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SUMMERTIME ELEVATION OF RADON IN SOUTHERN APPALACHIAN HOMES*

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R. B. Gammage
D. L. Wilson
Health and Safety Research Division
Oak Ridge National Laboratory
Oak Ridge, Tennessee 37831-6383

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R. B. Gammage
D. L. Wilson
Health and Safcty Research Division.
Oak Ridge National Laboratory
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For houses in particular counties of the southern Appalachians, the atypical situation arises of higher indoor levels of radon during summertime rather than wintertime. For example, in 90 houses located in Huntsville, Alabama, the summer and winter geometric means were 121 and 88 Bq m^{-3}, respectively. Where such conditions prevail, it is recommended that houses be screened for elevated radon during warmer rather than colder seasons of the year.

INTRODUCTION

When a house is being heated during cold weather, the indoor thermal stack effect (1) produces pressure differentials that draw radon from the underlying soil into the house. During summertime when the air is warmer outside, cooler and denser indoor air will tend to inhibit the ingress of radon-bearing soil gas. In many parts of the country, indoor levels of radon are thus found to be highest during wintertime. Consequently, the U.S. Environmental Protection Agency (EPA) and the Centers for Disease Control are recommending that short-term (i.e., less than three months in duration) screening measurements be made during the cool months of the year (2). Another EPA recommendation is that all short-term measurements be made during periods of the year when windows are normally kept closed (3). For most climates in the U. S. this will be during the winter months. By screening at the time of the year when indoor radon levels are likely to be highest, one minimizes the likelihood of false negatives.

It is important to discover if there are any regions of the country that present exceptions to the general rule of highest levels of indoor radon occurring in wintertime. The findings presented here show that indeed there are some exceptions. Houses built in some particular areas of the southern Appalachians have their highest indoor levels of radon during the warmer-weather seasons of the year. Warm-weather conditions prevail for about nine months in this region of the U.S. Thus a false negative measurement resulting from a wintertime screening measurement could miss a significant elevated radon exposure condition that prevails for the majority of the year.

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The possible causes for indoor levels of radon being most elevated during summertime are the subject of a companion paper presented at IndoorAir'90 (4)

MATERIALS AND METHODS

Alpha track detectors exposed for three months or more were the monitors used to measure indoor levels of radon. The detectors were deployed within the main living area, with the same position being used for both the winter and summer exposure; placement was typically on top of the kitchen refrigerator. Precision of the measurement under field conditions was evaluated by colocation of replicate monitors at some houses. Field blanks consisting of unopened detectors were also deployed. Calibration exposures were made inside an environmental chamber referenced to a primary calibration standard. The total error in integrated radon measurement was estimated to be less than 20% under field conditions. A fuller description of the QA/QC procedures and statistical treatments of the data are contained elsewhere (5,6).

Inside four houses in Huntsville, Alabama, continuous measurements (once each 30 min) of radon were made with Wrenn chambers during a period October through December. The purpose was to evaluate shorter as well as longer fluctuations in radon during a transitional period of warmer to colder weather. Detailed procedures and results are being published separately (7). These four houses were identified through summertime screening measurements as having considerably elevated indoor radon levels.

In general, selection of homes was made through news media advertising, door-to-door and letter solicitations.

RESULTS AND DISCUSSION

The results of the longer-term summer and winter measurements of indoor radon in four different regions of the south Appalachians are summarized in Table 1. Houses located in Chattanooga, Tennessee, and the twin cities of Kingston and Harriman, Tennessee, show the normal phenomenon of higher indoor radon levels prevailing during wintertime. The reverse is true for the housing sets in Birmingham, Alabama, and Huntsville, Alabama, where higher indoor radon levels prevail during summertime. In these latter two cities, one would recommend that radon screening be conducted during the summer rather than the winter, in order to minimize the likelihood of obtaining fake negative indications of the radon exposure potential.

The results of near-continuous radon measurement in two Huntsville houses selected for special studies are shown in Fig. 1. As change takes place from warm fall to cold winter weather, the radon levels drop. There are also more acute fluctuations in the radon levels. Over separate periods of a few days the radon levels can differ by nearly an order of magnitude. Thus, separate measurements using charcoal canisters for periods of a few days could produce significantly different screening results with the lowest radon levels occurring during spells of cold weather.

The EPA recommended screening protocol of measurement during the cool months of the year (2) does not seem appropriate for many houses in Huntsville and Birmingham. Indeed screening measurements conducted during the three winter months would likely produce false negatives, which EPA is striving to avoid (3).

In order to predict where and under what conditions higher summertime levels of radon will prevail, an understanding will be necessary of the underlying mechanisms that are responsible for transporting and injecting radon into the houses. A preliminary attempt at such explanations is made in an accompanying paper at Indoor Air '90 (4).

CONCLUSIONS AND RECOMMENDATIONS

In certain localized hilly regions of the southern Appalachians, indoor radon levels of radon peak during the summertime. For long-term (three month) measurements of radon made in Huntsville, Alabama, the geometric mean of the summer-to-winter ratio was 1.3. Inside a few more intensively studied houses in Huntsville, short-term (few days) radon levels were as much as an order of magnitude higher in warm as opposed to cold weather. In these parts of the U.S., warm weather prevails for about nine months of the year. Screening measurements made during the winter are likely, therefore, to produce false negative indications of the long-term radon exposure potential. These findings make it advisable to discover the degree and geographical extent of regions experiencing this phenomenon in order that appropriate modifications to current EPA recommended screening protocols can be devised.

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Table 1. Summary of Alpha Track Detector Measurements

City	Summer/winter ratio*		No. of houses
	Geometric mean	Geometric standard deviation	
Chattanooga	0.58	1.8	14
Kingston/Harriman	0.58	2.2	180
Birmingham	1.1	1.8	18
Huntsville	1.3	2.2	88

*Alpha track detector measurements of integrated radon concentrations over three months or longer.

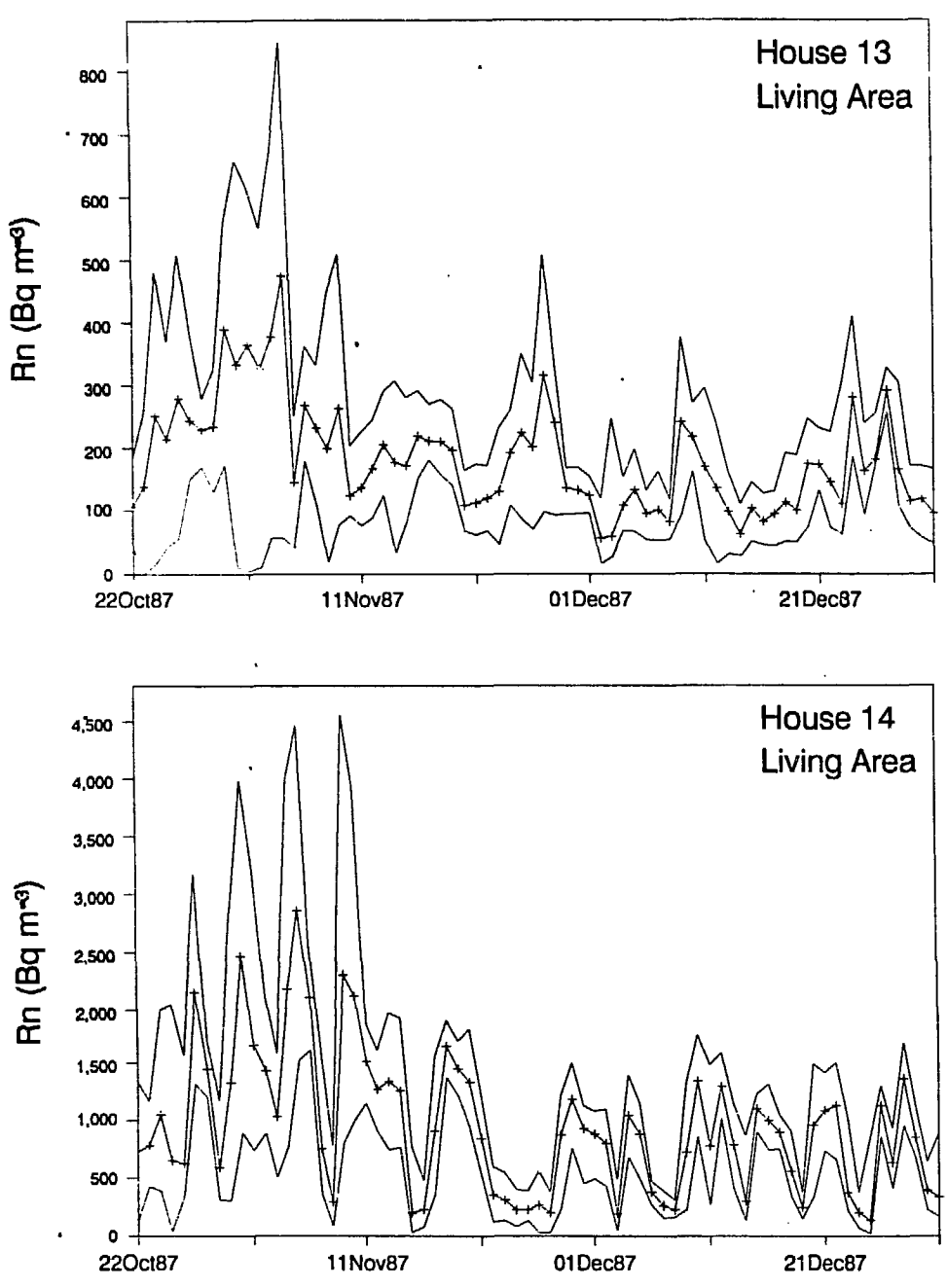

Fig. 1. Measurements of ^{222}Rn during fall in two Huntsville houses; the upper and lower curves represent daily maximum 30-minute integrated measurement while the middle curve shows the daily average ^{222}Rn concentration.