



Accepted Abstracts* **for the 2018 AARST International Radon** **Symposium™**

*Note: While Abstracts are accepted, this does not guarantee a presenter will be in attendance to present an oral or poster. Please refer to the symposium schedule for speaker days and times. Speakers are subject to change up to the day.

PATTERN OF RADON CONCENTRATION VARIATIONS IN THE INDOOR ENVIRONMENTS OF BUILDINGS IN LAGOS NIGERIA

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Abstract

In this study, concentrations of radon in residential buildings were investigated in order to establish the pattern of variation within the buildings in these environments. The target rooms were the bedroom, bathroom/ toilet, living room and kitchen. One hundred and thirty-seven (137) rooms were selected using multi-stage sampling protocol. Solid state nuclear track detectors, CR-39, were employed for the measurement so as to obtain average radon concentration in each room. Radon concentrations vary from 3.63 – 12.17 Bq/m³, 3.09 – 11.62 Bq/m³, 3.43 – 13.26 Bq/m³, and 4.09 – 13 Bq/m³ with mean of 6.75 ± 0.09, 6.89 ± 0.08, 6.44 ± 0.09 and 7.43 ± 0.09 Bq/m³ respectively in the bedrooms, bathrooms/ toilets, living rooms and kitchens. Therefore, the pattern of radon concentration variations observed in this study is of this order: bedroom < bathroom/toilet < kitchen < living room.

SELF-REPORTED RESPIRATORY SYMPTOMS IN HEALTHY ADULTS WITH HIGH HOME RADON LEVELS

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Abstract

The association between exposure to radon, tobacco smoke, and lung cancer is established; not as much is known about the immediate health effects of radon exposure. We examined the relationship between levels of radon and secondhand smoke (SHS) in the home and respiratory symptoms, controlling for smoking status and COPD diagnosis. The pilot study was a cross-sectional design with a convenience sample of 71 homeowners who had tested their homes for radon and SHS as part of a larger environmental risk reduction study. Of the 71 participants, 27 homes tested high for radon (≥ 4.0 pCi/L); 44 tested high for SHS. Logistic regression showed that radon level was the only significant variable associated with presence of respiratory symptoms, controlling for smoking status and COPD diagnosis. This study adds important information to the literature and indicates that more research is needed to understand the immediate health effects of radon exposure.

AN INNOVATIVE APPROACH TO RAISE RADON AWARENESS: TRAIN THE TRAINER AND TARGETED MAP INFOGRAPHICS

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Abstract

Most radon induced-lung cancers occur in those also exposed to tobacco smoke. We evaluated the impact of disseminating county-level radon map infographics using a Train-the-Trainer approach and free radon test kits. User-friendly geological map infographics were created and disseminated; 42 public health professionals participated in Train the Trainer workshops. Trainers received presentation slides and free radon test kits for distribution. Map infographics were posted to our website. On average, 22 test kits were distributed per trainee for a total of 903; 12% were deployed. Perceived barriers to distribution will be presented. There was no association between position or type of training on number of test kits distributed. There were 1,388 website hits to the map infographics. There was a marginal increase in trainees' perceived synergistic risk (radon + tobacco smoke) at post-training. This approach engaged the community, increased radon testing, and may decrease barriers to radon education and home testing.

THE ILLINOIS EXPERIENCE 20 YEARS OF LICENSING THE INDUSTRY 10 YEARS OF AWARENESS DISCLOSURE

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Abstract

Twenty years ago, in 1998, the Illinois Radon Industry Licensing Act (RILA) was passed by the Illinois General Assembly and signed into law by the Governor of Illinois. Ten years later, in 2008, the Illinois General Assembly and Governor enacted the Illinois Radon Awareness Act (IRAA) requiring specific disclosure of the radon risks in Illinois to homebuyers. These Acts have had effects on individuals who were try to make a living measuring and mitigating radon, the radon industry, and on the radon risks to the citizens of Illinois. The Illinois Emergency Management Agency has the authority from the RILA to collect data to determine the distribution and concentration of radon in dwellings and other buildings and the associated health risk and to evaluate measures that may be used to mitigate a present or potential health risk. The data collected by the Agency will be reviewed to show what effects the two acts have had on the radon industry and the health of Illinois citizens.

WHAT ROLE DO REALTORS PLAY IN THE RADON SCENE?

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Abstract

How is the State of Utah creating advocacy with Real Estate Companies? Radon is now listed on the Buyer-Due-Diligence-Checklist and has created a positive relationship for the radon educators and the realtors. The purpose of this presentation is to help other states and the Industry to take the steps needed to create positive relationships with Realtors in their States.

EFFECTIVENESS AND SAFETY OF USING 3X4 ALUMINUM DOWNSPOUT FOR EXTERIOR RADON MITIGATION VENTING IN DRYER AND WARMER CLIMATES

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Abstract

To analyze the use of 3 x 4 aluminum downspouts for the external venting system on residential Radon mitigation systems rather than PVC pipe to improve aesthetics. Explore the effects air flow volume, determine if aluminum downspout allows an excessive amount of radon gasses and/or moisture to escape through the seams. Specifically, can aluminum downspout be used without radon re-entry into to the home and/or moisture damage to the home?

DETERMINATION OF GEOGENIC RADON POTENTIAL OF SELECTED RESIDENTIAL AREAS OF SOUTHWESTERN ILE-IFE, OSUN STATE, NIGERIA

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Abstract

Soil gas radon concentration plays a vital role in the environmental radon risk assessment. This study determined the radon risk indices of staff residential quarters of Obafemi Awolowo University Campus, Ile-Ife (OAU). RAD7 was used to determine the *in-situ* soil gas radon concentration across different lithologies. Permeability of the soil types was also determined. The study revealed soil gas radon concentrations ranged from 0.04 kBq/m³– 190kBq/m³ with a mean of 18.8 kBq/m³. The mean concentration of radon-222 measured were 3.5±5.9 kBq/m³ for granite gneiss, 11.5±25.7 kBq/m³ for the grey gneiss, and 28.4±37.4 kBq/m³ for mica schist and these differ significantly (p<0.001). Estimated radon index revealed mica schist lithology has medium geogenic radon potential (GRP), whereas the other lithologies have low GRP. The first geogenic radon potential map was compiled for the eastern part of OAU campus, which covers 20% of the entire campus and in which about 15% of the population lives.

INCREASING ACCESS TO CERTIFIED RADON MITIGATION FOR LOW-INCOME RESIDENTS IN UNDERSERVED COMMUNITIES

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Abstract

We will describe a multi-pronged strategy to increase access to adequate and affordable radon mitigation services in Appalachia. Appalachian Kentucky leads the nation in new lung cancer cases, and is characterized by high poverty and smoking rates and low radon testing. Based on new radon/geologic maps and increased radon testing, we found that radon risk potential in the region is higher than earlier thought. We systematically evaluated access to certified radon measurement and mitigation providers and identified a critical need for adequate radon mitigation in most rural communities. The *Step Up to Reduce Radon Alliance* partnered with faculty at community and technical colleges in Northeast Kentucky to develop a radon measurement and mitigation certification program. To promote affordability of radon mitigation with low income property owners, we conducted key informant interviews with loan providers in the region to explore the feasibility of low-interest loan programs for mitigation services.

REACHING OVER 88,000 ANNUALLY AND OTHER EFFORTS

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Abstract

The NC Radon Program will present on new programs & efforts that are advancing measurable increases in awareness for radon testing and mitigation. For example, the NC Cancer Control Plan has, for the past three years, selected radon induced lung cancer as a priority issue. As a result, partnerships have evolved to create materials, research, and outreach efforts that have significantly increased public awareness. As an example, every NC licensed real estate broker (over 88,000) is now required to attend a one hour training on radon during their required continuing education course. The purpose of this presentation is to demonstrate opportunities for engagement/partnerships by certified radon professionals.

INVESTIGATING RADON DECAY PRODUCTS: CASE STUDIES AND REVIEW OF KEY SCIENTIFIC LITERATURE

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Abstract

Alpha radiation from radon decay products (RDPs) is the second leading cause of lung cancer in the United States. The relationship between RDP working level (WL) and radon concentration was investigated in several high radon environments where standard mitigation techniques are not feasible. By increasing air circulation through non-invasive methods, a decrease in RDP WL was observed. However, it was discovered that existing conditions within the study areas were already maintaining RDPs well below 0.02 WL. As RDPs are a notable health hazard and there exists locations where radon mitigation is impractical, further studies are needed to examine the effectiveness of long-term RDP mitigation techniques and to verify the equilibrium factors. In conjunction with this case study, a literature review of key research investigating RDPs is presented to help increase RDP awareness.

QUANTIFYING THE VALUE OF GEOLOGIC RADON POTENTIAL MAPS AND LUNG CANCER OUTCOMES

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Abstract

Population scientists, radon hazard prevention staff, geologists from a land-grant university, and economists from the USGS Science & Decisions Center collaborated to quantify the societal benefits derived from creating and disseminating radon risk potential maps. These maps were overlain on observed short-term home radon values statewide spanning over 20 years ($N > 70,000$) and outcropping geologic rock formations in Kentucky. We used available data to analyze the economic benefits of the maps on radon testing, radon mitigation, lung cancer incidence, years of potential lives lost, and healthcare cost savings adjusting for smoking rates. USGS scientists are applying value of information (VOI) techniques to estimate the economic impacts associated with lung cancer for scenarios with and without access to the radon potential maps. Results will be presented. There is an urgent need to communicate the value of geologic maps related to population health outcomes in light of increasingly complex scientific issues.

RADON AWARENESS BILL - OARP'S LEGISLATIVE ACTION

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Abstract

This presentation will discuss the challenges and obstacles that are involved with getting a bill introduced into state government. From finding a bill sponsor, to creating a PR campaign that promotes awareness amongst influential decision makers.

Using the OARP's (Ohio Association of Radon Professionals) efforts as a case study model, we will be discussing how to get meetings with legislators and what material and information you should prepare for these meetings. In addition, we will be discussing the legislative process and how to avoid mistakes that can cost you a bill sponsor.

The objective of this course is to give other radon professionals and state AARST chapters the tools to help create a legislative partnership that can impact radon policy at the state level.

**CREATING AND IMPLEMENTING A LOW INCOME RADON
MITIGATION ASSISTANCE PROGRAM IN COLORADO**

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Abstract

This presentation will discuss the steps involved in creating and implementing a statewide low income radon mitigation assistance (LIRMA) program. It will include information on how the law was passed, program design, the application process for homeowners and participating certified radon mitigators and the successes and challenges of the program.

**PROPOSED PERFORMANCE AND LISTING CRITERIA FOR
PROFESSIONAL RADON MEASUREMENT DEVICES**

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Abstract

The recent commissioning of the Canadian National Radon Chamber at the Radiation Safety Institute of Canada, marked a major milestone for the Canadian National Radon Proficiency Program. The Canadian chamber will facilitate domestic radon measurement performance testing for C-NRPP listed radon professionals. It will also serve as the national radon chamber for professional radon measurement device testing to be used by manufacturers worldwide wishing to have their devices listed by C-NRPP for use in Canada.

This paper discusses proposed performance and listing criteria for manufacturers of professional radon measurement devices. In-chamber test proposals and performance requirements for alpha track and electret ion chamber devices are presented; as are “dynamic” tests and performance requirements for continuous radon monitors and electronic integrating devices.

DOES RRRNC WORK? – A FLORIDA CASE STUDY

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Abstract

The US Environmental Protection Agency and states encourage building radon resistant (ready) new homes (RRNC). The Florida Radon Program evaluated a home built following RRNC practices in Tallahassee. The home in question was measured with the passive system in three occasions. Once with the passive system operating normally; next, with the system capped; and finally simulating a fan on the system by using a shop-vac at the end of the radon exhaust pipe on the roof. Data indicate the system is producing reductions on the radon levels from 25% to 99% depending on the method used.

ASSESSMENT THE CONTRIBUTION RATE OF RADON FROM BUILDING MATERIALS TO INDOOR ENVIRONMENTS

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Abstract

Radon, which is one of the major pollutants in indoor environments, is a radioactive gas naturally formed during the decay of radium, which is found in places such as soil, building materials, and groundwater. In this study, we conduct to evaluate the contribution rate of radon concentration by radon exhalation from building materials in real-life environments.

To control the effect of radon exhalation from the soil, measurements were conducted upper sixth floors. In order to evaluating radon concentration, in-situ method was used to measure radon exhaled from building material and indoor radon concentration was also measured with E-perm in same time.

Based on the results obtained in this study, it is expected that it will be used as basic data for setting the standard of radon exhalation from building materials in the future.

GRAPHENE POLYMER COMPOSITE FILM HAVING RADON GAS BARRIER FUNCTION AND METHOD

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Abstract

The revision of the Indoor Air Quality Management Act of Korea of the new housing complex changed the radon management perception and mitigation system. Therefore, the existing imported and installed radon barrier membrane was developed for the domestic environment.

Recently graphene polymer composite materials have been paid much attention for their potential applications in various areas. Although several studies of epoxy materials based on graphenes were reported, there are still needs in development of new polymer composites. Despite the report of araldite epoxy as a bisphenol type, there has been no report on its composites with graphene materials to the best of our knowledge. In this work, we report araldite 506 epoxy resin graphene composites. The potential application for the radon gas barriers will be tested.

As a result, radon barrier membrane is made of graphene polymer composite materials and commercialization is tried after confirming diminishing efficiency of mitigation system.

SUMMARY OF RESEARCH ON MITIGATION SYSTEM DESIGN AND MONITORING

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Abstract

The U.S. DOD sponsored research through the ESTCP Program for improved understanding of mitigation systems for radon and volatile organic compounds under project number ER2013-22. This presentation summarizes the findings of the 5-year study. For large buildings, the research indicates that significant improvements in cost-effectiveness can be achieved using a few new lines of evidence and a spreadsheet model. Lines of evidence include steady vacuum versus radial distance from a suction point, transient vacuum measurements (change in vacuum vs time in response to turning the fan on or off) and fitting data to equations to calculate the transmissivity (T) of the material below the floor slab and the leakance (B) of the floor slab. Helium tracer testing to measure flow rates below the slab and mass removal rate monitoring provide added value for system design and monitoring. Case studies of one residence and two commercial buildings will be included.

RISK ESTIMATES FOR AIRBORNE AND WATERBORNE RADON

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Abstract

A 3-year radon and health study was conducted using approximately 2000 occupied homes in VA, MD and DC over approximately 1000 square miles. Seasonal alpha-detectors and weekly charcoal detectors were used for indoor-radon measurements, with EPERMs used for drinking water. Home occupants provided the home location (radon vs. geology comparisons), home characteristics (radon vs. basement construction, size, HVAC system, water supply, etc.) and cancer experiences of family members (radon and time vs. cancer types). Higher indoor-radon tends to be in homes over sandy soil and acidic (granitic) soil, and in homes with larger basements, concrete block construction, heat pump HVAC systems, dry sump-pump crocks, etc.; while soft-tissue cancers (leukemia, brain, breast, liver, kidney) were more common in homes with waterborne radon above 2000 pCi/L. No correlation was found between waterborne radon and indoor radon, indoor radon and season-of-year, indoor radon and lung cancer, and drinking water radon and stomach cancer.

INITIAL UPDATE OF THE HUD MULTIFAMILY RADON STUDY

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Abstract

Approximately 36% of the U.S. population lives in multifamily housing. In the U.S, current recommendations for the number of individual units of multifamily housing that should be tested for radon vary from 10% (Fannie Mae), 25% (HUD) to 100% (ANSI-AARST). A three-year funded study to statistically examine the various radon-testing protocols in these multifamily housing was initiated in January 2018. Radon results for the study will be provided by accredited radon measurers. The goal is to determine the minimum percentage of the units that need to be measured to assure a low radon exposure to occupants of any unmeasured units. The study design, objectives, and progress to date will be presented.

USING A RADON DETECTOR TO VALIDATE RADON-POTENTIAL MAPS AND ASSESS RADON IN GROUNDWATER

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Abstract

A team of geologists, nurses, statisticians, and health educators collaborated to create lay-friendly, county-level maps showing varying radon potential using the novel concept of danger to non-technically communicate risk. The maps were created in 2016 by correlating observed radon values from short-term residential test kits with rock types, and have been widely circulated in the state in an attempt to create awareness and increase residential radon testing. We are in process of validating the radon-potential maps in the field using a portable laboratory grade electronic radon detector. We are taking real-time radon measurements with a soil-gas probe to help identify specific geologic units that are prone to high radon production. Data will be used to complement the maps in areas with little data. We will present preliminary data on radon in groundwater using water attachments from the radon detector.

OPTIMIZING THE POSITION OF SUCTION PITS IN LARGE BUILDINGS MITIGATION

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Abstract

The position of suction pits is of critical importance for the efficiency of the active soil depressurization mitigation systems. One of the factors that have to be considered is the distribution of the radon source in the soil beneath the building foundations. Our results show that in many cases the source is not homogeneous, with variations that can exceed an order of magnitude, especially for large buildings. We present an approach for robust estimation of the most likely radon distribution using radon-in-soil gas measurements at a depth of 60 cm made in points of a contour close to the external perimeter of the building. Then a mathematical model is employed to obtain the most likely radon distribution in the terrain beneath the building that best fits best the values measured on the contour. Obtained this way “radon source strength map” is used for optimal choice of positions of the suction pits.

STATIONARY ONLINE RADON MONITORING WITH ALPHAGUARD

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Abstract

Stationary radon monitoring with remote data access is more and more important today, for radiation protection purposes but also for applications using radon as a tracer. For example, in high seismological risk level areas the radon in soil gas can be used as a tracer for seismic activities. The remote online monitoring of the radon in soil gas enables a considerable improvement of the early detection of seismic activities. In mines or other industries with increased radon levels, radon monitoring stations are used for radiation protection purposes. Based on real-time measurement data fast actions can be taken, such as by adapting the ventilation to reduce the radon exposure of workers in case of an exceedance of reference or threshold values. With the AlphaGUARD and its accessories complete measuring stations can be provided for remote online monitoring of the radon concentration in air, water and soil, proven in numerous existing applications.

LARGE DECREASE OF RADON CONCENTRATIONS IN NEW-BUILT SWEDISH DWELLINGS

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Abstract

From the analysis of about 100,000 radon measurements in Swedish dwellings stored in the database of Radonova, it has been found that the number of dwellings above the reference level of 200 Bq/m³ (5.4 pCi/l) has decreased a lot for new buildings. The number of single-family houses with building year 2014-2016 with radon levels above the reference level was only about 2 % which can be compared with about 30% for houses built 1950-1980. These data show the importance of good building practice. The development in building technique which can have influenced this improvement will be discussed. Similar data will also be presented for multi-family houses as well as data showing how the radon levels in houses built around 2005 have changed from measurement at that time until now.

WHAT WE KNOW ABOUT URANIUM AND RADON GEORGIA WELL WATERS

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Abstract

Radionuclides from three naturally occurring decay series (headed by ²³⁸U, ²³⁰Th, and ²³⁵U), have long been known to be present in groundwaters in Georgia. In 2010, routine surveillance of drinking-water testing revealed uranium concentrations exceeded the U.S. Maximum Contaminant Level (30 ppb) in private wells in central Georgia. Since they are in the same ²³⁸U decay series, high levels of uranium in well water may be associated with elevated levels of dissolved radon gas. Drinking water that contains high levels of these contaminants can have adverse health consequences, though definite relationships of those health issues with uranium and radon in drinking water have not been established. This paper provides an overview of our testing, mapping programs, and public education programs for tracking and mitigating uranium and radon in Georgia well waters. It also sheds some lights on the temporal variation of these two contaminants in well waters and their interrelationships.

QUALITY ASSURANCE IN MEASUREMENT OF RADON IN WATER BY LIQUID SCINTILLATION COUNTING

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Abstract

Our papers in 2016 and 2017 Symposia discussed optimum sampling and analysis methods for radon in water. This presentation discusses quality assurance. The counting efficiencies of multiple liquid radium standards purchased from a commercial manufacturer produced inconsistent and unacceptable counting efficiencies; thus, their use in the analysis appeared

questionable. Duplicate analysis of radon in 142 well water samples mostly yielded relative percentage deviation (RPD) ≤ 15 and seldom > 15 . However, > 15 RPD was associated with the presence of an air bubble in one of the duplicate samples. Repeated analyses of two radon proficiency-test samples, regenerated at 40 to 60 day intervals over a period of two years, consistently yielded acceptable precision (based on the duplicate analyses) and accuracy (closeness to the theoretical radon concentration). Thus, a proficiency testing for radon in water is a valid and valuable option, and should be part of programs that analyze radon in water.

CONVEYING WORKER SAFETY: POTENTIAL RADON RISKS IN THE WORKPLACE

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Abstract

Employer risk of liability exists with potential exposure of employees to elevated levels of radon gas. Industry emphasis on single family and multifamily dwellings may impartially skew populations at risk of contracting radon induced lung cancer. Increased number of hours spent at the workplace may further increase exposure risks. Certified radon professionals can provide valuable public service through providing accurate information to companies and employers, improving reputation of AARST as well as saving lives through expanding knowledge. A simple method of presenting radon related facts is provided.

CORRELATING ENVIRONMENTAL VARIABLES WITH RADON ACTIVITY IN AN IOWA CAVE

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Abstract

Kemling Cave is located in Dubuque County, Iowa. It is a single-entrance cave with 3.51 km of surveyed passage. The entrance is gated, but done so in a manner that does not impede air exchange between the cave and the surface environment. Past work has shown that

measurement of radon activity as a function of time in this cave displayed an extreme degree of variability. In this work, follow-up studies were designed and carried out to measure radon activity in parallel with a number of other environmental parameters, seeking to find which of the parameters had the strongest correlation with the radon activity.

RADON CONTROL IN CANADIAN BUILDINGS: RESEARCH AT NATIONAL RESEARCH COUNCIL CANADA

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Abstract

Researchers at the National Research Council (NRC) of Canada have been conducting experimental studies related to radon control in buildings since 2011, in collaboration with Health Canada's National Radon Program. The presentation outlines the research outcomes covering the topics ranging from the impact of active soil depressurization on heating energy consumption and indoor environment, leakage through radon control fan enclosure, performance of passive radon stacks in Canadian homes, to the effectiveness of using heat recovery ventilator for radon control in airtight houses. In order to verify the effectiveness of sub-slab air barrier systems in reducing radon ingress, the NRC has developed the Radon Infiltration Building Envelope Test System (RIBETS) and Radon Diffusion Test Chamber (RDTC). The paper will focus on the testing from the RIBETS and the RDTC, summarizing the Radon Diffusion Coefficient and Radon Resistance results measured from 10 building materials that are used beneath concrete slabs.