Building-Specific Attenuation Factors from Flow and Vacuum Data

Todd McAlary (tmcalary@geosyntec.com) (Geosyntec Consultants, Inc, Toronto, ON, Canada)
William Wertz (wwertz@geosyntec.com) (Geosyntec Consultants, Inc, Albany, NY, USA)
Darius Mali (dmali@geosyntec.com) (Geosyntec Consultants, Inc, Guelph, ON, Canada)

Background/Objectives. Buildings vary by several orders of magnitude in their susceptibility to subsurface vapor intrusion to indoor air. Regulatory agencies use conservative estimates of building attenuation factors to derive screening levels for subslab soil vapor corresponding to conservative risk-based indoor air concentrations. EPA uses a default value of 0.03 for sub-slab to indoor air attenuation, which is equivalent to the 95th percentile of a distribution of empirical attenuation factors derived from North American residences. Some agencies have policies that mandate additional assessment (such as long-term monitoring) or pre-emptive mitigation if subslab vapor concentrations are higher than the conservative screening levels by more than a factor of 10, regardless of whether indoor air concentrations exceed health-based screening levels. Derivation of building-specific attenuation factors can be used to support a conclusion of no significant risk in scenarios where the subslab concentrations exceed screening levels, but the building is not very susceptible to VI. However, the current practice to derive building-specific attenuation factors requires multiple rounds of indoor air and subslab vapor concentration measurements, which can be time-consuming and expensive

Approach/Activities. A new method has been developed to derive a building-specific attenuation factor using flow and vacuum measurements, mathematical modeling, building dimensions, air exchange rate, and cross-slab pressure differentials. The test is essentially a “pump-test”, drawing from the field of hydrogeology, and using the Hantush-Jacob (1955) Leaky Aquifer Model to approximate the floor slab as a leaky aquitard and the material below the floor (commonly granular fill) as an aquifer. The procedure involves measuring vacuum versus time, vacuum versus distance, and conducting subslab tracer tests, which can be conducted in less than an hour with a crew of two people, so the cost is modest. The mathematical model calculates the transmissivity of the material below the floor, leakance of the floor, bulk average gas conductivity of the floor slab, and rate of soil gas entry to the building. These parameters, combined with building specific information mentioned above, allow calculation of a building-specific attenuation factor.

Results/Lessons Learned. The result of 121 pneumatic tests were summarized statistically and a case study provided to demonstrate the method. Statistics from the 121 tests were compared with the published 2012 US EPA empirical distribution of attenuation factors report and looking at the 5th to 95th percentile values for each model, there is agreement within a factor of 4. The method described here uses independent lines of evidence (flow and vacuum measurements, mathematical modeling, building dimensions, air exchange rate, and cross-slab pressure differentials) that are not subject to the same uncertainties as chemical sample-based attenuation factors. This method provides a line of evidence for vapor intrusion assessment that can provide important insight into building-specific susceptibility to vapor intrusion.