

Use of Thoron to Identify Preferential Pathways for Vapor Intrusion

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Background/Objectives. A series of former mill buildings located in a western suburb of Boston were being renovated into residential apartments. Historical operations at the mill involved use of radium in luminescent dial painting operations, resulting in contamination of vadose zone soil adjacent to and beneath a portion of the mill building. The mill buildings were constructed on granite block foundations with a combination of concrete and dirt floors and a series of sub-basements and tunnels. In addition to potential concerns about vapor intrusion (VI) of radon from residual radium, the building owner was concerned about VI from naturally occurring radon based on testing that had been performed in building sub-basements.

Approach/Activities. Due to historical release of radium, the property was being managed under the regulations of the Massachusetts Department of Public Health (MassDPH). The MassDPH regulations require that a demonstration be made that health risks for potential exposure pathways to the contamination are acceptable. A dose assessment demonstrated that acceptable risks could be achieved with soil remediation. However, due to concerns about potential VI from radon, VI mitigations were designed for each of the buildings. Best practices indicate that the protectiveness of the vapor mitigation design be demonstrated through indoor air sampling and analysis. Through the first phases of redevelopment, vapor mitigation installation was overseen by an environmental contractor, and indoor air testing demonstrated that the vapor mitigation systems were effective in eliminating the VI pathway for radon. Given the success of the vapor mitigation systems, the designs were applied to subsequent phases of the development, and the building owner elected to independently oversee the installation of the subsequent systems.

Upon completion of subsequent phases of the redevelopment, indoor air testing was conducted in select unoccupied units, but yielded mixed results: indoor air in some units showed no complete VI pathway, whereas indoor air in other units exhibited detections of radon above the USEPA recommended limit of 4 picocuries per liter (pCi/L). This in turn created uncertainty concerning the proper functioning of the VI mitigation system. VI system checks and adjustments were made, and engineering reviews were conducted with follow-up indoor air sampling yielding the same results. A preferential pathway was suspected, despite engineering designs that were intended to prevent such pathways.

With the knowledge that radon (Rn-222) was present in soil gas, it was recognized that thoron (Rn-220) was also likely present. Thoron has a short half-life (56 seconds) as compared to the radon half-life of 3.8 days) and can therefore be valuable as a tracer to identify sources of soil gas entry into enclosed space. Therefore, a RAD7 was used to investigate the unoccupied units to identify thoron in real-time. In units where radon had been detected in indoor air, thoron was detected emanating from the floor-wall seam in some areas of the units. Further review with the construction contractor and detailed inspection of the units revealed that the floor-wall seam had not been consistently sealed. After all sealing was completed, subsequent indoor air testing for radon demonstrated that the VI pathway was incomplete.

Results/Lessons Learned. The use of thoron as a tracer was valuable for the identification of VI preferential pathways because it cost-effectively offered a real-time analysis that was sensitive enough to pin-point preferential pathways that could in turn be mitigated quickly.

Based on our experience, it appears that use of thoron as a tracer may be useful for identifying VI preferential pathways for chlorinated volatile organic chemicals (VOCs) as well.