Inhalation studies with benzo[a]pyrene in Syrian golden hamsters. Journal of the National Cancer		Complete

	Part 201 Value	Updated Value	Source/Reference/Date	Comments/Notes/Issues
		Institute. 66: 575-577. **Methods:** Groups of Syrian golden hamsters were exposed by inhalation to benzo[a]pyrene (BP) in concentrations of 2.2, 9.5, and 45.6 mg/m^3 air. *Tumor type: incidence of tumors in the upper respiratory tract or pharynx; calculated by linear extrapolation (slope factor = 0.1/BMCL10) from a 32 BMCL10 of 0.16 mg/m^3 for the occurrence of upper respiratory and upper digestive tract tumors in 33 male hamsters* **IRIS Classification** – B2, probable human carcinogen. **IRIS Weight of Evidence**: Based on no human data and sufficient data from animal bioassays. Indeno [1, 2, 3-cd] pyrene produced tumors in mice following lung implants, subcutaneous injection and dermal exposure. Indeno [1, 2, 3-cd] pyrene tested positive in bacterial gene mutation assays. **Source**: IRIS; 3/1/1994 **Tier 2 Source:** **PPRTV (01/31/2002):** Per PPRTV, no value at this time. **MRL:** NA; MRLs are for non-cancer effects only. **Tier 3 Source:** **MDEQ/AQD (07/20/1995):** Per DEQ-CCD, the IURF for indeno(1,2,3-cd)pyrene should be developed using the Scientific Advisory Panel's 7/20/1995 advisory on how to calculate screening levels for carcinogenic PAHs using toxic equivalent factor (TEF) methodology. This advisory is based on USEPA's method for deriving comparative potency estimates for carcinogenic PAHs. AQD's IURF for benzo (a) pyrene = 2.1E-3 per µg/m^3 (see benzo (a) pyrene file for additional details). The estimated potential potency value for indeno (1, 2, 3-cd) pyrene supported by the SAP = 0.1. Therefore, the IURF for indeo (1, 2, 3-cd) pyrene = 2.1E-3 x 0.1 = 2.1E-4 per µg/m^3. **California OEHHA 2009:** IURF = 1.1E-4 (µg/m^3)$^{-1}$. Indeno [1, 2, 3-cd] pyrene was assigned a PEF of 0.1. Clement Associates (1988) used the mouse skin		

	Part 201 Value	Updated Value	Source/Reference/Date	Comments/Notes/Issues
		carcinogenesis data obtained by Habs et al. (1980) and by Hoffman and Wynder (1966) and the lung tumor data obtained by Deutsch-Wenzel et al. (1983) after intrapulmonary administration to estimate cancer potencies relative to BaP of 0.0302, 0.0292, and 0.246, respectively. These were averaged and rounded to obtain a PEF of 0.1. Thyssen et al. (1981) exposed male Syrian golden hamsters to BaP condensed onto sodium chloride particles at BaP concentrations of 2.2, 9.5, and 46.5 mg BaP/m^3. *Tumors: male hamster respiratory tract tumor incidence; unit risk calculated using a linearized multistage procedure.* **Source:** Cal OEHHA Appendix B. Chemical-specific summaries of the information used to derive unit risk and cancer potency values. Updated 2011. **Minnesota Pollution Control Agency 2015 Draft:** 7.69E-2 listed as µg/m^3. Source MN Dept of Health. No further details available. **New Jersey DEP 2011:** IURF = 1.1E-4 (µg/m^3)$^{-1}$. Based on Cal OEHHA 2009 value. **New York DEP 2006**: IURF = 1.1E-4 (µg/m^3)$^{-1}$. The unit risk values for indeno [1, 2, 3-cd] pyrene are based on benzo (a) pyrene and the application of relative potency factors. The recommended unit risk value for benzo (a) pyrene is 1.1 x 10-3 per mcg/m^3. Application of the recommended relative potency factor (0.1) yields a unit risk of 1.1 x 10-4 per mcg/m^3. Value recommended 12/2004. **Texas CEQ 2014**: IURF = 8.8E-5 (µg/m^3)$^{-1}$.Cited as EPA-93. No further information available. **Other Tier 3:** No value available from these sources: HEAST 1997, NTP ROC, Massachusetts DEP 2015, WHO (IARC and IPCS/INCHEM), Canada, RIVM, ECHA (REACH), OECD HPV		
Mutagenic Mode of Action (MMOA)? (Y/N)	No	**YES**	USEPA, 2015	
MMOA Details		BaP has been identified by USEPA as a carcinogen that acts via a mutagenic mode of action. Six other PAHs, including indeno(1,2,3-cd)pyrene, are also carcinogenic and		

	Part 201 Value	Updated Value	Source/Reference/Date	Comments/Notes/Issues
		their cancer potency is estimated relative to the potency of benzo(a)pyrene through the use of toxic equivalency factors. As a result, early-life exposure to the six other cPAHs is evaluated through implementation of the same ADAFs used for BaP.		
Developmental or Reproductive Effector? (Y/N)	No	No	MDEQ, 2015	
Developmental or Reproductive Toxicity Details				
State Drinking Water Standard (SDWS) (µg/L)	NA	NO	SDWA, 1976	
SDWS details		MI Safe Drinking Water Act (SDWA) 1976 PA 399		
Secondary Maximum Contaminant Level (SMCL) (µg/L)	NA	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? (Y/N)	No	Not evaluated.	NA	
Aesthetic value details	NA	NA		
Is there a Phytotoxicity Value? (Y/N)	No	Not evaluated.	NA	
Phytotoxicity details	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)	---	0.13	MDEQ, 2015	
AEd details				
Ingestion Absorption Efficiency (AEi)		0.5	MDEQ, 2015	
AEi 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)	ID
Updated GSI value (μg/L)	ID
Rule 57 Drinking Water Value (μg/L)	ID

	Rule 57 Value (μg/L)	Verification Date
Human Non-cancer Values- Drinking water source (HNV-drink)	NLS	NA
Human Non-Cancer Values- Non-drinking water sources (HNV-Non-drink)	NLS	NA
Wildlife Value (WV)	NA	NA
Human Cancer Values for Drinking Water Source (HCV-drink)	NLS	NA
Human Cancer values for non-drinking water source (HCV-Non-drink)	NLS	NA
Final Chronic Value (FCV)	ID	12/1997
Aquatic maximum value (AMV)	ID	12/1997
Final Acute Value (FAV)	ID	12/1997

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)	330	MDEQ, 2015
Target Detection Limit – Water (μg/L)	2	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