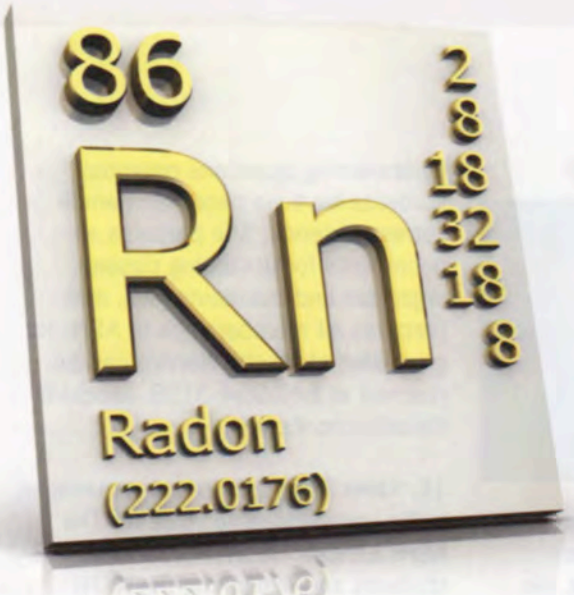

Radon is Real and Causes Cancer — Part II

BY KURT SALOMON

The Environmental Protection Agency has designated January as National Radon Action Month. This is the second of two articles addressing the number-one environmental hazard in the home: radon gas.

Last month we discussed what radon is and the potential dangers to your health. This month we finish by describing the various methods used to test for radon gas in a home and mitigation solutions.

Radon Testing

There are short-term and long-term radon tests. The short-term tests are usually two to four days and show the potential for high levels of radon in a house. They are most commonly used by home inspectors at the time of resale. Long term test are usually 1 year and show what the average radon level in the house was over the duration of one year.

The location of the radon test devices differ if they are for a citizen's own use or for a real estate transaction. For a citizen test, it should be placed in the lowest level in which **you live.** In a real estate transaction, it should be place in the lowest level of the house **suitable for living**. If an old 1930s bungalow has a finished nonconforming bedroom or room, this is a suitable room in the cellar. If there is only a washer-dryer and the cellar will not be occupied, the test should be on the first floor. However, if the cellar is to be used as an exercise room or shop, it is appropriate to test the cellar. Radon tests should not be done in crawl spaces, closets or storage rooms.

Another condition for short-term testing is that the test devices should be a minimum of 20 inches off the floor and 36 inches away from a window or exterior door. Furthermore, a ceiling fan in the room must not be run. The furnace should be on "auto mode." The furnace or central AC can be run, but a swamp cooler cannot be run during a radon test. This poses challenges for testing in the summer in the arid Southwest.

The EPA radon measurement protocol is silent as to whether the door to the room with the radon test device should be open or closed. It is also silent as to whether crawl space vents should be open or closed. In general, it is best to keep the doors to the rooms in their normal position and the same for the crawl space vents. Inspectors should note in the radon report the positions of each during the radon test.

Radon levels vary hour by hour and day to day. Severe weather and high winds will temporarily elevate the radon levels. A short-term radon test should not be done during severe storms or when the winds are 30 mph over the average wind speed.

Short-Term Test & Closed House Conditions. The EPA defines a short-term test as only lasting between two and 90 days. During a short-term test, "*closed house conditions*" are to be maintained. This means that **all** the windows in the house remain closed and exterior doors are only momentarily opened and closed for normal entry and exit. For tests of two to three days in duration, the windows must be closed 12 hours before the start of the test. Charcoal canisters cannot be used for tests longer than seven days.

For a real estate transaction, two side-by-side charcoal or two liquid scintillation test kits are to be used. Alternatively, a single continuous radon monitor showing hourly readings can be used. Most relocation companies require active electronic hourly continuous radon monitors.

Long-Term Test. The EPA defines a long-term test as only lasting between 91 and 365 days. During a long-term test, the house is maintained at "normal" living conditions. There is no requirement for the windows and exterior doors to remain closed. The most common long-term test device is an *alpha-track* plastic canister that has a special plastic slide or strip to record the number of alpha particle hits.

Seasonal Variation. The Utah Department of Environmental Quality presented a paper at the 2008 AARST Symposium showing the fluctuation of radon testing during various times of the year. This study showed the average radon level was 4.9 pCi/L in February and 2.7 pCi/L in June, which means a home inspector conducting a short-term test should be specific in the report as to the dates and times the tests were conducted because things can change, especially in high-radon potential areas.

Professional Radon Testers. Approximately 19 states have some type of requirement for certification of inspectors performing radon services. Some states have their own certification program, and other states require radon professional testers and mitigators be certified by the National Radon Proficiency Program (NRPP) or National Radon Safety Board (NRSB). There are 31 other states that are silent on radon testing. If you are going to test for radon, it is prudent and a good marketing strategy to become certified and get your name on the state lists of qualified service providers. Part of being a certified or licensed radon tester is having a quality assurance program, including annual calibration of continuous radon monitors. There is a national guide to state radon regulations at the Environmental Law Institute (eli.org).

Radon Measurement Devices

Activated Charcoal Test Kits. Activated Charcoal Detectors (AC) collect radon gas that is trapped in the voids of the charcoal granules. When the radon test kits are returned to the laboratory, the kit is placed in a detection chamber, which measures the gamma radiation emissions. These gamma emissions are used to determine the radon gas concentration to which the detectors were exposed. The calculation takes into account the half-life decay of the radon gas. When you receive the test result, there will be a *confidence level* factoring in the time and the associated radon-222 decay from the completion of the test to laboratory analysis. If the charcoal test devices are deployed in a high-humidity area, there is less space for the radon gas to get trapped, thus skewing the radon measurement. However, proper calibration accounts for the competition from the water vapor.

The original charcoal canisters looked like metal hockey pucks, other charcoal kits look like oversized tea bags and some kits look like horizontal paper insect bait traps.

Liquid Scintillation. Liquid scintillation also uses charcoal to measure the radon gas. Instead of measuring the gamma emissions from the exposed charcoal, this method converts the alpha emissions to light, which is then measured.

Continuous Monitors. Continuous Radon Monitors (CRMs) are electronic devices that record and report radon concentrations on an hourly basis. The CRM is designed so that only radon gas can enter the radon chamber. As the radon gas decays, it produces alpha particles that are registered by various counting technologies specific to the CRM. The number of "pulses" counted over time is then used to calculate the radon concentration, which is reported on an hourly basis.

E-PERMs®. E-PERMs, also known as Electret Ion Chambers (EIC), are passive integrating ionization chambers consisting of a stable electret mounted inside a chamber made of electrically conducting plastic. The electret, a charged Teflon® disk, serves as both the source for ion collection and the integrating ion sensor. Radon passively diffuses into the chamber through filtered inlets, and the alpha particles emitted by the decay process ionize air molecules. Negative ions produced inside the chamber are collected on the positively charged electret, causing a reduction of its surface charge. The change in the surface charge on the electret is measured using an Electret Voltage Reader and the results are calculated using a software program. The reduction in charge is a function of the radon concentration, the duration of the testing period and the chamber volume. EICs can be used for both short-term radon testing and long-term radon testing programs.

Alpha Tracks. Alpha Track (AT) detectors consist of a piece of special plastic or film inside a small container. The container is designed so that only radon gas will passively diffuse into the chamber. When alpha particles from radon and its decay products strike the film or plastic, they cause damage tracks like a golf divot. At the end of the test, the container is sealed and returned to a laboratory for reading.

The plastic or film detector is treated to enhance the damaged tracks and then the tracks over a predetermined area are counted using a microscope or optical reader. The number of tracks per area counted is used to calculate the radon concentration of the site tested. The detectors factor for the secondary hits or skips of the alpha particles similar to a stone being thrown and skipping across the water.

Alpha track detectors are used for long-term radon testing – generally three to 12 months.

Working Level Monitors and Continuous Working Level Monitors. Working Level Monitors (WLM) and Continuous Working Level Monitors (CWLM) measure the radon decay products that are

reported in Working Levels (WL). Radon decay products are collected by continuously pumping air through a filter that "catches" the radon decay products. A special detector counts the alpha particles produced by radon decay products as they decay on this filter. A CWLM typically contains a microprocessor that records the number of counts on an hourly basis.

Differences between Radon & Working Level Monitors. The difference between a radon monitor and a working level monitor is that a radon monitor measures the ionization caused by the radon gas decay while a working level monitor measures the radon decay products trapped by the filter.

Radon gas is measured in picocuries per liter (pCi/L) and reflects the potential for health hazards. Working Level monitors report the actual radon decay products (RDP) measured in Working Levels. It is the RDPs that are the real hazard to the development of lung cancer.

Reporting Radon Test Results

The EPA states there is no safe level of radon. The test results should indicate if the test level was either below or at/above the action level of 4 pCi/L or 0.02 working levels. The test results in radon concentration should be reported with one decimal of accuracy, and working with two decimal places. If two charcoal devices are used and one result is less than 4 and one is over 4: a) if the higher is not twice the lower, report both results and calculate the average; or b) if the higher is more than twice the lower, report both and recommend a retest. The statistical term relative percentage difference (RPD) is used. If both tests are less than 4 and the RPD is less than 67%, report each and the average; but if the RPD is greater than 67% report the results and suggest a retest. If the test results are greater than 4 and the RPD is greater than 36% report the results and recommend a retest.

Fixing a Radon Problem

The most common solution to reducing radon levels in a house is a sub-slab depressurization system also called a radon fan system. For houses with a crawl space the system is referred to as a sub membrane depressurization system. In simple terms, a radon reduction or mitigation system creates negative pressure in the radon-laden soil below the house, collects the gas before it enters the home, and exhausts it into the atmosphere above the roof. It takes about one day to install a system in an average house. First a hole is bored in the concrete floor and about 15 gallons of gravel or other material from below the concrete are removed, creating a radon collection pit. Then 4" PVC pipe is sealed to this hole and run to the outside.

If a house has a crawl space plastic sheeting is glued to the foundation walls with perforated drain tile laid under the plastic. A 4" PVC pipe, sealed where it passes through the plastic sheeting, connects the drain tile to the exhaust system.

There are interior and exterior radon systems. For an interior system, the radon exhaust pipe is either run through the garage or through the furnace vent pipe chase (if there is adequate space and allowing for adequate clearance to the furnace flue vent and restoring fire blocks between floors), then through the attic and roof where the gases can safely be exhausted to the atmosphere. The fan is in the attic. For exterior systems the pipe comes through the rim joists to the exterior, then a fan is installed and exhaust is run to above the roof eave. Some states such as Illinois and Ohio have their own standards, which vary slightly.

Often the best place to install the suction point is at the perimeter of the foundation, not in the center of the house. It only takes a slight change in negative pressure at the extremities of the basement floor for a radon system to be successful. A pressure difference of only a few thousands of an inch of water column is often all that is necessary. As a home inspector, you will not be measuring the suction under the concrete slab. Rather you will see a U-tube and the suction will typically be in the 0.5" to 3" range. This range of suction can reflect the porosity of the soil and/or specifications of the fan.

There are two protocols for installing radon mitigation systems in existing houses: EPA 402R93078 and ASTM 2121; and three protocols: ASTM 1465, AARST RRNC 2.0 and the IRC Appendix F for radon resistance in new construction. There are variances from one standard to another. The ASHI EPA Radon Installation Checklist provides a good guide to inspecting these systems.

The standards for new construction allow for a passive system, which is the previously described radon system without a fan. The Fort Collins, Colorado, study showed that passive systems only work 50% of the time. When passive systems don't work, a fan is simply added to the system.

Other ways to control indoor radon levels include installing heat recovery ventilators (HRVs) or air cleaning systems. HRVs dilute the concentration of the radon gas with conditioned outside air. Air cleaning systems capture the radon decay products, thereby reducing the real health risk of radon and the radon decay products.

ASHI & EPA Checklist

The EPA references ASHI in their website page "*Radon and Real Estate*" (http://www.epa.gov/radon/realestate.html). This appears at the top of the page:

The EPA, with cooperation from its radon partners, has developed a number of tools and resources for use by the real estate community:

- Financing Residential Radon Mitigation Costs: the HUD 203(k) Mortgage Insurance Program
- American Society of Home Inspectors (ASHI) Radon Mitigation System Inspection Checklist
- How to Find a Qualified Radon Service Professional in Your Area

The second bullet links to ashi.org to download the checklist. This web page further states: "Home inspectors have a new service to offer their home inspection clients: radon mitigation system inspections. The tool that makes this possible is the "Radon Mitigation System Inspection Checklist (PDF)," created by the American Society of Home Inspectors (ASHI), in cooperation with the EPA's Indoor Environments Division. The checklist promotes radon awareness, testing and mitigation with people who are having their home or prospective home inspected. With just seven inspection elements, the checklist takes under 15 minutes to complete. Inspectors can easily integrate it into a general home inspection. The inspection results indicate whether the home has a mitigation system and, if so, whether the system is active or passive. It also encourages the consumer to verify that indoor radon levels are below 4 pCi/L, and to consult a qualified mitigator if the inspection notes any apparent deficiencies."

Business Case for Radon Testing

Radon is real and can cause lung cancer. Testing houses for radon adds to your clients' peace of mind and can improve your bottom line."

If you are going to test for radon, take a good course, either distance-learning or live classroom. You should follow the radon-testing protocols found in ***"Indoor Radon and Radon Decay Product Measurement Device Protocols"*** *EPA 402-R-92-004, July 1992* and ***Protocols for Radon and Radon Decay Product Measurements in Homes*** *EPA 402-R-93-003, June 1993.*

You should also become certified by one of the two national radon bodies: the National Radon Proficiency Program (NRPP) or the National Radon Safety Board (NRSB). Most home inspectors and professional radon testers use continuous monitors. You also need to price into your business model the cost of a radon monitor, the cost of the extra trip to pick up or retrieve the radon monitor and the cost of your quality assurance, including annual radon monitor calibrations.

This article has been peer-reviewed by *Shawn Price, Air Check-general manager, 2013-14 AARST president; Carolyn Allen, Accustar-president; 2011-2012 AARST president; Doug Kladder, director Center for Environmental Training Institute; Rick Stieff, RadElec, CEO, Steven Gladstone, Stonehollow Inspections 2004 ASHI President; Phil Jalbert, EPA IAQ Radon.* ■

Kurt Salomon, Advocate Inspections, Abodee Radon, 2011 ASHI president

Other ways to control indoor radon levels include installing heat recovery ventilators (HRVs) or air cleaning systems. HRVs dilute the concentration of the radon gas with conditioned outside air. Air cleaning systems capture the radon decay products, thereby reducing the real health risk of radon and the radon decay products.

REFERENCES

1 DEQ Seasonal Study *radon.utah.gov*

2 Environmental Law Institute *eli.org*

3 epa.gov/radon/realestate.html

Kurt Salomon was 2011 ASHI president, founded the Utah ASHI Chapter, has been a home inspector since 1992 and has a B.S. in mechanical engineering from the University of Illinois. He serves on two American Association on Radon Scientists and Technologists (AARST) Standard Committees: Radon Resistance New Construction and Radon Testing.

Summary

Radon can cause lung cancer. The U.S. Surgeon General recommends all houses should be tested for radon. Houses with an average radon level 4 pCi/L or greater should be fixed and reduced to below 4 pCi/L. If you are not doing radon testing, you should check the probability of high-radon levels in the counties or cities you service, and you might consider adding radon testing as an ancillary service.

For their protection, the buyers should get an ASHI home inspection, and get a radon test.