R 299.5713 Rescinded.

R 299.5714 Generic cleanup criteria for groundwater based on hazardous substance vapors emanating from groundwater to indoor air.

Rule 714. (1) Inhalation of hazardous substance vapors volatilizing from groundwater to indoor air shall be considered a reasonable and relevant exposure pathway for hazardous substances in groundwater that have a Henry's law constant greater than or equal to 0.00001 atm-m^3/mole.

(2) Except as provided in subrule (1) of this rule, if any of the following conditions exist, the generic criteria developed pursuant to this rule shall not apply and a site-specific evaluation of indoor inhalation risks shall be conducted:

(a) There is a structure present or planned to be constructed at the facility which does not have a concrete block or poured concrete floor and walls.

(b) The highest water table elevation of a contaminated saturated zone at the facility, considering seasonal variation, is within 3 meters of the ground surface.

(c) There is a sump present that is not completely isolated from the surrounding soil by its materials of construction, or there is other direct entry of contaminated groundwater into the basement.

(3) Groundwater cleanup criteria based on inhalation of hazardous substance vapors volatilizing from groundwater to indoor air shall be called groundwater volatilization indoor air inhalation criteria ("GVIIC"). The GVIIC is determined by the following series of calculations, except as provided in R 299.5734(3):

EQUATION FOR CARCINOGENIC EFFECTS:

$$\text{GVIIC} = \frac{\text{TR} \times \text{AT x AIR}}{\text{IURF} \times \text{EF} \times \text{ED} \times \text{CR}_{\text{building}}}$$

WHERE,

GVIIC	(Groundwater volatilization indoor air inhalation criteria)	=	chemical-specific, ug/L
TR	(Target risk level)	=	10^{-5}
AT	(Averaging time)	=	25,550 days (70 x 365)
AIR	(Adjusted inhalation rate)	=	1 (residential)
		=	2 (commercial/industrial)
IURF	(Inhalation unit risk factor)	=	chemical-specific, $(ug/m^3)^{-1}$
EF	(Exposure frequency)	=	350 days/year (residential)
		=	245 days/year (commercial/industrial)
ED	(Exposure duration)	=	30 years (residential)
		=	21 years (commercial/industrial)
$CR_{building}$	(Ratio of indoor air concentration	=	chemical-specific,

to groundwater concentration) (ug/m^3)/(ug/L)

EQUATION FOR NONCARCINOGENIC EFFECTS:

$$GVIIC = \frac{THQ \times AT}{(1/ITSL) \times EF \times ED \times CR_{building}}$$

where,

GVIIC	(Groundwater volatilization indoor air inhalation criteria)	= chemical-specific, ug/L
THQ	(Target hazard quotient)	= 1
AT	(Averaging time)	= 10,950 days (residential)
		= 7,665 days (commercial/ industrial)
EF	(Exposure frequency)	= 350 days/year (residential)
		= 245 days/year (commercial/industrial)
ED	(Exposure duration)	= 30 years (residential)
		= 21 years (commercial/ industrial)
ITSL	(Initial threshold screening level)	= chemical-specific, ug/m^3
$CR_{building}$	(Ratio of indoor air concentration to groundwater concentration)	= chemical-specific, (ug/m^3)/(ug/L)

The ratio of the indoor air concentration to the groundwater concentration is calculated as:

$$CR_{building} = CR_{source}^{gw} \times \alpha$$

where,

$CR_{building}$	(Ratio of indoor air concentration to groundwater concentration)	= chemical-specific, (ug/m^3)/(ug/L)
α	(Attenuation coefficient)	= chemical-specific, unitless
CR_{source}^{gw}	(Ratio of soil vapor concentration to groundwater/source concentration)	= chemical-specific, (ug/m^3)/(ug/L)

The soil vapor-phase concentration generated from a hazardous substance in groundwater is assumed to be in equilibrium with the aqueous phase concentration

(C_w) of that substance as related by the dimensionless Henry's law constant (H') such that:

$$CR_{source}^{gw} = H' \text{ x } TAF \times C_w \times 10^3 \text{ l/m}^3$$

where,

CR_{source}^{gw}	(Ratio of soil vapor concentration to groundwater/source concentration)	= chemical-specific, $(\text{ug/m}^3)/(\text{ug/L})$
H'	(Dimensionless Henry's law constant, where H' = HLC x 41)	= chemical-specific, unitless
HLC	(Henry's law constant at 25 degrees Celsius)	= chemical-specific, $(\text{atm-m}^3/\text{mol})$
TAF	(Temperature adjustment factor)	= 0.5, unitless
C_w	(Uniform unit groundwater concentration)	= 1 ug/L

The intrusion rate of hazardous substance vapors into buildings is predicted using an analytical solution which couples both diffusive and convective transport of vapors emanating from groundwater into enclosed spaces. An attenuation coefficient (α) is calculated that is expressed as the ratio of building indoor air concentration to the vapor-phase concentration at the source. Values of α are calculated assuming infinite source conditions. For infinite source conditions α is written as follows:

$$\alpha = \frac{\left[\left[\frac{D_T^{eff} A_b}{Q_{building} L_T}\right] \times \exp\left(\frac{Q_{soil} L_{crack}}{D^{crack} A_{crack}}\right)\right]}{\left[\exp\left(\frac{Q_{soil} L_{crack}}{D^{crack} A_{crack}}\right) + \left[\frac{D_T^{eff} A_b}{Q_{building} L_T}\right] + \left[\frac{D_T^{eff} A_b}{Q_{soil} L_T}\right]\left[\exp\left(\frac{Q_{soil} L_{crack}}{D^{crack} A_{crack}}\right) - 1\right]\right]}$$

where,

α	(Attenuation coefficient)	= unitless
D_T^{eff}	(Total effective diffusion coefficient)	= chemical-specific, cm^2/s
D^{crack}	(Effective diffusion coefficient through crack)	= cm^2/s, ($D^{crack} = D_v^{eff}$, see equation for D_v^{eff} below)
A_b	(Area of enclosed space below grade)	= 1.96E+6 cm^2 (residential) = 3.83E+6 cm^2 (commercial/

		industrial)
$Q_{building}$	(Building ventilation rate)	= 1.51E+5 cm^3/s (residential) = 5.04E+5 cm^3/s (commercial/ industrial)
L_{crack}	(Building foundation thickness)	= 15 cm
L_T	(Source-building separation distance)	= 115 cm (residential) = 300 cm (commercial/ industrial)
Q_{soil}	(Volumetric flow rate of soil vapor into the building)	= 0.81 cm^3/s (residential) = 2.10 cm^3/s (commercial/ industrial)
A_{crack}	(Total area of cracks below grade)	= 196 cm^2 (residential) = 383 cm^2 (commercial/ industrial)
exp(p)	(The base of the natural logarithm raised to power p)	= e^p

To characterize contaminant diffusion from groundwater into buildings a total effective diffusion coefficient (D_T^{eff}) is calculated to account for both liquid phase diffusion of the contaminant through the capillary fringe, (D_{cf}^{eff}), and vapor phase diffusion through the vadose zone, (D_v^{eff}). The calculation is as follows:

$$D_T^{eff} = \frac{L_T}{\left[\left(h_v + L_{crack}\right)/D_v^{eff}\right] + \left(h_{cf}/D_{cf}^{eff}\right)}$$

where,

D_T^{eff}	(Total effective diffusion coefficient)	= chemical-specific, cm^2/s
L_T	(Source-building separation distance)	= 115 cm (residential) = 300 cm (commercial/ industrial)
h_v	(Thickness of vadose zone below enclosed space floor)	= 75 cm (residential) = 260 cm (commercial/ industrial)
L_{crack}	(Building foundation thickness)	= 15 cm
D_v^{eff}	(Effective diffusion coefficient through vadose zone)	= chemical-specific, cm^2/s
h_{cf}	(Thickness of capillary fringe)	= 25 cm
D_{cf}^{eff}	(Effective diffusion coefficient through capillary fringe)	= chemical-specific, cm^2/s

The effective diffusion coefficient calculation for the vadose zone (D_v^{eff}) is written as:

$$D_v^{eff} = \left[D_a\left(\theta_a^{3.33}/n^2\right)\right] + \left[\frac{D_w}{H' \times TAF}\left(\theta_w^{3.33}/n^2\right)\right]$$

where,

D_v^{eff}	(Effective diffusion coefficient through vadose zone)	=	chemical-specific, cm^2/s
D_a	(Diffusivity in air)	=	chemical-specific, cm^2/s
θ_a	(Soil air-filled porosity)	=	0.13 cm^3/cm^3
N	(Total soil porosity)	=	0.43 cm^3/cm^3
D_w	(Diffusivity in water)	=	chemical-specific, cm^2/s
H'	(Dimensionless Henry's law constant, where H' = HLC x 41)	=	chemical-specific, unitless
HLC	(Henry's law constant	=	chemical-specific, (atm-m^3/mol)
TAF	(Temperature adjustment factor)	=	0.5
θ_w	(Soil water-filled porosity)	=	0.3 cm^3/cm^3

The effective diffusion coefficient calculation for the capillary fringe (D_{cf}^{eff}) is written as:

$$D_{cf}^{eff} = \left[D_a\left(?_{a,cf}^{3.33}/n^2\right)\right] + \left[\frac{D_w}{H' \times TAF}\left(?_{w,cf}^{3.33}/n^2\right)\right]$$

where,

D_{cf}^{eff}	(Effective diffusion coefficient through capillary fringe)	=	chemical-specific, cm^2/s
D_a	(Diffusivity in air)	=	chemical-specific, cm^2/s
$\theta_{a,cf}$	(Soil air-filled porosity in capillary fringe)	=	0.078 cm^3/cm^3
D_w	(Diffusivity in water)	=	chemical-specific, cm^2/s
H'	(Dimensionless Henry's law constant, where H' = HLC x 41)	=	chemical-specific, unitless
HLC	(Henry's law constant)	=	chemical-specific, (atm-m^3/mol)
TAF	(Temperature adjustment factor)	=	0.5
$\theta_{w,cf}$	(Soil water-filled porosity in capillary fringe)	=	0.352 cm^3/cm^3
N	(Total soil porosity)	=	0.43 cm^3/cm^3

(4) Facility-specific measurements of the following parameters may be substituted individually for the generic assumptions and still allow the facility to satisfy the generic categorical criteria under section 20120a(1)(a) to (e) of the act.

(a) Dry soil bulk density.

(b) Fraction of organic carbon in soil.

(c) Soil vapor permeability.

(d) Temperature adjustment factor for Henry’s law constant.

(e) Source-building foundation separation distance.

(f) Vertical thickness of capillary fringe.

Facility-specific measurements shall be based on representative characterization. Documentation of all facility specific values shall be provided in the remedial action plan.

(5) The department may approve of methods to demonstrate compliance with criteria for this exposure pathway if those methods are more representative of in-situ conditions at the facility. Methods acceptable to the department may include, but are not limited to, use of representative soil gas concentrations.

(6) A site-specific GVIIC may be developed for remedial action plans prepared pursuant to section 20120a(2) of the act that is based on demonstration of compliance with 1974 PA 154, MCL 408.1001 et seq. and the rules promulgated pursuant to that act. This subrule shall apply only when all of the following conditions are satisfied:

(a) The risk being evaluated results from inhalation by workers of hazardous substances in indoor air within an active workplace that is regulated by 1974 PA 154, MCL 408.1001 et seq. and the rules promulgated pursuant to that act.

(b) The exposure to hazardous substances from environmental contamination is a portion of the exposure to which workers are otherwise subject from process-related sources of the same hazardous substance.

(c) The risk to the non-worker population, if any, from inhalation of indoor air at the property has been evaluated using generic residential GVIIC or a site-specific evaluation has been conducted for the non-worker population according to methods acceptable to the department, and the risk is not unacceptable on the basis of the risk management objectives set forth in section 20120a of the act.