# 2024 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), the Agency for Toxic Substances and Disease Registry (ATSDR), and the California Environmental Protection Agency.

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, weak evidence of carcinogenicity, and other considerations.

For some chemicals the toxicity value advice is different from what was used as the basis for the 2002 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 less-than-chronic duration RfCs to calculate ISVs when chemicals lacked acceptable chronic RfCs. The shorter duration values were considered acceptable for vapor intrusion screening. These are indicated by footnotes in the main table below.

MDH reviewed available acute RfCs only if they were lower than any of the ISVs. The following table provides these additional acute toxicity values that were reviewed and are used in the ISV table per MDH recommendation:

| Chemical | CAS # | Acute RfC (µg/m$^3$) | RfC Source |
|---|---|---|---|
| Chloroform | 67-66-3 | 5 | ATSDR (2024) |
| Methylene chloride (Dichloromethane) | 75-09-2 | 2,000 | ATSDR (2000) |
| Toluene | 108-88-3 | 5,000 | CalEPA (2020) |
| 1,1,1-Trichloroethane (Methyl chloroform) | 71-55-6 | 6,000 | ATSDR (2024) |
| Vinyl acetate | 108-05-4 | 3,500 | ATSDR (2023) |

## 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 (except for 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 2024

- Acetone – New acute value (ATSDR, 2022). This is the only value available.
- Chloroform – New chronic value (ATSDR, 2024)
- Chloromethane (Methyl chloride) - New chronic value (ATSDR, 2023)
- 1,1-Dichloroethene (DCE) - New chronic value (ATSDR, 2022)
- 1,4-Dioxane – Reviewed at MPCA's request; added a new chronic value and IUR (IRIS, 2013)
- Methyl tert-butyl ether (MTBE) - New chronic value (ATSDR, 2023)
- 2-Methylnaphthalene – New short-term value (ATSDR, 2024). This is the only value available.
- Vinyl acetate - New chronic value (ATSDR, 2023)
- Vinyl chloride - New subchronic value (ATSDR, 2024) replaces a higher chronic value.
- MDH reviewed and recommended the acute values in the above table.

## 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.

# 2024 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[1] | 67-64-1 | **20,000** | ATSDR (2022) | **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[2] | 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)[2] | 75-00-3 | **4,000** | PPRTV (2007) | **NA** | NA |
| Chloroform | 67-66-3 | **2** | ATSDR (2024) | **NA** | NA |
| Chloromethane (Methyl chloride) | 74-87-3 | **60** | ATSDR (2023) | **NA** | NA |
| Cyclohexane | 110-82-7 | **6,000** | 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 | **4** | ATSDR (2022) | **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[3] | 10061-01-5 | **20** | IRIS (2000) | **4.0E-06** | IRIS (2000) |
| trans-1,3-Dichloropropene[3] | 10061-02-6 | **20** | IRIS (2000) | **4.0E-06** | IRIS (2000) |
| Dichlorotetrafluoroethane | 76-14-2 | **NA** | NA | **NA** | NA |
| 1,4-Dioxane | 123-91-1 | **30** | IRIS (2013) | **5.0E-06** | IRIS (2013) |

| Chemical | CAS # | RfC µg/m$^3$ | RfC Source | IUR (µg/m$^3$)$^{-1}$ | IUR Source |
|---|---|---|---|---|---|
| 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)[1] | 78-93-3 | **3,000** | ATSDR (2020) | **NA** | NA |
| Methyl isobutyl ketone (MIBK) | 108-10-1 | **3,000** | IRIS (2003) | **NA** | NA |
| Methyl-tert-butyl ether (MTBE) | 1634-04-4 | **4,000** | ATSDR (2023) | **2.6E-07** | CalEPA |
| Methylene Chloride (Dichloromethane) | 75-09-2 | **600** | IRIS (2011) | **1.0E-08** | IRIS (2011) |
| 2-Methylnapthalene[4] | 91-57-6 | **2** | ATSDR (2024) | **NA** | NA |
| Naphthalene | 91-20-3 | **9** | MDH (2004, 2017) | **NA** | NA |
| Propylene (Methylethylene) | 115-07-1 | **3,000** | 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 | **2,000** | IRIS (2012) | **NA** | NA |
| Toluene (Methylbenzene) | 108-88-3 | **4,000** | 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 | **5,000** | 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)[2] | 75-69-4 | **1,000** | PPRTV (2009) | **NA** | NA |
| 1,1,2-Trichlorotrifluoroethane (CFC-113) | 76-13-1 | **5,000** | 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 | **1,100** | ATSDR (2023) | **NA** | NA |
| Vinyl chloride[5] | 75-01-4 | **50** | ATSDR (2024) | **4.4E-06** | IRIS (2000) |
| m&p-Xylene[6] | 179601-23-1 | **100** | IRIS (2003) | **NA** | NA |

| Chemical | CAS # | RfC µg/m$^3$ | RfC Source | IUR (µg/m$^3$)$^{-1}$ | IUR Source |
|---|---|---|---|---|---|
| o-Xylene[6] | 95-47-6 | **100** | IRIS (2003) | **NA** | NA |

Notes

NA = not available
[1] based on an acute RfC
[2] based on a subchronic RfC
[3] based on 1,3-Dichloropropene cas # 542-75-6
[4] based on a short-term RfC
[5] 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 continuous exposure from birth for a lifetime of exposure.
[6] based on total xylenes cas # 1330-20-7

# Contact Information

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