COMPARISON OF TWO DAY CONSECUTIVE RADON MEASUREMENT RESULTS TO A 90 DAY AVERAGE MEASUREMENT RESULTS USING THE DATA FROM CONTINUOUS RADON MONITORS IN A TYPICAL SINGLE FAMILY HOME IN FREDERICK, MD, USA

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ABSTRACT

Two calibrated Radon Scout continuous radon monitors were installed in the basement of a typical single family home in Frederick, MD, USA, in accordance with the USEPA deployment protocols. These units were set to collect and average radon concentrations over three hour intervals. In addition to logging the average radon concentrations, the basement temperature, humidity, and barometric pressures were also collected. The units were run for three months in closed house conditions. The data was analyzed with an aim to find any correlation of three hourly peaks to outdoor environmental conditions such as precipitation, temperature, and wind. Further aim was to determine how the two day consecutive average radon concentrations compare with the three month average radon concentrations. This work describes the results for the first two quarters of 2010 and will continue for the entire year. This may answer some frequently faced queries by the radon measurement professionals, in the course of their work.

INTRODUCTION

In accordance with the USEPA radon testing protocols, short term indoor radon measurements are usually carried out for 2 to 7 days; and long term measurements are carried out for a period of more than 90 days. Radon concentrations at a given time depend upon the time of the day, and atmospheric conditions such as barometric pressure, precipitation, and outside temperature differentials. It is widely accepted that the emanation of radon from the ground and diffusion of radon into home is dependent upon these parameters. Such dependence is very complex. When short term measurements are conducted for a period less than 91 days, such as for two days, seven days or even for 30 days, such measured values can be different from the long term average. The purpose of this study is to compare 2 day averages, seven day averages, and monthly averages to the long term average. Such a comparison provides the type of uncertainties encountered when a short term measurements are done. Further whether there are some noticeable episodes of weather conditions. In fact USEPA has recommended: "Quote Radon Measurement Protocol: EPA-402-R—92-004(1992):

Short-term tests lasting for two to three days should not be conducted if severe storms with high winds (e.g.., >30 mph) or rapidly changing barometric pressure are predicted during the measurement period. Weather predictions available on local news stations can provide sufficient information to determine if these conditions are likely". It is of interest to examine the data and find any correlation of high transient radon concentration with other major episodes such as light/heavy rains, heavy snow, slow /fast thaws, high winds, and unusually low or high temperatures.

METHODOLGY

A pair of calibrated Radon Scout Continuous Radon Monitors (CRMs), were installed in the basement of a typical single family home in Frederick, MD, USA. The Radon Scout CRMs are NRSB listed devices, based on USEPA evaluation. These instruments have the capability of recording hourly or 3 hourly readings, temperature, humidity and atmospheric pressures in the area where the monitors are located. The units were set up to measure 3 hourly average parameters. The readings were down loaded and displayed in an Excel® spread sheet. The data was analyzed to calculate consecutive two day averages, consecutive 7 day averages, and consecutive monthly (30 day) averages for each quarter. The home had a sub slab depressurization mitigation system installed in the basement, but this mitigation system was turned off during these studies. The home has typical forced air heating unit and a centralized air conditioning system. The thermostat was maintained at about 70 degrees F in winter and about 80 degrees F in summer. Closed house conditions that complied with USEPA short term radon testing protocols were maintained for the entire period of the studies. This is the normal operating conditions for the home.

RESULTS

Two sets of quarterly data were analyzed - one set for the period from Jan 20 to April 20, 2010 and another set for the period from April 20 to July 20, 2010. The first set of data covers part of winter and a part of spring. Second quarter covers part of spring and a part of summer.

FIRST QUARTER (January 20 to April 20, 2010)

Results are displayed in Figures 1 to 5. Figure 1 is a record of the radon concentrations over the stated periods. Note that the radon concentration averaged over 3 hours is recorded to provide better statistics. The concentrations varied from insignificant radon concentrations, to a high of 12 pCi/L with several peaks and dips. Such variations are attributed to the varying environmental conditions. Due to such variation, a two day measurement can lead to significant errors relative to a 3 month average. Figure 2 presents consecutive two day average concentrations. These show a spread from 1.9 pCi/L to 5.5 pCi/L. Any random 2 day measurement can be anywhere between these two numbers, depending upon the environmental conditions. The Standard Deviation of the 2 day measurements is about 40%. Figure 3 presents consecutive seven day average concentrations. These show a spread from 1.9 pCi/L to 5.0 pCi/L. Any random seven day measurement can be anywhere between these two numbers, depending upon the environmental conditions. The Standard Deviation of the 7 day measurements is about 30%. Figure 4 presents consecutive monthly averages. The data indicates that even a monthly measurement can vary from 2.5pCi/L to 4 pCi/L, and can be quite different from the 3 month average.

Figure 5 gives a correlation between the atmospheric pressure (as measured inside the monitoring area) and the radon concentration .There is no very clear correlation. Generally, lower pressures lead to higher radon concentration, but not all the time.

SECOND QUARTER

Figure 6 to 10 gives data for this period. Comments for the first quarter are generally applicable for this quarter. However the quarterly average is higher (4.7 pCi/L) compared to the first quarter average of 3.4 pCi/L.

EPISODES AND CORRELATIONS WITH RADON PEAKS

The radon concentration of a 7.0 pCi/L and above is considered as significant peak for the fist quarter. This is about twice the quarterly average. Table-1 gives the list of major episodes for the first quarter and their association, if any, with the radon peaks. NS stands for "not significant". Table 2 gives the list of major episodes for the second quarter and their association with major radon peaks.

DISCUSSIONS AND CONCLUSIONS:

Steck and his associates (Steck 1990; Steck 1992; Steck (2009) have done similar studies extending to several years. Their conclusions regarding the in adequacy of making short term measurement is similar to the one that is made in this paper. The Spring/Summer season (second quarter) gave higher quarterly average radon concentrations, compared to the Winter/Spring season.

During the first quarter (Table-1), major snow storms and high winds did not show any association with high radon peaks. However, in four cases high radon is associated with the rain. There are four cases where high radon is not associated with the rain.

During the second quarter (Table-2), there are only in two cases where there is an association of high radon with rain. High wind is not associated with radon peaks. Other radon peaks are not associated with rain. The association of radon peaks with rain is not unexpected. Moist soil has higher radon emanation coefficient in moist to wet conditions. This leads to higher emanation of radon. However, there may be cases of very wet conditions that may also block the radon. In spring months, the ground is generally wetter which "releases" more radon. This may be the reason for higher average concentration in spring compared to winter, but fewer peaks are associated with the rain.

Table-1 Episodes and Radon concentration peaks in first quarter

Dates	Radon Peaks pCi/L	Rain Inches	Snow Inches	Wind MPH
1/25-1/26	11.8	Heavy 2 to 3		High wind
1/30	NS		Heavy 4 to 6	
2/5- 2/6	NS		Heavy 20-30	
2/9-2/10	NS		Heavy 15-20	
2/11-2/12	NS		Snow drift	Very high 45
2/14-2/15	NS		2- 3	
2/25	NS		Snow melt	
3/6	6.8	-	-	
3/12-3/13	10.1	2.5 to 3	-	
3/14-3/15	8.8	Rain continued	-	
3/22	8.6	-	-	
3/28-29	9.4	1.0	-	
4/3	6.8	-	-	
4/7	7.1	-	-	
4/17	7.6	-	-	

Table-2 Episodes and Radon concentration peaks in second quarter

Dates	Radon Peaks pCi/L	Rain Inches	Snow Inches	Wind MPH
4/25-4/27	10.5	Heavy 1.71	-	
5/3-5/4	11.4	0.26		
5/7-5/8	NS	-		Very high wind
5/23-5/24	12.2	-		
5/31-6/1	8.3	-		
6/3-6/8	13.3	-		
6/13- 6/16	13.1	-		

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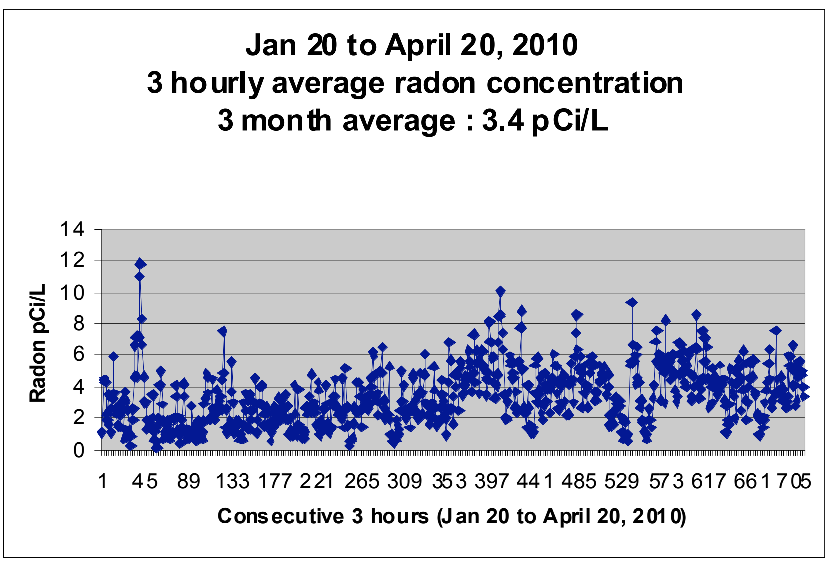

Figure 1 Consecutive 3 hourly radon Concentration for period Jan 20 to April 20, 2010