Measurement of Soil Gas to Indoor Air Attenuation Rates Using Radon as a Naturally Occurring Tracer Gas

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Background/Objective. The quantification of exposure risks associated with soil gas intrusion to indoor air is becoming increasingly important as properties impacted with volatile organic compounds (VOCs) are routinely being redeveloped. The migration of soil gas containing VOCs to indoor air can result in significant carcinogenic and toxicological exposure risks. The typical presence of many sources of VOCs on the interiors of buildings, including building materials, flooring, finishes, cleaning products, and even chlorinated water) often makes the identification of soil gas intrusion through indoor air VOC testing difficult, if not impossible. VOCs are almost universally present in the interior air of all buildings - including those at sites where there is no subsurface contamination. The presence of ambient levels of many VOCs in the outdoor air further complicates the interpretation of indoor air VOC testing results. The authors have found that the concurrent measurement of the concentrations of naturally-occurring radon in the soil gas beneath buildings, and in the interior air of buildings, can provide a reliable basis for calculating building-specific soil gas to indoor air attenuation rates.

Approach/Activities. Radon is a naturally-occurring gas that is present in the subsurface at significant levels at most locations. It is generally not found in building materials so there are few, if any, potential sources of radon gas on the interiors of most buildings. Radon is not sorbed onto soil or building materials so it functions as a conservative tracer. This approach resolves the alternate source and background source issues associated with direct interior air VOC measurements. The authors have concurrently measured radon gas levels in the soil gas, the indoor air, and the outdoor air at several hundred buildings to date. Measurements are made in real time, typically over 24 to 48 hour monitoring periods, with a high level of resolution. The monitoring equipment and protocol are presented along with typical results. Measured soil gas to indoor air attenuation rates have typically been found to range from around 1,000 for older slab-on-grade buildings that do not have mitigation measures to in excess of 50,000 for modern buildings with vapor intrusion mitigation systems. Relatively economical semi-permanent radon monitors are also available for long term interior air monitoring. These devices have been installed in a number of buildings in conjunction with soil vapor intrusion mitigation system monitoring programs.

Results/Lessons Learned. Measurement of the levels of naturally-occurring radon in the soil gas and indoor / outdoor air provides a means of determining building-specific soil gas to indoor air attenuation rates in a reliable, timely and cost-effective manner. If significant soil gas intrusion is detected at a building, the monitoring equipment can be utilized to identify the entry point(s) of that incursion. The installation and periodic monitoring of semi-permanent radon gas indoor air detectors can be used to screen for soil gas intrusion over an extended period of time. That data can be used to monitor the long-term performance of soil vapor mitigation systems.