TRACERS FOR DETERMINATION OF ATTENUATION FACTORS AND VENTILATION RATES FACT SHEET

Determination of Slab-Specific Attenuation Factor Using Tracers

Measurement of a conservative tracer inside the building and in the sub-slab soil vapor can enable calculation of a site-specific attenuation factor. The calculated attenuation factor can then be used to estimate the indoor air concentration of other vapor-forming chemicals (VFCs) by multiplying the measured sub-slab soil vapor concentration by the attenuation factor for the tracer (or *marker compound*). This method assumes that all sub-slab vapor-phase contaminants are entering the building at equal rates. This is a relatively safe assumption for dilute groundwater sources and small buildings but may not apply in situations with localized hot spots or large buildings.

Naturally occurring radon is the most commonly used conservative tracer. Other potential tracers include breakdown products such as 1,1-dichloroethene (1,1-DCE) or cis-1,2-dichloroethene (cis-1,2-DCE), which are generally not found in consumer products, building materials, or outdoor air. Complications to this technique include the presence of indoor sources of the tracer (if any) and any temporal variations. If sub-slab samples are being collected, concurrent collection of radon or another tracer data may prove useful and is generally not too expensive. Determination of radon concentration using adsorbents is possible for indoor air samples but not for soil vapor samples including sub-slab samples. Soil vapor methods exist for the collection of sub-slab radon concentration measurements (USEPA 2006), but analysis of the samples may not be readily available from most commercial laboratories. There are, however, many commercially available field instruments for analyzing radon, including the Accustar CLS-2 (a standard measurement device), RA-Dome Electret (an electret ion chamber and reader), Ecosense EcoGuard EQ200EG (a blind continuous radon monitor), and an AirThings Corentium Pro (continuous radon monitor). These instruments (**Figure 1**) can be properly certified/calibrated and can function with an inlet line and pump. A complete list of acceptable instruments can be found on the National Radon Proficiency Program website (NRPP 2025). Radon concentrations do not always correlate with dynamic vapor-forming chemical concentration patterns (Lutes and Holton 2023; Lutes et al. 2015; 2023; Schuver and Steck 2015).

Determination of Room Ventilation Rate Using Tracers

The indoor air concentration is inversely proportional to the room ventilation rate: doubling the ventilation rate halves the indoor air concentration. The default ventilation rates used by the U.S. Environmental Protection Agency (USEPA) and many other agencies are conservative; they use room exchange rates of once every 1–4 hours for residences and once every hour for commercial buildings (USEPA 2011). For some buildings, typically commercial buildings, the actual ventilation rate can be determined from the heating, ventilation, and air conditioning system or building design specifications, keeping in mind that the air exchange rate should be calculated from the make-up volume, not the total air-handling volume. For other buildings, typically residences, this information is not readily available, so the ventilation rate must be either measured or assumed at the default value. ASTM International Method E741 describes techniques for measuring ventilation rates using gaseous tracers such as helium.

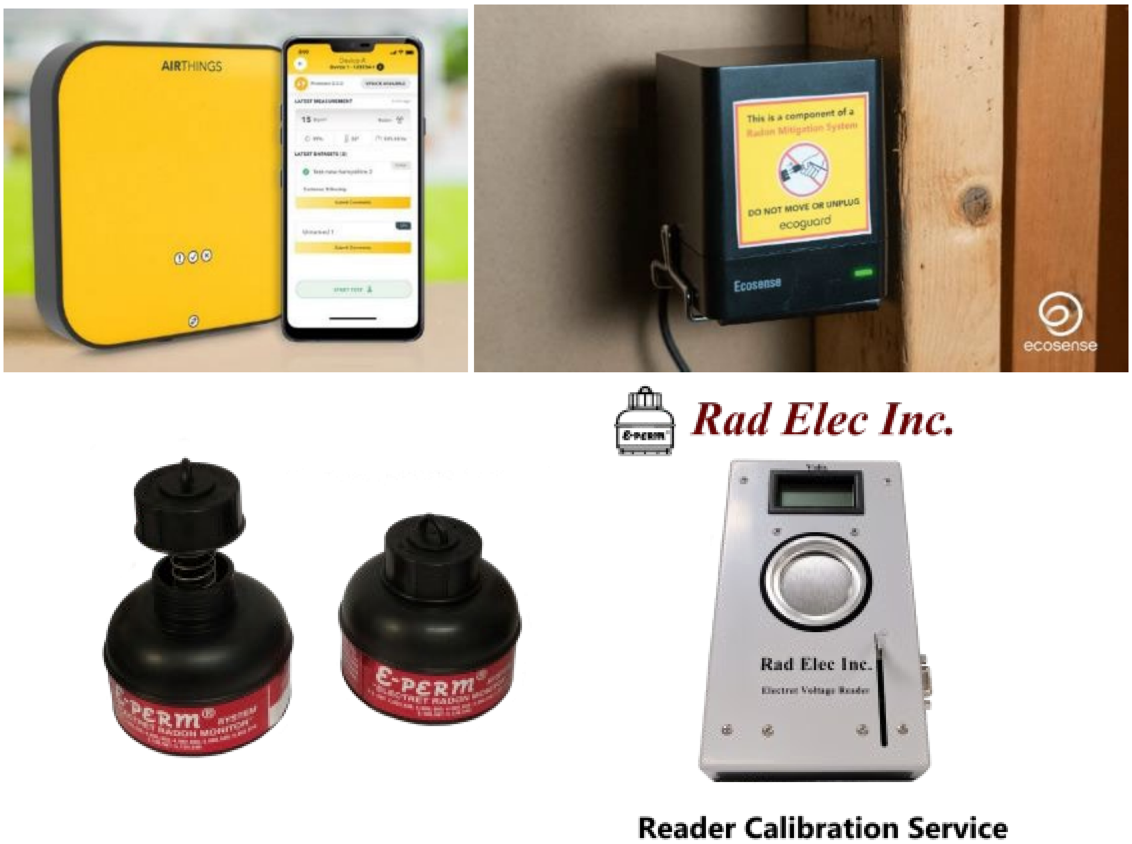

Figure 1. Examples of radon meters, including AirThings Corentium Pro (top left), Ecosense EcoGuard EQ200EG (top right), and E-Perm radon monitor (bottom left) with calibrator (bottom right).

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Typically, a pulse input of tracer gas is applied, and the decay in concentration versus time is measured. The inverse of the air exchange rate is the slope of a plot of natural logarithm of the normalized concentration (Ct = n / Ct = 0) versus time. If a subsurface tracer gas is used, this can serve as the pulse input. Alternatively, a tracer gas can be released at a constant rate and the concentration measured once steady state conditions are reached (i.e., typically after three or four air exchanges).

The techniques are quick and relatively inexpensive. For colder climates, measurement during the cold and warm seasons may be prudent if the ventilation rate during the more conservative case (cold season) suggests unacceptable indoor air concentrations.

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