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Controlling Soil Gases

The entry into buildings of soil gases—including, but by no means limited to, radon—is an important area of concern. The few studies that have investigated soil gas entry report that 1–20% of the outdoor air entering buildings enters from below grade. Some gases, such as radon and hydrocarbons (from fuel or chemical spills), are health and safety risks to building occupants. Others, principally water vapor, may put the building at risk or cause secondary IAQ problems such as mold growth. Controlling soil gases is an important priority to ensure a safe working or living environment. Fortunately, the strategies for keeping soil gases out are relatively easy.

Opportunities

Soil gases are very easy to control in new buildings through proper design and construction practices. Specific measures for soil gas control should be included in all new buildings, but they are especially important in areas known to have high soil radon levels, on brown-field sites, and on land previously used for agriculture. In existing buildings, dealing with soil gas problems is more difficult and more expensive—but still doable. Before investing in a soil-gas remediation program in an existing building, however, test the area carefully to determine the type and extent of the contamination.

Technical Information

In order for radon or other soil gases from an underground source to end up in a building, there must be a way for the soil gases to enter (passageways) and a driving force to bring them in. The driving force is usually a combination of differences in air pressure (air-flow through the below-grade material) and differences in contaminant concentrations. Passages include pores in the soil matrix, fissures and cracks in the underlying bedrock, porous fill around buildings, and cracks and holes in the building foundation walls and floor.

The most common driving force is negative pressure in the building. Exhaust fans, the stack effect, or air-handler returns may create negative pressure in the basement or crawl space that draws air from the soil into the building. Natural systems can also be the driving force. For example, a low-pressure weather system accompanied by a heavy rain may force the soil air mass to equalize with atmospheric air through a building. Rapidly rising water tables displace a large amount of soil air, generating positive pressure in the soil around a building. Air moves easily through gravel and rock that is fractured or has been dissolved by water, so pressure differentials can move large amounts of underground air and soil gases.

UNDERSTANDING SOIL GASES

The soil air contaminants we know the most about are radon, vapors from petroleum products, gases released by other volatile compounds, gases released by anaerobic or aerobic decomposition of carbon-containing materials, and water vapor.

Radon is a radioactive gas released when radium, a trace element in many soils, undergoes nuclear decay. These decay products include radon and various other radioactive “daughter products” from the breakdown of radon. The only known health effect from exposure to radon and its short-lived decay products is an increased risk of lung cancer. Radon is the only carcinogen that is documented with human exposures at levels that may actually occur in buildings. It is classified by the EPA as a Group 1 (known human) carcinogen and is considered the second leading cause of lung cancer in the United States (after tobacco).

Gasoline and fuel oil are the most common sources of below-grade petroleum vapors. These hydrocarbons can get into the soil through spills, leaks, and intentional dumping. Gasoline fumes present an explosion hazard at levels of 14,000 ppm; fuel oil vapors entering a building are not generally explosive. Petroleum products contain a host of other compounds, including benzene, toluene, ethyl-benzene and xylenes (collectively referred to as BTEX). Although there are many other compounds released by petroleum products, these BTEX compounds are always present and pose substantial health risks; they can be detected very easily with portable, relatively inexpensive equipment.

Nonpetroleum VOCs disposed of underground or present in contaminated groundwater can be a big problem if they make their way into buildings. The best known example is the contamination at Love Canal in New York State. Common VOC soil gases include solvents, thinners, and de-icers—the constituents are as varied as the activities that produced them. A wide variety of short-term and long-term health effects could result from exposure to VOCs, depending on the contaminant(s) involved.

Buried materials that contain carbon are often decomposed by bacteria or fungi. Fungi most commonly digest organic matter in the presence of oxygen (aerobic decomposition), while bacteria generally operate in the absence of oxygen (anaerobic decomposition). Gases released by aerobic decomposition are primarily carbon dioxide, water vapor, and trace VOCs; the associated smell is often described as “moldy,” “musty,” or “earthy.” Compounds released by anaerobic bacterial decomposition include methane, nitrogen, hydrogen, and sulfur compounds—and the associated smell can

