How Much Additional Radon Dose Are We Getting While We're Home During the Pandemic?

Bruce Snead and Brian Hanson – National Radon Program Services at Kansas State University - and our thanks to Kevin Stewart of the American Lung Association for his input on this topic.

The leading cause of lung cancer death in people who have never smoked is the person's radon dose. The primary place people get radon exposure is in our homes. The process by which long-term lung cancer risk from radon exposure is calculated, however, is often not well understood by the radon industry or the public. Below we take a look at the potential increase in radon dose from radon levels in a home due to increased time at home during the Covid-19 Pandemic.

The risk of cancer from a source of radiation like radon is called the dose which is equal to the radiation level of the radon source multiplied by the time of exposure.

Radon Dose = Radon Level X Time of Exposure

In Kansas, approximately 38% of all radon measurements reported are at or above the EPA Radon Action Level of 4.0 pCi/L. The average radon level for all reported Kansas measurements is 4.6 pCi/L. Approximately 2%, or 2 out of every 100 homes, have radon levels above 20 pCi/L. Under normal circumstances many people would spend 8-12 hours/day outside the home working, attending school, or running household and other errands, etc. However, during the pandemic, many have spent those same hours at home for the past several months. Consequently, we can estimate how much one's radon dose has changed based on radon levels in the home and the likely increase in the hours at home. Another factor in the radon dose change is what the radon levels are in the locations now being avoided due to Covid 19. It is possible those levels could be higher than at home but there is greater probability of them being lower. EPA lung cancer risk estimate tables are based on 18-hour per day average annual exposure at home and use 1.3, 4.0, 8.0, and 20.0 pCi/L as common radon levels in homes.

A key point related to radon is that the primary exposure comes from the proportion of the two polonium particles produced in the air during the ongoing radioactive decay of the radon gas in the home. The unit of measurement for these decay products is known as the Working Level (WL), which is the amount of polonium available in the environment to be inhaled. 100 pCi/L of radon will produce 1 working level of the decay products. How much of those decay products that are airborne and breathable is determined by the Equilibrium Ratio (ER). In order to calculate the WL from a known radon concentration, the Equilibrium Ration (ER) of the home must be known or assumed; in general, an ER = 0.5 is assumed for most residences. An ER = 0.5 indicates that approximately 50% of generated polonium is airborne and available to be inhaled by residents. This means that in such an environment, a radon level of 200 pCi/L results in 1 WL of the decay products. This relationship is shown in the formula.

WL = (ER X Radon Concentration (pCi/L)/ 100

Long-term lung cancer risk from residential radon exposure then is equal to the WL of the residence multiplied by the time of exposure. This calculation is known as the Working Level Month (WLM). The number of hours in a working month is 170 – this is based on 8 hours a day for 21 working days per month. Lung cancer risk over time is calculated based on an individual's cumulative WLM value.

WLM = (WL X Hours of Exposure)/ 170 working hours in a month

Let's look at the increase in radon dose for some common radon levels for various number of hours spent at home. Table 1 lists the annual radon exposure in working level months (WLM) of four common radon concentrations in homes: 1) 1.3 pCi/L (the EPA's estimated national indoor radon average), 2) 4.0 pCi/L (the EPA's Radon Action Level – 38% of Kansas homes test over this level), 3) 8.0 pCi/L and 4) 20 pCi/L. The dose is calculated at four average daily exposure hours in the home: 1) 8 hours at home/day, 2) 12 hours at home/day, 3) 18 hours at home/day and 4) 24 hours at home/day. The calculations assume an ER = 0.5 or that half the radon-released particles are in the air available to breathe.

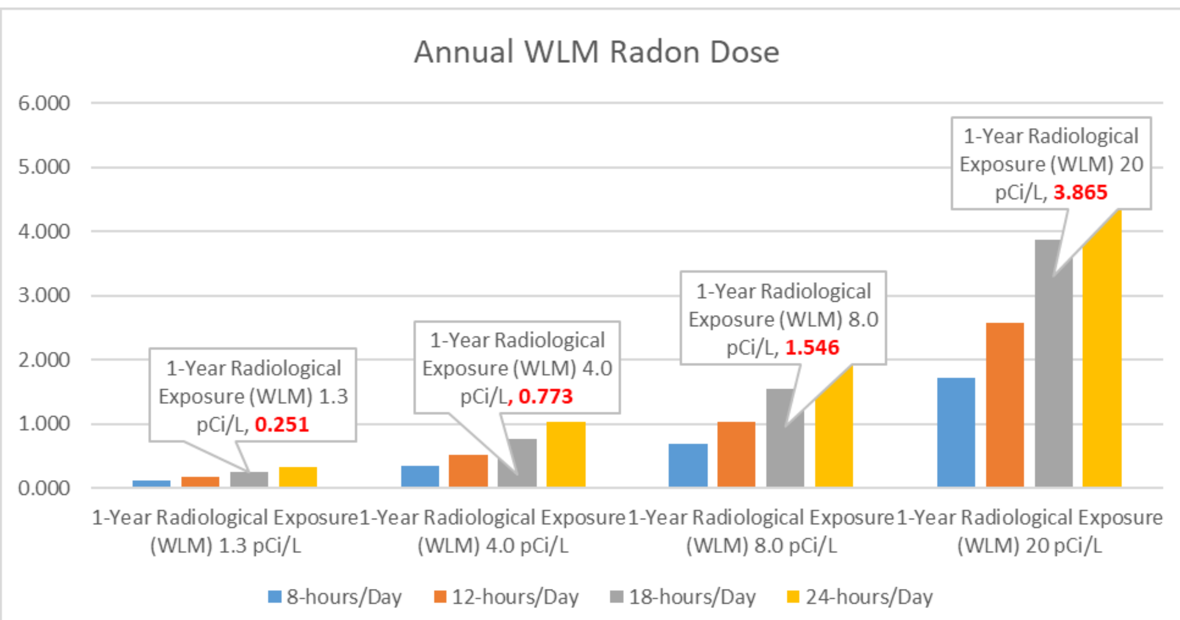
If time at home for a full year increases from an average of 12-hours/day to 18-hours/day, the annual radon dose in WLM from the radon levels in the home increases by 50%, or by one half!

For every additional 1 hour per day spent at home at the same radon level, the annual radon dose increases by about an average of 7%.

Table 1. Annual radon dose when spending 8-, 12-, 18-, or 24-hours in a home with 1.3, 4.0, 8.0, or 20.0 pCi/L radon levels. ER = 0.5

TIME AT HOME	1.3 PCI/L	4.0 PCI/L	8.0 PCI/L	20 PCI/L
8-HOURS/DAY	0.112 WLM	0.344 WLM	0.687 WLM	1.178 WLM
12-HOURS/DAY	0.167 WLM	0.515 WLM	1.031 WLM	2.576 WLM
18-HOURS/DAY	**0.251 WLM** (12 hrs +50%)	**0.773 WLM** (12 hrs +50%)	**1.546 WLM** (12 hrs +50%)	**3.865 WLM** (12 hrs +50%)
24-HOURS/DAY	0.335 WLM	1.031 WLM	2.061 WLM	5.153 WLM

Chart 1. Annual WLM radiological dosage at four common radon concentrations and four average residential time exposure periods



The local, state and national level response to the current pandemic conditions has radically changed how many of our clients and their families are spending their time. It is the responsibility of the radon industry in Kansas (public and private sectors alike) to help those clients understand how shifting use in residential spaces can impact their long-term lung cancer risks from radon exposure. Although, as a general approximation, a 50% increase in annual dose over a year might result in a 1-3% increase in lifetime lung cancer risk due to radon, bear in mind that the additional risk will continue to increase should that higher dose become persistent over many years.

As always, when your clients ask questions to which you may not know the full answer, please feel free to refer them to the National Radon Program Services (NRPS) and our hotline (800.767.7236) or to www.sosradon.org