2002 International Radon Symposium Proceedings

Difficult to Digest Myths and Mysteries of Radon

Paul Kotrappa Ph.D.
President, Rad Elec Inc.
5714-C Industry Lane
Frederick, MD 21704
Pkotrappa@aol.com

ABSTRACT

There are several myths and mysteries about radon some of which can be explained and some can not be explained satisfactorily. Radon is a heavy gas, eight times heavier than air, why does it not settle to the floor in the room? There is no doubt at all that radon causes lung cancer, but it is used in high concentrations in radon SPAS to alleviate many diseases, are these consistent? There are scientific publications that indicate the residential radon increases the risk of lung cancer, some indicate that there is no increased risk and some data indicate that the radon decreases the risk of lung cancer. What is the best consensus truth and why? It is well know that the hazard from radon is mainly from inhaling radon daughter products and the hazard from radon gas itself is nearly one hundredth of that due to progeny, why do we remove radon in mitigation procedure and not the progeny? These questions are answered as best as possible by referring to the published literature, wherever applicable.

Radon is a heavy gas, eight times heavier than air, why does it not settle to the floor in the room?

This crosses the minds of most people concerned with radon. Radon is an inert gas found in very trace quantities mass wise, even at high radon concentrations of several hundreds of pCi/L, gravimetric properties do not play any roll is the first quick answer. Radon quickly diffuses from high concentration area to low concentration area and density of gas has no role. Such diffusion is controlled only by concentration gradient. This is the reason radon escape easily through windows open to outside or to passages that have low radon concentration. This is also the reason that the sensor areas of the radon monitors rapidly equilibrate with room air, representing the room air concentration all the time, tracking real time radon concentration, thanks to diffusion.

If the diffusion is the main process of dispersing radon, does it mean that radon concentration is uniform through out the basement?

Concentration tends to be uniform. This is the reason EPA recommends only one radon measurement for every 2000 ft^2 area in large rooms. However, if the source is localized, such as sump area, the concentration in the immediate vicinity can be relatively higher, because radon has not yet diffused and diluted with room air. Such areas may not represent a proper location for locating radon monitors. Protocols usually exclude such areas for locating radon monitors. This is also addressed in Iowa radon lung cancer study (Fisher et al 1998).

Why radon concentration in Carlsbad Cavern remains steady through out the Cavern and all round the year?

Radon concentration was found to be unusually steady and uniform at 49 +/- 1.5 pCi/L through out the Cavern and all round the year (Cheng et al , 1997)

Extremely low air exchange rate of once in 18 days and the diffusion properties of radon can explain unusually steady nature of radon concentration in the Carlsbad Cavern.

Probably, Carlsbad Cavern forms world's largest single concentration radon test chamber for centuries! No one, except nature can change the concentration!

There have been a large number of case control studies relating lung cancer cases with exposure to radon at residential levels. What are the conclusions of the recent (2002) review papers?

Total of 15 case control epidemiological studies relating lung cancer to exposure to radon published in the literature covering USA, Canada, Sweden, Finland, England, and Germany during 1990 to 2001 are critically reviewed in a review paper published in July 2002 (Neuberger and Gessell, 2002)

From scientific point of view residential radon exposure provides:

An opportunity to examine LNT (linear non-threshold) model that is used for carcinogens and exposure to ionizing radiation. Whether extrapolations from dusty mine exposure is justified for use in indoor radon exposures. Nearly 5 % to 15 % of lung cancer cases are attributable to passive smoking, occupational exposure to certain chemicals, ionizing radiation, diet and family history of cancer. Exposure to radon and radon progeny constitutes a major component to the exposure to ionizing radiation.

Here are some conclusions:

- The risk for lung cancer among nonsmokers remains uncertain.
- Residential radon exposure in high radon areas may be a risk factor in the smoking population.
- Some studies show a non-significant increase in risk for lung cancer among non-smokers as radon level increases. This study need to be watched further to see whether there is an evidence of threshold.
- There is no evidence to a significant inverse association, nor of any protective effect of radon and lung cancer.

- A larger-scale case-control study is important both from the scientific point of view and arriving at the action limit for radon.
- What may be needed is a large case-control study in high radon areas for NEVER smokers using more recent and better methodologies including better estimate of integrated exposure to radon may to remove some uncertainties.

Better and more refined methods of assessment of cumulative radon are used in few recent studies (Lagarde et al 2002). Do these provide a better correlation between lung cancer and radon exposure?

Sure, this study (Lagarde et al 2002) gives unequivocal conclusion. The excess relative risk is 75% per 100 Bq m(-3). LNT hypothesis appears to hold well. Below is a quote on the conclusions from this study.

"Lung cancer risk estimation in relation to residential radon exposure remains uncertain, partly as a result of imprecision in air-based retrospective radon-exposure assessment in epidemiological studies. A recently developed methodology provides estimates for past radon concentrations and involves measurement of the surface activity of a glass object that has been in a subject's dwellings through the period for exposure assessment. Such glass measurements were performed for 110 lung cancer subjects, diagnosed 1985 to 1995, and for 231 control subjects, recruited in a case-control study of residential radon and lung cancer among never-smokers in Sweden. The relative risks (with 95% confidence intervals) of lung cancer in relation to categories of surface-based average domestic radon concentration during three decades, delimited by cut points at 50, 80, and 140 Bq m(-3), were 1.60 (0.8 to 3.4), 1.96 (0.9 to 4.2), and 2.20 (0.9 to 5.6), respectively, with average radon concentrations below 50 Bq m(-3) used as reference category, and with adjustment for other risk factors. These relative risks, and the excess relative risk (ERR) of 75% (-4% to 430%) per 100 Bq m(-3) obtained when using a continuous variable for surface-based average radon concentration estimates, were about twice the size of the corresponding relative risks obtained among these subjects when using air-based average radon concentration estimates. This suggests that surface-based estimates may provide a more relevant exposure proxy than air-based estimates for relating past radon exposures to lung cancer risk.

The Missouri and Iowa (Field et al, 2001 and 2002), that used enhanced dosimetry methods, found higher risk estimates than previous studies. These findings strongly suggest that previous radon studies may have actually underestimated the risk posed by residential radon, because exposure misclassification was found to bias the studies toward finding no association. It is believed that risk estimates from rigorously designed analytic epidemiological studies provide compelling evidence that prolonged residential radon exposure increases the risk of lung cancer.

There are some studies that tend to indicate there is an inverse relationship between lung cancer and radon concentration, is this true?

Scientifically conducted case control studies have not demonstrated any protective action of radon for lung cancer. Some ecological studies tend to indicate inverse relationship between lung cancer and radon concentration, but have been discounted "as not based on acceptable scientific facts" (Lubin 2002). One of the conclusions in recent review paper is "There is no evidence to a significant inverse association, nor of any protective effect of radon and lung cancer" (Neuberger and Gessell, 2002). Such conclusions can also be drawn from another recent publication (Lagarde et al 2002).

Why do people expose themselves to extremely high radon levels in special Radon SPAS- Radon Therapy? Are the benefits proved?

There has been large number of publications describing the virtues of exposure to radon and the associated beneficial effects. Many of these come from testimonials listed in marketing and promotional literature. The diseases listed include virtually all diseases found to occur in humans.

The levels are usually in the range of 2000 to 50,000 pCi/L with temperatures (room temperature to 125° F) and humidities (comfort to 100 %). Exposure periods range from half-hour to several hours.

There has been large number of publications describing the virtues of exposure to radon and the associated beneficial effects. Many of these come from testimonials listed in marketing and promotional literature. The diseases listed include virtually all diseases found to occur in humans. Following is quote from one of the Free Enterprise Radon Health Mine located at 149 Depot Hill Rd., PO Box 67, Boulder MT 59632-0067, and USA. . http:\\www.radonmine.com

DISCLAMER NOTICE

This mine facility is available for persons seeking an alternative or complement to present treatment for pain relief and disease symptom management. Call for contraindications if you are unsure whether or not your symptoms will respond favorably. The exposure to these radon levels are considered "perfectly safe" by the State of Montana. Children under 18 are requested to first obtain a written prescription from a licensed doctor. Pregnant women are asked to consult with their physician. This is not a medical facility. Doctor's inquiries are welcome. Supportive technical information is available upon request or print from the Resource Document link on this web site.

Ailments that are alleviated by radon exposure, but not limited to are:

Ankylosing Spondylitis (AS),Arthritis, Asthma,Bursitis,Cancer (Breast),Carpal Tunnel, Circulation, Diabetes Type I (Juvenile)
Diabetes Type II (Adult onset), Eczema, Emphysema, Fibromyalgia (FMS), Gout
Hayfever, High Blood Pressure, Juvenile Rheumatoid Arthritis (JRA), Lupus, Migraine Headaches, Multiple Sclerosis (MS), Osteo Arthritis (OA), Prostate (BPH), Psoriasis
Rheumatoid (RA), Scleroderma, Sinus

Conclusions:

The fact that most diseases are mentioned as alleviated means it can not be fully true. Many patients who are suffering from chronic diseases over extended period go to these SPAS and alleviation may be mostly due to psychological factors, based on setting, whom they meet, and glorious testimonials. But there are many publications, which prove the beneficial effects, in reputed journals (Reiner et al. 2000). It is still one of the item that does not have full explanation.

It is known that radon is sparingly soluble in water, why water in some wells can have extremely high radon levels (0.1 to 10 million pCi/L)? (Field 1998)

Equilibrium partition coefficient between radon in air and water is about 20%. This means that radon concentration in water is only 20% of that in air and therefore termed as "sparingly soluble". However water is continuously in contact with soil gas radon and radon in fractures and fissures in rocks and soils. These concentrations can be very large, leading to high levels of radon in water.

Radium concentration in soil in the earth crust may vary by a factor of 10 in residential areas, howcome the indoor radon concentrations are found to vary by very large factors (thousands)?

Indoor radon concentration depends upon many factors, which include radium concentration in soil. These are radon flux from the ground, porosity of soil, geological formations such as cavities, fractures, and fissures and the suction provided by the stack effect of home. This is how very high concentrations (several thousand pC/L), in some homes are explained.

Sometime we hear about thoron, another isotope of radon, howcome it is not routinely measured and reported in "indoor radon concentrations in homes"?

Radon (^{222}Rn) comes from the decay of uranium and thoron (^{220}Rn) comes from the decay of thorium. Both uranium and thorium are trace elements in earth crust and are ultimately responsible for indoor radon and thoron in air. The concentrations of uranium and thorium may vary from area to area. Important difference between the half-lives of radon (4 days) and thoron (one minute) makes a big difference in resulting indoor concentrations. Most of thoron decays before reaching indoors. Further it can not build up to high values because of the short half-life. This is the reason it is not measured routinely in homes. However this becomes important in areas rich in thorium, in areas thorium is handled or stored. There are special E-PERM ® thoron detectors based on the principle of electret ion chambers, which are used for surveying thoron (Kotrappa, Stieff and Bigu, 1994). It must be kept in mind that thoron may be an interfering parameter while measuring radon in some radon detectors and must be taken into account.

REFERENCES:

Cheng YS, Chen TR, Wasiolek PT and VanEngen A "Radon and Radon Progeny in the Carlsbad Caverns" Aerosol Science and Technology 26:74-92, 1997

Field, R.W. and Kross, B.C., Iowa Survey of Waterborne ^{222}Rn Concentrations in Private Wells. *Health Physics.* 74(2):249-252, 1998.

Field, R.W.. A Review of Residential Radon Case-Control Epidemiologic Studies Performed in the United States. Reviews on Environmental Health. 16(3): 151-167, 2001

Field RW, Smith BJ, Steck DJ, Lynch CF. Residential radon exposure and lung cancer: Variation in risk estimates using alternative exposure scenarios. Journal of Exposure Analysis and Environmental Epidemiology. 12(3): 197-203, May 2002.

Fisher EL, Field RW, Smith BJ, Lynch CF, Steck DJ, Neuberger JS. Spatial variation of residential radon concentrations: the Iowa Radon Lung Cancer Study. Health Physics. 75(5): 506-13, Nov 1998).

Lagarde F, Falk R, Almren K, Nyberg F, Svensson H, Pershagen G."Glass-based radon-exposure assessment and lung cancer risk" J Expo Anal Environ Epidemiol 2002 Sep: 12(5): 344-54: 2002

Lubin J.H "The Potential for bias in Cohen's ecological analysis of lung cancer and residential radon" J.Radiological Protection 22:141-148 (2002)

Kotrappa P, Stieff L.R and Bigu J "Measurement of ^{220}Rn, thoron, using Electret Ion Chambers" 1994 International Radon Symposium, Atlantic City, NJ, sponsored by AARST Pages IIIP-2.1- 2.7, 1994

Neuberger John S. and. Gessell Thomas F "Residential Radon Exposure and Lung Cancer: Risk in Nonsmokers" Health Physics 83:1-18; 2002

Reiner F.A. et al. "Long term efficacy of radon spa therapy in rheumatoid arthritis – a randomized, sham-controlled study and follow up" RHEMATOLOGY: 39:804-902; 2000.

Steck DJ, Alavanja MC, Field RW, Parkhurst MA, Bates DJ, Mahaffey JA. 210Po implanted in glass surfaces by long term exposure to indoor radon. Health Physics. 83(2): 261-71, Aug 2002