How does Radon enter into a Building

Most soil gas reaching the surface is quickly diluted by the surrounding air. In the event that a structure is built in or on top of the soil, the dilution of the radon does not take place as quickly, and the radon in the structure may accumulate.

Several factors govern the extent of how much radon will enter a building. The single most important factor is the local geology and surrounding soils. The immediate precursor to most radon gas is radium.

The existence of even a small deposit of radium under a building will greatly influence the concentration of radon gas within the building. Micro geological formations such as local disturbances during construction, micro faults and rock out-croppings can significantly alter the radon concentration at the surface. An example of the extreme variability of radon was seen in one study [13] where one soil gas sample contained 250 pCi/l and a second sample taken at 10 meters distance contained 86,000 pCi/l. "Normal" indoor levels in the U.S [14] are typically about 1 pCi/l (using the EPA pCi/l, not the real pCi/l) which is 10 times greater than the outdoor concentrations of about 0.15 pCi/l.

When a building is constructed, pressure differentials between the interior of the building and the exterior of the building are inadvertently created, especially when there is a significant temperature difference between the interior of the building and the outdoors. This pressure differential, delta P (DP) is mostly due to a phenomenon known as the "Stack Effect". The building mimics an exhaust stack and is under negative pressure with regard to the surrounding environment including the atmosphere and the soil gas below the slab. Typically, the DP is greater toward the bottom portion of the building and is equalized near the top of the building.

To satisfy the negative pressure in the building, the net air movement toward the bottom of the building is from the outside of the building to the inside of the building. It has been estimated [14] that as much as 20% of this infiltration comes from below ground level. This 20% infiltration accounts for between 80% and 90% of the total radon which enters the building.

In the early days of radon investigations, it was assumed that drafty houses would have less radon than "tight" houses. Additionally, it was assumed that houses with high exchange rates would have lower radon concentrations than houses with few air changes per hour. Contrary to expectations, studies performed thus far show that there is no correlation between "tightness" of a building and the radon concentration [15],[16]. Very low radon concentrations are commonly seen in very tight buildings and high levels are often seen in the leakiest of houses.

Therefore, the second most important factor in radon entry into buildings is the DP. Several studies have shown that a very strong correlation between DP and radon concentration exists. All things being equal, the greater the pressure differential, the higher the radon level.

Since most commercial buildings fitted with industrial heating, ventilation and air conditioning (HVAC) systems are designed to keep the structure at positive pressure, excessive radon levels in commercial buildings in the U.S. are rare even in "high radon" areas. Typically, the most successful radon reduction techniques are those which address the driving forces of the pressure differential.

Weather can also affect the DP. Generally speaking, when the outside air is cold and the interior of the building is warm, the DP is greater. When the wind blows, the DP is greater. Additionally, when the water table rises, such as following a recent rain, the soil gas pressure rises, increasing the DP. Other meteorological factors such as snow cover can also effect the radon concentrations in a building by creating a "cap" under which the radon can accumulate.

In the U.S., Britain and Sweden, the majority of the radon which enters a building is from the presence of radon in the soil gas. However, there are two other significant sources of radon-well water and building materials. For structures, which are serviced by well water, a significant contribution of indoor radon can be from the radon in well water. Worldwide [16a], the average concentration of radon in surface water is about 10 pCi/l. In the U.S., the average private well-water contains about 750 pCi/l. Levels exceeding 20,000 pCi/l are not uncommon and this author has seen references to levels exceeding 1.6 million pCi/l (0.16 µCi/l).

Due to radon's very high Henry's Law Constant, radon will quickly evolve from water when it is aspirated or exposed to the air. For this reason, processed city water is rarely seen as a contributing factor to the overall radon concentration in a building, since essentially all the radon has left the water in the pre-distribution processing. However, in well water, the water is not subject to the chlorination and aspiration processes and can be a significant contributor to the building's burden of radon. It is commonly quoted that a water radon concentration of between 6,000 and 10,000 pCi/l will increase the airborne radon concentration in a building by 1 pCi/l.

In a few isolated cases, decorative stone and other building materials have also been identified as being the single largest significant contributors to indoor radon concentrations. The building construction material called "granite" is usually a similar material called granodiorite. The granodiorite has been shown in some cases to be the sole source of radon in a structure. However, no studies have ever demonstrated that the radon contributed by these materials pose a health hazard.