2021 Volatile Organic Compounds Inhalation Toxicity Value Review

Purpose

The Minnesota Pollution Control Agency requested that Minnesota Department of Health (MDH) review and recommend inhalation toxicity values (inhalation unit risks [IURs] and reference concentrations [RfCs]) for use in deriving Intrusion Screening Values (ISV) for vapor intrusion investigations. IURs are defined as the upper bound excess cancer risk from a continuous lifetime exposure to a chemical, which is derived from toxicological studies. RfCs are also derived from toxicological studies and are defined by EPA as "an estimate, with uncertainty spanning perhaps an order of magnitude, of a continuous inhalation exposure to the human population, including sensitive subgroups, that is likely to be without an appreciable risk of deleterious effects during a lifetime." These values are provided here for transparency of MDH's toxicity value recommendations. Because these values were selected for use for vapor intrusion investigations, there may be exceptions to using these values for other applications.

Toxicity value selection

The sources of toxicity values used to develop the ISVs are MDH, EPA Integrated Risk Information System (IRIS), EPA's Provisional Peer Reviewed Toxicity Values (PPRTVs), California Environmental Protection Agency, and the Agency for Toxic Substances and Disease Registry (ATSDR).

MDH used professional judgment to evaluate toxicity study designs and findings to select the highest quality toxicity values available at the time, given limited review time. For some chemicals, toxicity values were available, but not used to calculate an ISV because of concerns about data quality, inappropriate use of route-to-route extrapolation, weak evidence of carcinogenicity, and other considerations.

For some chemicals (benzene, carbon disulfide, 1,2-dibromoethane, cis- and trans-1,3-dichloropropene, ethyl acetate, n-hexane, methylene chloride, styrene, toluene), the toxicity value advice is different from what was used as the basis for the MDH Health Risk Value (HRV) because newer information was available for these chemicals. The vinyl chloride IUR is different for the ISV than the HRV because MDH used a unique equation provided by EPA (EPA, 2000) that adds early-life risk to later-life risk for a less than lifetime exposure. MDH continues to support the vinyl chloride HRV for a lifetime of exposure.

In addition, MDH chose to use subchronic RfCs to calculate ISVs for three chemicals in the ISV spreadsheet (bromodichloromethane, chloroethane, and trichlorofluoromethane). MDH recommends the acute ATSDR value for methyl ethyl ketone based on an exposure study in human volunteers because it is lower than the EPA IRIS chronic value based on animal studies. These chemicals lacked acceptable chronic RfCs, but the shorter duration values were considered acceptable for vapor intrusion screening.

Incorporating early-life sensitivity for linear carcinogens

The EPA recommends combining age-dependent adjustment factors (ADAFs) with the cancer toxicity values to account for early-life sensitivity. EPA developed ADAFs of 10, 3, and 1 for the age groups of 0-2 years, 2-16 years, and 16-70 years, respectively (USEPA, 2005). MDH agrees that for many carcinogens, toxicity values calculated from adult animal studies or adult epidemiological studies underestimate lifetime exposure cancer risk. MDH applies EPA's ADAFs to linear carcinogens, unless study data sufficiently account for early-life susceptibility, or there is other chemical-specific information to determine that a different numerical adjustment should be made, or that no adjustment is appropriate (MDH, 2010). MDH reviewed the study data for the carcinogens and as a result recommends applying ADAFs to risk assessment equations for these compounds (with the exception of vinyl chloride) when the exposure scenario includes early-life.

Limitations

It may be appropriate to request further consideration of toxicity values from MDH as these recommended values do not reflect full chemical reviews. In addition, for chemicals that do not have a recommended toxicity value, it may be appropriate to contact MDH to see if *any* data exists to help determine if there is a risk for a given scenario.

Updates in 2021

- Benzene: MDH released new Health Based Values in 2020
- Bromomethane (Methyl Bromide): New value based on 2020 ATSDR
- trans, 1-2-Dichloroethylene: MDH released new Risk Assessment Advice in 2020
- Methyl Ethyl Ketone: New value based on 2020 ATSDR
- Toluene: MDH reviewed the 2020 CalEPA value and does not recommend use

References

EPA 2000. U.S. Environmental Protection Agency. Toxicological Review of Vinyl Chloride. May 2000. https://cfpub.epa.gov/ncea/iris/iris_documents/documents/toxreviews/1001tr.pdf.

EPA 2005. U.S. Environmental Protection Agency. Supplemental Guidance for Assessing Susceptibility from Early Life Exposures to Carcinogens. March 2005. http://epa.gov/cancerguidelines/guidelines-carcinogen-supplement.htm.

MDH 2010. Minnesota Department of Health. Risk Assessment Advice for Incorporating Early-Life Sensitivity into Cancer Risk Assessments for Linear Carcinogens. July 2010. http://www.health.state.mn.us/divs/eh/risk/guidance/adafrecmd.pdf.

Questions?

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2021 MDH Volatile Organic Compound Toxicity Value Review for Vapor Intrusion Screening Values

Chemical	CAS #	RfC µg/m^3	RfC Source	IUR (µg/m^3)$^{-1}$	IUR Source
Acetone	67-64-1	**31,000**	ATSDR (1994)	**NA**	NA
Benzene	71-43-2	**3**	MDH (2020)	**7.8E-06**	MDH (2020)
Benzyl chloride	100-44-7	**1**	PPRTV (2008)	**4.9E-05**	CalEPA
Bromodichloromethane[1]	75-27-4	**20**	PPRTV (2009)	**NA**	NA
Bromoform	75-25-2	**NA**	NA	**NA**	NA
Bromomethane (Methyl bromide)	74-83-9	**4**	ATSDR (2020)	**NA**	NA
1,3-Butadiene	106-99-0	**2**	IRIS (2002)	**3.6E-05**	MDH (2010)
Carbon disulfide	75-15-0	**800**	CalEPA (2002)	**NA**	NA
Carbon tetrachloride	56-23-5	**100**	IRIS (2010)	**6.0E-06**	IRIS (2010)
Chlorobenzene	108-90-7	**50**	PPRTV (2006)	**NA**	NA
Chloroethane (Ethyl chloride)[1]	75-00-3	**4000**	PPRTV (2007)	**NA**	NA
Chloroform	67-66-3	**100**	ATSDR (1997)	**NA**	NA
Chloromethane (Methyl chloride)	74-87-3	**90**	IRIS (2001)	**NA**	NA
Cyclohexane	110-82-7	**6000**	IRIS (2003)	**NA**	NA
Dibromochloromethane	124-48-1	**NA**	NA	**NA**	NA
1,2-Dibromoethane (Ethylene dibromide)	106-93-4	**0.8**	CalEPA (2001)	**6.0E-04**	IRIS (2004)
1,2-Dichlorobenzene	95-50-1	**NA**	NA	**NA**	NA
1,3-Dichlorobenzene	541-73-1	**NA**	NA	**NA**	NA
1,4-Dichlorobenzene	106-46-7	**60**	ATSDR (2006)	**NA**	NA
Dichlorodifluoromethane (Freon 12)	75-71-8	**NA**	NA	**NA**	NA
1,1-Dichloroethane	75-34-3	**NA**	NA	**NA**	NA
1,2-Dichloroethane	107-06-2	**7**	PPRTV (2010)	**2.6E-05**	IRIS (1987)
1,1-Dichloroethene (DCE)	75-35-4	**200**	IRIS (2002)	**NA**	NA
cis-1,2-Dichloroethylene	156-59-2	**NA**	NA	**NA**	NA
trans-1,2-Dichloroethylene	156-60-5	**20**	MDH (2020)	**NA**	NA
1,2-Dichloropropane	78-87-5	**4**	IRIS (1991)	**3.7E-06**	PPRTV (2016)
cis-1,3-Dichloropropene[2]	10061-01-5	**20**	IRIS (2000)	**4.0E-06**	IRIS (2000)
trans-1,3-Dichloropropene[2]	10061-02-6	**20**	IRIS (2000)	**4.0E-06**	IRIS (2000)
Dichlorotetrafluoroethane	76-14-2	**NA**	NA	**NA**	NA
Ethanol	64-17-5	**NA**	NA	**NA**	NA
Ethyl acetate	141-78-6	**70**	PPRTV (2013)	**NA**	NA
Ethylbenzene	100-41-4	**300**	ATSDR (2010)	**2.5E-06**	CalEPA (2007)
4-Ethyltoluene	622-96-8	**NA**	NA	**NA**	NA
n-Heptane	142-82-5	**400**	PPRTV (2016)	**NA**	NA
Hexachlorobutadiene	87-68-3	**NA**	NA	**NA**	NA
n-Hexane	110-54-3	**700**	IRIS (2005)	**NA**	NA
2-Hexanone	591-78-6	**30**	IRIS (2009)	**NA**	NA
Isopropanol (2-propanol, isopropyl alcohol)	67-63-0	**200**	PPRTV (2014)	**NA**	NA
Methyl ethyl ketone (MEK, 2-Butanone)[3]	78-93-3	**3000**	ATSDR (2020)	**NA**	NA
Methyl isobutyl ketone (MIBK)	108-10-1	**3000**	IRIS (2003)	**NA**	NA
Methyl-tert-butyl ether (MTBE)	1634-04-4	**3000**	IRIS (1993)	**2.6E-07**	CalEPA
Methylene Chloride (Dichloromethane)	75-09-2	**600**	IRIS (2011)	**1.0E-08**	IRIS (2011)
2-Methylnapthalene	91-57-6	**NA**	NA	**NA**	NA
Naphthalene	91-20-3	**9**	MDH (2004, 2017)	**NA**	NA

Propylene (Methylethylene)	115-07-1	**3000**	CalEPA (2000)	**NA**	NA
Styrene	100-42-5	**900**	CalEPA/ATSDR	**NA**	NA
1,1,2,2-Tetrachloroethane	79-34-5	**NA**	NA	**NA**	NA
Tetrachloroethylene (PCE)	127-18-4	**15**	MDH (2014)	**3.0E-06**	MDH (2014)
Tetrahydrofuran	109-99-9	**2000**	IRIS (2012)	**NA**	NA
Toluene (Methylbenzene)	108-88-3	**4000**	ATSDR (2017)	**NA**	NA
1,2,4-Trichlorobenzene	120-82-1	**2**	PPRTV (2009)	**NA**	NA
1,1,1-Trichloroethane (Methyl chloroform)	71-55-6	**5000**	IRIS (2007)	**NA**	NA
1,1,2-Trichloroethane	79-00-5	**0.2**	PPRTV (2011)	**NA**	NA
Trichloroethylene (TCE)	79-01-6	**2**	IRIS (2011)	**4.1E-06**	IRIS (2011)
Trichlorofluoromethane (Freon 11)[1]	75-69-4	**1000**	PPRTV (2009)	**NA**	NA
1,1,2-Trichlorotrifluoroethane (CFC-113)	76-13-1	**5000**	PPRTV (2016)	**NA**	NA
1,2,4-Trimethylbenzene	95-63-6	**60**	IRIS (2016)	**NA**	NA
1,3,5-Trimethylbenzene	108-67-8	**60**	IRIS (2016)	**NA**	NA
Vinyl acetate	108-05-4	**200**	IRIS (1990)	**NA**	NA
Vinyl chloride[4]	75-01-4	**100**	IRIS (2000)	**4.4E-06**	IRIS (2000)
m&p-Xylene[5]	179601-23-1	**100**	IRIS (2003)	**NA**	NA
o-Xylene[5]	95-47-6	**100**	IRIS (2003)	**NA**	NA

Notes:

NA = not available

[1] based on a subchronic RfC

[2] based on 1,3-Dichloropropene cas # 542-75-6

[3] based on an acute RfC

[4] this vinyl chloride IUR is based on an exposure for an adult and is used in a special equation for a less than a lifetime exposure.

MDH continues to support the HRV and the IUR of 8.8E-06 for continous exposure from birth for a lifetime of exposure.

[5] based on total xylenes cas # 1330-20-7