Screening Values for Residential and Nonresidential Indoor Air

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VERMONT
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Introduction

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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.

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.

Screening Value Derivation

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 1×10^{-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}:

Equation 1.

$$Cumulative\ ILCR_{(Residental or\ Nonresidental)} = \sum_{i=1}^{n} (Site\ Concentration_i)(1x10^{-6})/(Residental\ or\ Nonresidental\ SV_i)$$

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:

Equation 2.

$$Total\ Hazard\ Index_{(Residental or\ Nonresidental)} = \sum_{i=1}^{n} (Site\ Concentration_i)(1)/(Residental\ or\ Nonresidental\ SV_i)$$

A 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.

Toxicity Values

Toxicity information and inhalation and oral toxicity values are obtained from relevant sources including:

- Environmental Protection Agency (EPA) Integrated Risk Information System
- EPA Office of Pesticide Programs
- EPA Provisional Peer-Reviewed Toxicity Values (PPRTVs)
- International Agency for Research on Cancer
- National Toxicology Program
- California EPA Office of Environmental Health Hazard Assessment
- Agency for Toxic Substances and Disease Registry

Mutagenic Mode of Action

Consistent with EPA guidance (EPA 2005), multipliers termed Age Dependent Adjustment Factors (ADAFs) are used in the evaluation of carcinogens identified by 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 Assumptions

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 2025), 250 days per year (EPA 2024) 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 2025 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 x 10-6.

References

BLS 2025. 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 January 2025. Accessed 11/2025) https://www.bls.gov/cps/cpsaat19.htm

EPA 2024. United States Environmental Protection Agency. Regional Screening Levels (RSLs) User's Guide. November 2024 edition. (accessed 2025). https://www.epa.gov/risk/regional-screening-levels-rsls-usersguide.

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 Endponit	Nonresidential Air Value (µg/m^3)	Nonresidential 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 and 210 µg/m^3 for Nonresidential Indoor Air.

Attachment 2
Chemical Specific Cancer and Noncancer Values

Chemical Name	CAS No.	IUR ($\mu g/m^3)^{-1}$	IUR Reference	Note	RfC mg/m^3	RfC Reference	Note	Residental Air Value Cancer ($\mu g/m^3$)	Residental Air Value Noncancer ($\mu g/m^3$)	Nonresidential Air Value Cancer ($\mu g/m^3$)	Nonresidential Air Value Noncancer ($\mu g/m^3$)
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 $7.8E^{-06}$ $(\mu g/m^3)^{-1}$]
b. Tetrachloroethylene - Geometric mean of IUR presented in IRIS citation dated 2/10/12 [$2.6E^{-07}$ $(\mu g/m^3)^{-1}$ based on hepatocellular adenoma/carcinoma & 1E-05 $(\mu g/m^3)^{-1}$ based on mononuclear cell leukemia]
c. Vinyl chloride - Residential IUR $8.8E^{-6}$ $(\mu g/m^3)^{-1}$ based on continuous lifetime exposure from birth, Nonresidential IUR of $4.4E^{-06}$ $(\mu g/m^3)^{-1}$ 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.
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.

Attachment 3
Exposure Assumptions

Symbol	Definition (Units)	Value	Reference
RAV	Residential Air Value (µg/m^3)	Chemical-Specific	Attachments 1, 2, 4
$RAV_{nc\text{-}inh}$	Resident, Air, Noncancer, Inhalation (µg/m^3)	Chemical-Specific	Attachments 4
$RAV_{ca\text{-}inh}$	Resident, Air, Cancer, Inhalation (µg/m^3)	Chemical-Specific	Attachments 4
$RAV_{m\text{-}inh}$	Resident, Air, Mutagenic, Inhalation (µg/m^3)	Chemical-Specific	Attachments 4
NAV	Nonresidential Air Value (µg/m^3)	Chemical-Specific	Attachments 1, 2, 4
$NAV_{nc\text{-}inh}$	Nonresidential, Air, Noncancer, Inhalation (µg/m^3)	Chemical-Specific	Attachments 4
$NAV_{ca\text{-}inh}$	Nonresidential, Air, Cancer, Inhalation (µg/m^3)	Chemical-Specific	Attachments 4
RfC	Chronic Inhalation Reference Concentration (mg/m^3)	Chemical-Specific	Attachment 2
IUR	Inhalation Unit Risk (µg/m^3)$^{-1}$	Chemical-Specific	Attachment 2
THQ	Target Hazard Quotient (unitless)	1.0	See Text
TR	Target Incremental Lifetime Cancer Risk (unitless)	$1x10^{-6}$	See Text
LT	Lifetime (years)	70	EPA 2024
$AT_{R\text{-}ca}$	Averaging Time, Resident, Cancer (days)	25550	Calculated
$AT_{N\text{-}nc}$	Averaging Time, Nonresidential, Noncancer (days)	10950	Calculated
$AT_{N\text{-}ca}$	Averaging Time, Nonresidential, Cancer (days)	25550	Calculated
$EF_{R\ (all\ ages)}$	Resident Exposure Frequency (days/year)	365	See Text
EF_N	Nonresidential Exposure Frequency (days/year)	250	EPA 2024
ED_R	Resident Exposure Duration (years)	70	See Text
$ED_{Birth\text{-}<2yr}$	Resident Exposure Duration, Child $_{Birth\text{-}<2years}$ (years)	2	Calculated
$ED_{2\text{-}<6yr}$	Resident Exposure Duration, Child $_{2\text{-}<6years}$ (years)	4	Calculated
$ED_{6\text{-}<16yr}$	Resident Exposure Duration, Child $_{6\text{-}<16years}$ (years)	10	Calculated
$ED_{16\text{-}<18yr}$	Resident Exposure Duration, Child $_{16\text{-}<18years}$ (years)	2	Calculated
ED_A	Resident Exposure Duration, Adult (years)	52	Calculated
ED_N	Nonresidential Exposure Duration (years)	30	(a)
$ET_{R\ (all\ ages)}$	Resident Exposure Time (hours/day)	24	EPA 2024
ET_N	Nonresidential Exposure Time (hours/day)	10	BLS 2025
$IFAM_{R\text{-}adj}$	Resident Mutagenic Air Inhalation Factor, age-adjusted (hours)	1,016,160	Attachment 4

Notes

(a) General estimate of years of service for full benefits

References

BLS 2025. 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 January 2025. Accessed 11/2025)

EPA 2024. United States Environmental Protection Agency. Regional Screening Levels (RSLs) User's Guide. November 2024 edition. (accessed 2025).

Attachment 4
Scenario, Endpoint and Pathway Specific Equations

Residential Air Value Equations

Equation 1.Noncancer Residential Air Value

$$RAV_{nc-inh}(\mu g/m^3) = Inhalation\ Reference\ Concentration\ (RfC)\ (\mu g/m^3) * \text{THQ}$$

Equation 2. Cancer Residential Air Value

$$RAV_{ca-inh}(\mu g/m^3) = \frac{TR * AT_{R-ca}\left(\frac{365\ days}{year} * LT\ (70\ years)\right)}{IUR(^{\mu g}/_{m^3})^{-1} * EF_R\left(\frac{365\ days}{year}\right) * ED_R(70\ years) * ET_R\left(\frac{24\ hours}{day} * \frac{1\ day}{24\ hours}\right)}$$

Equation 3. Mutagenic Mode of Action and Default ADAFs

$$RAV_{m-inh}(\mu g/m^3) = \frac{TR * AT_{R-ca}\left(\frac{365\ days}{year} * LT\ (70\ years)\right)}{IUR(^{\mu g}/_{m^3})^{-1} * \left(\frac{1\ day}{24\ hours}\right) * IFAM_{R-adj}(1{,}016{,}160\ hours)}$$

Equation 3. (continued)

Where:

$IFAM_{R\text{-}adj}$ (1,016,160 hours) =

$$[ET_{Birth-<2yr}\left(\frac{24\ hours}{day}\right) * EF_{Birth-<2yr}\left(\frac{365\ days}{year}\right) * ED_{Birth-<2yr}(2\ years) * 10] +$$

$$[ET_{2-<6yr}\left(\frac{24\ hours}{day}\right) * EF_{2-<6yr}\left(\frac{365\ days}{year}\right) * ED_{2-<6yr}(4\ years) * 3] +$$

$$[ET_{6-<16yr}\left(\frac{24\ hours}{day}\right) * EF_{6-<16yr}\left(\frac{365\ days}{year}\right) * ED_{6-<16yr}(10\ years) * 3] +$$

$$[ET_{16-<18yr}\left(\frac{24\ hours}{day}\right) * EF_{16-<18yr}\left(\frac{365\ days}{year}\right) * ED_{16-<18yr}(2\ years) * 1] +$$

$$[ET_{A}\left(\frac{24\ hours}{day}\right) * EF_{A}\left(\frac{365\ days}{year}\right) * ED_{A}(52\ years) * 1]$$

2. Nonresidential Air Values Equations

Equation 4. Noncancer Nonresidential Air Value

$$NAV_{nc-inh}(\mu g/m^3) = \frac{THQ * AT_{N-nc}\left(\frac{365\ days}{year} * ED_N\ (30\ years)\right) * \left(\frac{1000\ \mu g}{mg}\right)}{\frac{1}{RfC(\frac{mg}{m^3})} * EF_N\left(\frac{250\ days}{year}\right) * ED_N(30\ years) * ET_N\left(\frac{10\ hours}{day} * \frac{1\ day}{24\ hours}\right)}$$

Equation 5. Cancer Nonresidential Air Value

$$NAV_{ca-inh}(\mu g/m^3) = \frac{TR * AT_{N-ca}\left(\frac{365\ days}{year} * LT\ (70\ years)\right)}{IUR\left({}^{\mu g}/_{m^3}\right)^{-1} * EF_N\left(\frac{250 days}{year}\right) * ED_N(30\ years) * ET_N\left(\frac{10\ hours}{day} * \frac{1\ day}{24\ hours}\right)}$$