Public Health Implications of Volatile Organic Compounds in Sub-Slab Samples in Arlington, VA

ARLINGTON, VA

Letter Health Consultation

March 3, 2017

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COMMONWEALTH of VIRGINIA

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Arlington Department of Human Services
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Dear Dr. Varghese,

The Virginia Department of Health (VDH) was contacted by an Arlington, VA resident on January 20, 2017, who is concerned about volatile organic compounds (VOCs). Sub-slab air sampling concentrations of VOCs were found beneath their residence as part of an investigation of Fairlington Cleaners in Alexandria, VA. The resident asked about medical tests for VOCs, and an interpretation of the sub-slab air sampling report. VDH concludes that the indoor air calculated concentrations of VOCs reported are not a health hazard because the concentrations are below non-cancer comparison values and the calculated cancer risk is low. Vapor intrusion can exhibit variability from a daily to seasonal basis. Multiple sampling events in multiple seasons are recommended to characterize variation in vapor intrusion over time.

DISCUSSION

VDH has limited information at this time regarding the source of the VOCs and any ongoing environmental investigation. With that in mind this health consult briefly discusses the public health implications of the reported sub-slab concentrations.

Vapor intrusion and determining indoor air concentrations

The discussion begins with a description of vapor intrusion and attenuation factors described by the U.S. Environmental Protection Agency (EPA).[1] A picture of vapor intrusion is attached.

> *Vapor intrusion (VI) is the general term given to the migration of volatile chemicals from subsurface contaminated soils and groundwater into the indoor air spaces of overlying buildings through openings in the building foundation (for example, cracks and utility openings). A key concept of VI is that the vapor concentrations attenuate (decrease) as the vapors migrate. The attenuation occurs as a result of the processes that control vapor migration in soil (for example, diffusion, advection, sorption, and potentially*

degradation), coupled with the dilution that results when the vapors enter a building and mix with indoor air. The term "attenuation factor," defined as the ratio of indoor air concentration to subsurface concentration, is used as a measure of the decrease in concentration that occurs during vapor migration and may vary with space and time.[1]

VDH multiplies the attenuation factor (0.03) times the sub-slab concentration to calculate the indoor air concentration to assist the risk assessor with determining what concentration of VOCs the residents may be inhaling.

Using the sub-slab concentration of tetrachloroethene as an example:

$$\text{calculated indoor air concentration} = \text{subslab concentration x attentuation factor}$$

$$\text{tetrachloroethene}_{(\text{calculated indoor air concentration})} = 180\ \mu g/m^3\ \text{x}\ 0.03 = \mathbf{5.4\ \mu g/m^3}$$

where 0.03 is the attenuation factor.[1]

November 2016 Sub-slab volatile organic compounds concentration and comparison values

Volatile organic compound	Sub-Slab concentration	Calculated indoor air concentration	Comparison Value	Source & Type
Acetone	69.5	2.09	31,000	ATSDR Chronic EMEG
Carbon tetrachloride	ND		0.17	ATSDR CREG
			190	ATSDR Chronic EMEG
Ethylbenzene	ND		260	ATSDR Chronic EMEG
n-Heptane	1.97J	0.06J	N/A	N/A
Methylene chloride	ND		63	ATSDR CREG
			1000	ATSDR Chronic EMEG
Methyl ethyl ketone (2-Butanone)	5.07	0.15	5,000	EPA RfC
Propene	5.99	0.18	N/A	N/A
Tetrachloroethene (tetrachloroethylene, PERC)	**180**	**5.4**	3.8	ATSDR CREG
			41	ATSDR Chronic EMEG
Tetrahydrofuran	8.61	0.26	2000	EPA RfC
Toluene	10.7	0.32	3,800	ATSDR Chronic EMEG
1,1,1-Tri-chloroethane	ND		5,000	EPA RfC
Trichlorofluoro-methane (Freon 11)	3.15 J	0.09 J	N/A	N/A

[1] U.S. EPA. OSWER Technical Guide for Assessing and Mitigating the Vapor Intrusion Pathway from Subsurface Vapor Sources to Indoor Air. **June 2015.**

Volatile organic compound	Sub-Slab concentration	Calculated indoor air concentration	Comparison Value	Source & Type
1,2,4-Trimethyl-benzene	1.97 J	0.06 J	60	EPA RfC
o-Xylene	ND		220*	EPA RfC
m- & p-Xylenes	2.61 J	0.08 J	220*	EPA RfC

All units in µg/m^3 (micrograms per cubic meter). *Comparison value for total xylenes. **Bold** face concentrations are above their comparison value. **N/A** = not available. **J** = detected but below the reporting limit; therefore, result is an estimated concentration. **ND** = not detected. **EMEG** = environmental medium evaluation guide. **CREG** = cancer risk evaluation guide. **RfC** = reference concentration.

Comparison values are used to evaluate indoor air concentrations

After calculating the indoor air concentration, this concentration is compared to health-based values called, comparison values (CVs). CVs allow the risk assessor to screen a large number of chemicals to determine which ones may be a health hazard. Indoor air concentrations greater than their CVs are not necessarily a health hazard, but require further evaluation. CVs used in this health consultation include cancer and non-cancer CVs.

Environmental Media Evaluation Guides (EMEGs) are estimated contaminant concentrations that are not expected to result in adverse non-carcinogenic health effects based on ATSDR evaluation. They are based on conservative assumptions about exposure, such as intake rate, exposure frequency and duration, and body weight. ATSDR has developed EMEGs that apply to acute (14 days or less), intermediate (15–364 days) and chronic (365 days or more) exposures.

Cancer Risk Evaluation Guides (CREGs) are estimated contaminant concentrations that would be expected to cause no more than one excess cancer in a million persons exposed during their lifetime. ATSDR's CREGs are calculated from EPA's cancer slope factors for oral exposures or unit risk values for inhalation exposures. These values are based on EPA evaluations and assumptions about cancer risks at low levels of exposure.

Reference concentrations (RfCs) are derived by EPA and are an estimate (with uncertainty spanning perhaps an order of magnitude) of a continuous inhalation exposure of a chemical to the human population through inhalation (including sensitive subpopulations), that is likely to be without risk of deleterious non-cancer effects during a lifetime.

The only CV that was exceeded was tetrachloroethene's CREG.

Evaluating tetrachloroethene's cancer risk

VDH assesses the additional cancer risk posed by the calculated indoor air concentration of tetrachloroethene by multiplying the concentration by EPA's inhalation unit risk (IUR) for tetrachloroethene, 2.6×10^{-7} per µg/m^3. The IUR is an estimate of the increased cancer risk from inhalation exposure to a concentration of 1 µg/m^3 of a carcinogen for a lifetime. The IUR can be multiplied by an estimate of lifetime exposure (e.g., 5.4 $\mu g/m^3$ tetrachloroethene) to estimate the lifetime cancer risk.

$$\text{calculated cancer risk} = 2.6 \times 10^{-7} \text{ per } \mu g/m^3 \times 5.4\ \mu g/m^3 = 1.4 \text{ in one million}$$

This increased calculated cancer risk from inhaling 5.4 $\mu g/m^3$ of tetrachloroethene for a lifetime is considered extremely low. Regulatory agencies consider a 1 in 10,000 risk to be low and 1 in 1,000,000 to be extremely low. Anything between that range is considered acceptable.

LIMITATIONS

The use of attenuation factors to determine indoor air concentrations has several limitations. Attenuation factors from sub-slab vapor to indoor air concentrations depend upon the assumption that the slab is solid. If there are direct routes to indoor air (for example, cracks, expansion joints, utility line openings, drain pipes, or sumps) the generic attenuation factor may be too high. In these cases it is more accurate to measure indoor air concentrations. Also, vapor intrusion can exhibit variability from a daily to seasonal basis.

In addition, indoor air levels may vary with environmental conditions. Changes in temperature, ambient air pressure, wind direction and speed, and indoor air pressure can alter the pressure gradient from sub-slab to building and change the rate of diffusion into the indoor air.

Finally, the below-ground plume can change in direction or extent with changing environmental conditions. Changes in groundwater levels, ground contour or coverage, or vegetation can change the hydraulic gradient and alter the plume.

CONCLUSION

VDH concludes that the indoor air calculated concentrations of VOCs reported are not a health hazard because the concentrations are below non-cancer comparison values and the calculated cancer risk is low.

RECOMMENDATION

Vapor intrusion can exhibit variability from a daily to seasonal basis. Multiple sampling events in multiple seasons are recommended to characterize variation in vapor intrusion over time.

PUBLIC HEALTH ACTIONS

VDH has provided medical testing information to the concerned resident and is working with Arlington Public Health Division staff to develop outreach material for other residents in your district that may similar concerns.

I trust that you will find this useful. If you have any questions please contact me at (804) 864-8127 or via email: dwight.flammia@vdh.virginia.gov

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ATTACHMENT

Vapor intrusion illustration (Taken from EPA)[1]