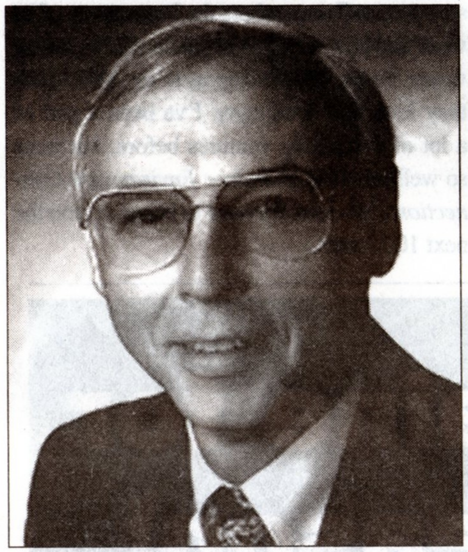
Measuring Low Levels of Radon Inexpensively



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This past December, Dr. William Fields posed the seemingly simple question of "What is the maximum period after exposure ends that [charcoal] labs can provide reliable results?" Like many simple questions, the answers are not equally simple and at times can reveal some answers we may not want to know. This simple question may indeed be such a question. To understand the import of this question, one needs to understand how charcoal canisters, which have become a mainstay of the short-term radon-measurement industry, work.

Charcoal Devices Are Like Leaking Sample Bottles

Simple charcoal devices, regardless if they are diffusion-barrier, open-face or whatever, function as collectors of radon in the air. These collectors are then transported to a lab where the radon can be sampled. In some respects, they are like a sample bottle used to collect water in that they can be shipped to an analytical facility. However, this is where the similarity ends.

Unfortunately, unlike filling a bottle with water that is held within the bottle until it is analyzed, the radon collected on the charcoal device will dissipate due to its short half-life of 3.8 days. If several days go by from when the sample was taken to when the laboratory analyzes it, there may be little radon, or perhaps even no discernible radon at all, for the lab to analyze without a lot of guesswork, which is what gives rise to the simple question raised by Dr. Field.

Returning to the sample bottle analogy, the decay of radon in the charcoal device would be like having a hole in your water bottle and needing to get it to the lab while there is still some water in the bottle to sample. I suppose the answer depends on how large the original sample was and how large the hole is as to whether there would be a sufficient quantity for the lab technician to perform an analysis.

In the case of radon, it is not a leak that is necessarily causing its time sensitivity in returning it to the lab, but rather that the radon trapped within the charcoal devices is radioactively breaking down to a smaller and smaller sample as time goes on. For example, if a laboratory claims to be able to measure to a lower level of detection (LLD) of 1 pCi/L, a sample taken in an environment of 100 pCi/L that arrives at the lab four days after the end of the test will contain a radon equivalency of 50 pCi/L, which is well above the LLD. It could take an even longer period of time (up to 25 days) to be returned to the lab and still be above the LLD for the sample. However, if the environment was initially 4 pCi/L in the home being tested, then taking eight days to get the sample to the lab could be problematic. So the first answer to Dr. Field's questions is, "It depends on the initial sample. The higher the radon, the more forgiving the delivery period can be."

Background Activity

The lower level of detection for charcoal canisters is also a function of the minimum detectable activity level for a laboratory. I spoke with Shawn Price, National Radon Manager for Air Check, a long-experienced and well-respected charcoal laboratory, about what MDA is and what factors can influence it. According to Mr. Price and his colleague, Mike DeVaynes, charcoal laboratories measure the gamma bursts released from radon-decay products that are created from the radon collected on the charcoal during deployment. These gamma bursts, the frequency of which is the activity of the sample at the time it is analyzed and knowing the amount of time elapsed from when the sample was collected and the analysis performed, are counted and the lab can back-calculate to the amount of radon activity that was in the room, knowing the decay rate for radon.

Sounds simple, right? It would be simple if one could just measure the activity emanating from the charcoal device rather having to differentiate this from other gamma in the lab. Since there is gamma from sources all around us other than the radon sample, the lab has to be able to discern the gamma from the radon daughters on the charcoal separately from the gamma around us. This background gamma comes from the earth, the sun and the universe and can mask the gamma signal that the lab is attempting to measure from the radon-charcoal device. If the activity from the device is much higher than the background gamma, the amount of signal is easy to measure. However, if the gamma from the sample is equal to or less than the background, all bets are off.

According to Price and DeVaynes, the ability to have a sample activity level in excess of the MDA is directly a function of how high the sampled radon environment was and how fast the sample is sent to the laboratory after deployment. But it is certainly possible to have a situation in which the amount of activity on a delayed sample or low-environment sample is less than the background level, and that is where concerns arise as to how this

For example, if the background gamma at a lab is equivalent to an activity reading of 0.5 pCi/L, a sample set in an environment of 6 pCi/L would have an equivalent activity level of less than 0.5 pi/L if it took two weeks to get to the laboratory. Does this mean, since the activity level is not discernible, the lab would report "non-detectable?" If so, this would be very misleading, since the radon at 6.0 was greater than the guidance level of 4.0 pCi/L.

When I asked this question of Price, he indicated that their laboratory reports, in which any activity less than the MDA and were returned to the laboratory over 12 days later, were "non-reportable" rather than being less than their LLD, which is an entirely different result. Although we can compliment Air Chek on this approach, one has to wonder how prevalent this same approach is within the entire charcoal-laboratory industry.

The minimum detectable activity level is not a number carved in stone, either. Every lab is different in its ability to both measure background and also to minimize its effects. Most labs go to great lengths to shield out gamma from the earth and sky with lead shielding. Even so, some background gamma enters the detector, which has to be measured regularly, since gamma from solar flares and whatnot is variable. Price indicated that they measure background many times a day to ensure that their detectors are functioning properly and that proper gamma-correction factors are being applied.

Transporting the Device

Adding to the issue of measuring at lower levels is the environment in which the devices are being shipped to the laboratory. Since radon is a gas and will want to desorb from the charcoal when heated, the temperature of the truck in which it is transported can also make a difference if the device is not sealed.

Price indicated in our discussion that his lab has conducted tests in which a significant amount of radon can escape a sampling device if simple sealing instructions are not followed. In this case, the loss of radon is like the water leaking from a sample bottle. When a device returns to a laboratory, the lab assumes the activity on the device is specifically due to the exposure when the device was open and not after it was presumably closed – in which radon could leak out or perhaps leak into the device if stored in a high-radon environment.

Why Is This an Issue?

Since the ability to measure radon levels above a minimum detectable activity is a function of the amount measured and the time to return it to the lab, recent interest in measuring lower and lower radon levels is beginning to push the envelope for charcoal devices not immediately returned to a laboratory. With new Environmental Protection Agency and state documents recommending post-mitigation levels to less than 2.0 pCi/L, the need to measure reasonably well at these low exposures is becoming more and more important.

DeVaynes indicated that, barring transportation and deployment issues, a device exposed to 2.0 pCi/L and analyzed two days after the completion of the test would have a variance of 0.2 pCi/L. If the same sample instead had been measured eight days later, the variance would more than double that, at 0.5 pCi/L. This amount of variance may not be a big deal when concerned about a criterion of acceptance of less than 4.0 pCi/L, but if a homeowner wants their radon exposure to be less than 1.5, it could make or break a mitigation contractor guaranteeing these kinds of results.

It may appear that our ability to reduce radon levels may not only be challenged by our mitigation technology but also by our measurement technology to validate such reductions. Alternatively, we may need to turn to more sophisticated devices than charcoal, which, according to Price, was initially developed to quickly and inexpensively provide a means for consumers to easily identify significantly elevated levels. They are not designed to measure very low radon levels and perhaps not even to the precision of a tenth of a pCi/L, which real estate transactions have moved to mistakenly expect.

As always, who says there is nothing new in radon?

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