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Published May 2017; updated November 2021, updated April 2025

The Vermont Department of Health (Health) develops and maintains two sets of chemical-specific values, Residential Air Values (RAVs) and Nonresidential Air Values (NAVs), which may be used in the evaluation of potential exposure to chemicals in indoor air. RAVs are appropriate for consideration in the assessment of potential residential exposure to chemicals in indoor air. NAVs are appropriate for consideration in the assessment of potential exposure to chemicals in indoor air under a hypothetical nonresidential exposure scenario.

The 2025 list of chemicals and associated values are presented in Attachment 1. Additional chemicals may be considered for evaluation and potential inclusion based on request by other State of Vermont offices, in response to public comments or as deemed appropriate by Health.

A detailed summary of toxicity values, endpoint-specific risk-based concentrations and any chemical-specific notes of interest is presented in Attachment 2.

In addition, a brief chemical-specific monograph summarizing the information available for review, scenario-specific value and derivation thereof is prepared. Any variance from the general process is noted.

Each value is based upon the best available information at the time of derivation; therefore, is subject to change as updated information and risk assessment methodologies become available.

This memo provides an overview of the general approach used to develop the 2025 RAVs and NAVs and how these values are recommended to be applied.

RAV and NAV Derivation Process and Application

In general, RAVs are generated by combining current toxicity values (e.g., inhalation reference concentrations and inhalation unit risks) with a hypothetical residential exposure scenario using standard point estimate risk assessment procedures to derive an estimate of the concentration of each individual chemical in indoor air that corresponds to a fixed level of risk i.e., a target Hazard Quotient (THQ) of 1.0 for noncarcinogenic (systemic, threshold) effects or a target incremental lifetime cancer risk (ILCR) of one-in-one million (1×10^{-6}).

Similarly, NAVs are generated by combining current toxicity values (e.g., inhalation reference concentrations and inhalation unit risks) with a hypothetical nonresidential exposure scenario using standard point estimate risk assessment procedures to derive an estimate of the concentration of each individual chemical

in indoor air that corresponds to a fixed level of risk i.e., a THQ of 1.0 for noncarcinogenic (systemic, threshold) effects or a target ILCR of 1 x 10^{-6}.

For each scenario, where a chemical is known to have both noncarcinogenic and carcinogenic effects and toxicity values are available, a value is derived based on each endpoint with the most conservative reported as the value for that chemical under that scenario. Thus, the most conservative value derived for each chemical based on the residential scenario is reported as the RAV for that chemical. Likewise, the most conservative value derived for each chemical based on the nonresidential scenario is reported as the NAV for that chemical.

In those instances where values are based upon carcinogenic effects, if more than one chemical is reported in excess of its analytical laboratory reporting limit, it is recommended that a receptor and medium-specific cumulative (total) ILCR be estimated (i.e., a Residential Air or Nonresidential Air cumulative ILCR) and compared to a target cumulative ILCR of 1 x 10^{-6}. This can be accomplished using the following approach where *i* represents the i^{th} such chemical reported in indoor air and, as described above, the target ICLR associated with each cancer based indoor air level (SL) is 1 x 10^{-6}:

$$MediumCumulativeILCR_{(\mathrm{Re}sident\ or\ Nonresident)} = \sum_{i=1}^{n}(SiteConcentration_i)(1x10^{-6})/(\mathrm{Re}sidentialorNonresidentialSL_i)\ .$$

A receptor and medium-specific cumulative ILCR in excess of 1 x 10^{-6} indicates a closer look at the medium in question or further consideration is warranted.

If more than one environmental medium is under investigation, it is recommended that medium-specific ICLRs for the same hypothetical receptor (e.g., Hypothetical Resident) be summed to yield a receptor-specific estimate of total site ILCR. A receptor-specific total site ILCR in excess of 1 x 10^{-6} indicates a closer look at the area in question or further consideration is warranted.

Similarly, for noncarcinogenic effects, it is recommended that a medium-specific total HQ, termed a Hazard Index (HI is the sum of two or more HQs), be estimated for each receptor (Residential and Nonresidential) and compared to a target Total HI=1.0. HQ are summed across all chemicals to develop the HI; chemicals are not segregated by critical effect. This can be accomplished using the following approach where *i* represents the i^{th} such chemical reported in indoor air and, as described above, the target HQ associated with each noncancer risk-based value is 1:

$$MediumTotalHazardIndex_{(\mathrm{Re}sident\ or\ Nonresident)} = \sum_{i=1}^{n}(SiteConcentration_i)(1)\ /\ (\mathrm{Re}sidentialorNonresidentialSL_i)$$

A medium-specific total HI in excess of 1 for a receptor suggests further consideration is warranted.

Direct exposure via inhalation of indoor air is the only route of exposure considered in the development of RAVs and NAVs. These evaluations do not take into account potential existing concentrations of these chemicals in either indoor or ambient air.

Toxicity

Toxicity information and inhalation and oral toxicity values are obtained and reviewed from a number of relevant and appropriate sources including:

- U.S. Environmental Protection Agency (EPA) Integrated Risk Information System
- U.S. EPA Office of Pesticide Programs
- U.S. EPA Office of Research and Development/National Center for Environmental Assessment / Superfund Health Risk Technical Support Center (STSC) Provisional Peer Reviewed Toxicity Values

- International Agency for Research on Cancer
- National Toxicology Program
- California EPA Office of Environmental Health Hazard Assessment
- California Department of Pesticide Regulation
- Agency for Toxic Substances and Disease Registry

Mutagenic Mode of Action

Consistent with U.S. EPA guidance (EPA, 2005), multipliers termed Age Dependent Adjustment Factors (ADAFs) are used in the evaluation of carcinogens identified by U.S. EPA to operate via a mutagenic mode of action. Such chemicals are noted in the detailed Summary Table (Attachment 2). Per the guidance, ADAFs "…reflect the potential for early-life exposure to make a greater contribution to the cancers appearing later in life."

Chemical-specific ADAFs are used if available.

Otherwise, the following non-chemical specific, default adjustments provided by U.S. EPA are employed:
- A 10-fold increase for exposures between the day of birth up until the second birthday.
- A 3-fold increase for exposures between the second birthday up until the sixteenth birthday.
- No adjustment is made for exposures occurring after turning 16 years of age.

Exposure

Several conservative assumptions are made in order to estimate the potential intake of a chemical in indoor air by a hypothetical receptor. In reality, the magnitude and frequency of exposure will vary depending on individual circumstances. The use of such health protective assumptions, which tend to represent reasonable upper bound estimates of exposure, adds additional conservatism to the two sets of values derived.

Overall, for the residential scenario, a 70-year time-weighted approach (birth to age 70 years) is employed in the assessment of carcinogens. Continual exposure is assumed.

For the nonresidential scenario, a hypothetical adult is assumed to be on-site 10 hours per day (BLS, 2016), 250 days per year (EPA, 1991) for 30 years. A 70-year lifetime is assumed. A 30-year time-weighted approach is employed in the assessment of carcinogens.

A summary of exposure assumptions and factors employed in the development of the 2019 RAVs and NAVs is presented in Attachment 3.

Equations

Endpoint and exposure route specific equations used in development of the 2025 RAVs and NAVs are presented in Attachment 4. These equations combine chemical-specific toxicity information with scenario-specific exposure assumptions to generate a level in indoor air estimated to correspond to a fixed level of risk i.e., a THQ of 1.0 or ILCR of 1×10^{-6}.

References

BLS, 2016. United States Bureau of Labor Statistics. Division of Labor Force Statistics. Labor Force Statistics from the Current Population Survey. Household Data Annual Average. Last modified February 8, 2017. Accessed 3/28/2017) https://www.bls.gov/cps/cpsaat19.htm

EPA, 1991. Human Health Evaluation Manual, Supplemental Guidance: "Standard Default Exposure Factors". Unites States Environmental Protection Agency. Office of Solid Waste and Emergency Response. OSWER Publication 9285.6-03. March 1991.

EPA, 2005. Supplemental Guidance for Assessing Susceptibility from Early-Life Exposure to Carcinogens. U.S. Environmental Protection Agency. Washington, D.C. EPA/630/R-03/003F. March 2005.

Attachment 1

2025 Indoor Air Values (µg/m^3)

Chemical Name	CAS Number	Residential Air Value µg/m^3	Residential Air Value Endpoint	Nonresidential Air Value µg/m^3	Nonresidential Air Value Endpoint
Benzene	71-43-2	0.13	C	1.05	C
Carbon tetrachloride	56-23-5	0.17	C	1.36	C
Chlordane (technical mixture)	12789-03-6	0.010	C	0.082	C
Chloroethane	75-00-3	4000	NC	14016	NC
Chloroform	67-66-3	0.043	C	0.36	C
Dichloroethane, 1,1-	75-34-3	0.63	C	5.11	C
Dichloroethene, 1,1-	75-35-4	4.0	NC	14	NC
Ethylbenzene	100-41-4	0.40	C	3.27	C
Mercury (elemental)	7439-97-6	0.30	NC	0.30	NC
Methylene chloride	75-09-2	60	C	818	C
Naphthalene	91-20-3	0.029	C	0.24	C
Polychlorinated Biphenyls (high risk)	1336-36-3	0.0018	C	0.014	C
Tetrachloroethylene	127-18-4	0.63	C	5.11	C
Trichloroethylene	79-01-6	0.20	NC	0.70	NC
Trimethylbenzene, 1,2,3-	526-73-8	60 (a)	NC	210 (a)	NC
Trimethylbenzene, 1,2,4-	95-63-6	60 (a)	NC	210 (a)	NC
Trimethylbenzene, 1,3,5-	108-67-8	60 (a)	NC	210 (a)	NC
Vinyl chloride	75-01-4	0.11	C	1.86	C

Abbreviations

µg/m3 - micrograms per cubic meter

CAS - Chemical Abstracts Service

C - value corresponds to a one-in-one-million incremental lifetime cancer risk

NC - value corresponds to a noncancer Hazard Quotient of 1.0

Notes

(a) Trimethylbenzenes - The sum of the 3 isomers should not exceed 60 µg/m^3 for Residential - Indoor Air and not exceed 210 µg/m^3 for Nonresidential - Indoor Air.

Attachment 2
Summary Table
2025 Indoor Air Values (µg/m^3)

		Toxicity and Chemical Specific Information						Resident Air Value		Nonresidential Air Value	
Chemical Name	**CAS No.**	**IUR (µg/m^3)$^{-1}$**	**IUR Reference**	**Note**	**RfC mg/m^3**	**RfC Reference**	**Note**	**Cancer Target Risk 1x10^{-6} (µg/m^3)**	**Noncancer Hazard Quotient = 1 (µg/m^3)**	**Cancer Target Risk 1x10^{-6} (µg/m^3)**	**Noncancer Hazard Quotient = 1 (µg/m^3)**
Benzene	71-43-2	7.80E-06	I	a	3.00E-02	I	--	0.13	30	1.05	105
Carbon tetrachloride	56-23-5	6.00E-06	I		1.00E-01	I	--	0.17	100	1.36	350
Chlordane (technical mixture)	12789-03-6	1.00E-04	I		7.00E-04	I	--	0.010	0.70	0.082	2.5
Chloroethane	75-00-3	--	--		4.00E+00	P	--	--	4000	--	14016
Chloroform	67-66-3	2.30E-05	I		1.95E-03	A	--	0.043	2	0.36	6.8
Dichloroethane, 1,1-	75-34-3	1.60E-06	CE		--	--	--	0.63	--	5.11	--
Dichloroethene, 1,1-	75-35-4	--	--		3.96E-03	A	--	--	4	--	14
Ethylbenzene	100-41-4	2.50E-06	CE		2.60E-01	A	--	0.40	260	3.27	911
Mercury (elemental)	7439-97-6	--	--		3.00E-04	I	e	--	0.30	--	0.30
Methylene chloride	75-09-2	1.00E-08	I	mmoa	6.00E-01	I		60.3	600	818	2102
Naphthalene	91-20-3	3.40E-05	CE		3.00E-03	I	--	0.029	3.0	0.24	11
Polychlorinated Biphenyls (high risk)	1336-36-3	5.71E-04	I (Aroclor 1254)		8.00E-05	CE	--	0.0018	0.08	0.014	0.28
Tetrachloroethylene	127-18-4	1.60E-06	I	b	4.00E-02	I	--	0.63	40	5.11	140
Trichloroethylene	79-01-6	3.1E-06/1.0E-06	I	non-mmoa & mmoa	2.00E-03	I	d	0.25	0.20	1.99	0.70
Trimethylbenzene, 1,2,3-	526-73-8	--	--		6.00E-02	I	f	--	60	--	210
Trimethylbenzene, 1,2,4-	95-63-6	--	--		6.00E-02	I	f	--	60	--	210
Trimethylbenzene, 1,3,5-	108-67-8	--	--		6.00E-02	I	f	--	60	--	210
Vinyl chloride	75-01-4	8.8E-06/4.4E-06	I	c, mmoa	5.11E-02	A	--	0.11	51	1.86	179

Abbreviations

A - ATSDR
CAS No. - Chemical Abstracts Service Registration Number
IUR - Inhalation Unit Risk
RfC - Inhalation Reference Concentration
CE - California Environmental Protection Agency
I - U.S. EPA Integrated Risk Information System
P - EPA Provisional Peer Reviewed Toxicity Value (PPRTV)
mmoa - carcinogen identified by U.S. EPA to operate via mutagenic mode of action
non-mmoa - carcinogenic but not identified by U.S. EPA to operate via a mutagenic mode of action
µg/m3 - micrograms per cubic meter

Notes

a. Benzene - Most conservative end of range of IUR presented in IRIS citation dated 1/19/2000 [2.2E^{-06} to 7.8E^{-06} (µg/m^3)$^{-1}$]
b. Tetrachloroethylene - Geometric mean of IUR presented in IRIS citation dated 2/10/12 [2.6E^{-07} (µg/m^3)$^{-1}$ based on hepatocellular adenoma/carcinoma & 1E-05 (µg/m^3)$^{-1}$ based on mononuclear cell leukemia]
c. Vinyl chloride - Residential IUR 8.8E^{-6}(µg/m^3)$^{-1}$ based on continuous lifetime exposure from birth, Nonresidential IUR of 4.4E^{-06} (µg/m^3)$^{-1}$ based on continuous lifetime exposure during adulthood.
d. Trichloroethylene - Due to the nature and severity of a particular non-cancer endpoint (fetal cardiac malformations) that may be associated with a brief window of susceptibility, there is significant uncertainty regarding the exposure period of concern. Thus, a target hazard quotient of 0.1 was used in the calculation of noncancer values.
e. Mercury - Due to the developmental toxicity associated with mercury exposure, the Reference Concentration is used as the nonresidental air value without adjusting for the exposure period.
f. Trimethyl benzenes - The sum of the 3 isomers should not exceed 60 µg/m3 for Residential - Indoor Air and not exceed 210.24 µg/m3 for Nonresidential - Indoor Air.