ANNUAL PROGRESS REPORT - MARCH 1991-FEB 1992

DOE/ER/60547--2

DE92 005526

Project Title: Measurement and Apportionment of Radon Source Terms for Modeling Indoor Environments

Organization: NYU Medical Center
Department of Environmental Medicine
550 First Avenue
New York, NY 10016

Principal Investigator: Naomi H. Harley, Ph.D., Res. Professor

Phone :212 - 263 - 5287
FAX :212 - 263 - 7190

OVERALL SCOPE OF WORK

Research Objectives

This research has two main goals; (1) to quantify mechanisms for radon entry into homes of different types and to determine the fraction of indoor radon attributable to each source and (2) to model and calculate the dose (and therefore alpha particle fluence) to cells in the human and animal tracheobronchial tree that is pertinent to induction of bronchogenic carcinoma from inhaled radon daughters. The dosimetry has been extended to include organs other than the lung.

ACCOMPLISHMENTS DURING 1991-1992

a. Research House Activities

a. 1. Evaluation of Measurement Protocol

Thirteen months of hourly ^{222}Rn data from one of our research homes (the ultra-high energy efficient home) were divided into different interval lengths. The purpose was to simulate the existing measurement protocols that are currently being used by vendors or proposed by EPA as a measurement strategy.

The data were averaged over 180, two day measurement periods; 52, seven day periods; and 5, ninety day periods. These intervals are equivalent to measurements being made with charcoal canisters and alpha track detectors. The annual average for the home is known from the hourly measurements and the annual average

MASTER

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED

concentration during this time was 2.7 pCi L^{-1}. In all cases, a single measurement taken randomly over the thirteen month interval had a 20% chance of being over the EPA guideline of 4 pCi L^{-1}. This included the single 90 day measurement protocol. The potential for obtaining a measurement a factor of 2 above the average is due to the natural variability of ^{222}Rn concentration over time.

The only measurement protocol that provides unambiguous data on the annual average ^{222}Rn concentration is to obtain two, 90 day measurements, in opposite seasons, and average the values. Only then can a sound decision be made (without the chance of false positives or negatives) concerning the need for remediation.

This protocol is suggested only if the indoor concentration approaches the EPA guideline. Naturally, a home with very high indoor concentration can be identified immediately with even a short term test. A general protocol is recommended.

In many situations of buying or selling a home, it is virtually impossible to wait for results of two long term tests. The following protocol was suggested to EPA as a way to avoid this type of logistic difficulty. A short term test (2 to 7 days) and the first 90 day test should be started at the same time. The short term test provides rapid information concerning the scope of the problem. If the short term result is in the range where ambiguous decision making is possible (say 2 to 10 pCi L^{-1}) then a decision should be deferred until both 90 day measurements (one each in opposite seasons) are available.

Such a measurement protocol will save enormous amounts of funds in avoiding unnecessary remediation.

This work was presented at the DOE Science Writer's Symposium in Washington, DC. A manuscript was available for the participants and is attached to this proposal. It has been submitted for publication. We have been in discussion with individuals in EPA ORP concerning measurement strategy in the new Citizen's Guide.

Protocol analysis with the research home data base is ongoing. An optimum measurement protocol for decision making is a particularly important aspect in the DOE ^{222}Rn Research Program.

a. 2. Evaluation of Year Long CR-39 Measurements

Most environmental epidemiological studies base their human exposure estimates on year-long alpha track data. There are two publications in the literature that present data to show that year long alpha track data is about 60% of the value obtained with simultaneous seasonal data that are averaged to provide the same information.

This is a serious problem. We developed a small personal ^{222}Rn and gamma-ray detector at NYU to be able to measure personal versus home exposure to ^{222}Rn(*). We also use this detector for quality control in both our research homes. Because we now have over one year's worth of data collected by season as well as a full year it was possible to study and detect differences between the measurement intervals.

(*) Patent application filed by NYU Medical Center.

The NYU monitor(*) differs from commercial detectors in that duplicate CR-39 solid state nuclear track films within the detector are protected by a thin aluminized Mylar film. This avoids the problems of track clustering due to charge artifacts. Also, we measure tracks over the entire film area, not just a small section as done by commercial vendors. The error of measurement with the NYU detector has been shown to be equal to the Poisson counting error. The detector was developed to have high precision and accuracy in order to determine differences in home versus personal exposure for measurement intervals ranging from a few days to a few weeks.

No statistically significant difference was found between the year long measurements and the seasonal averages for our detector. The lack of difference can only be stated for the NYU detector and cannot be inferred to be a general conclusion for all alpha track detectors without additional confirmatory work. The large differences reported in the literature have not been resolved. This problem requires further study because of the extensive use of year long alpha track measurements in epidemiology, remediation and other areas important to the DOE ^{222}Rn program.

<u>a. 3. Influence of Ground Water on Indoor Radon.</u> Our work with the influence of water use on indoor ^{222}Rn continues. Our ultra-high energy efficient home has a private well and this water is used exclusively in the home. The ^{222}Rn concentration in the water averages about 150 Bq L^{-1} (4,000 pCi L^{-1}). This should not add measurably to the house average ^{222}Rn but may be detectable near the shower. EPA is currently elaborating upon exposure of this kind from water and measurements in an actual home setting are important.

a. 4. Quality Assurance

A radon counter which accommodates measurement of a 1.7 liter flask was constructed in-house for the purpose of quality control measurements. Samples of indoor air (grab samples) are taken weekly with the flasks and counted in the QC counter for comparison with the data from the continuous radon detectors. Grab samples are taken weekly in the old-style research house and several times per year in the ultra-high energy efficient home. This insures the measurement quality of our data base. These same flasks are used in the EML radon intercomparison exercise. The most recent intercomparison (April 1991) was run at about 6 pCi/L. Our measured value was 1.06 of the EML true value.

In the second year of the project we added a second QC feature to the project. We have developed a personal/home ^{222}Rn (and gamma-ray) detector which has high accuracy and precision. The accuracy and precision were necessary to distinguish the difference between measurements made in the home and simultaneous measurements on individuals carrying the detector. We participated in the EML passive monitor intercomparison and our results showed the highest accuracy and best precision of all participants. The value we reported was 0.98 $\pm$.03 of the "true" EML value.

Multiple personal ^{222}Rn detectors are now deployed in all research homes to obtain simultaneous average ^{222}Rn measurements with the hourly continuous monitors as an additional QC measure.

b. 1. Cellular Dosimetry

We continue to assist Dr. Edith Robbins in the data handling aspects of the morphometric analysis of human and dog bronchial airway cells.

In the human population it is important to document the details concerning the patient's life style, such as smoking, occupational, residential, family and dietary history. This will assist in the analysis when data are fully tabulated. The PI reviews the clinical charts for details and conducts a patient interview with essentially every patient in the data base.

The cell depths for the preliminary base are being coded by hand into a PC. In the human population, 12 subjects have been completed. This included 1700 basal cell and 600 mucous cell nuclei. Airway branching generations 3 to 6 were included for most persons. The 12 subjects included smokers, never smokers and exsmokers. Slight variations in cell depth were apparent among the three groups but the number of cells is not yet

sufficient to detect statistically significant differences.

The depths from epithelial to apical surface of the nucleus have now been determined for 2200 basal and 1500 mucous cell nuclei in dog airways.

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

Harley
Shortcomings in Risk Projection
Environmental Health Perspectives, 81, 137-138, 1989

Maiello and Harley
Determining the Charged Fractions of ^{218}Po and ^{214}Pb Using an Environmental Gamma-Ray and Radon Detector
Health Physics 57, 51-59, 1989

Hart, Mettier, and Harley,
Radon: Is it a problem?
Radiology 172: 593-599, 1989.

Harley and Fisenne
The Distribution and Alpha Radiation Dose from Naturally Occurring U, Th and Ra in the Human Skeleton
Health Physics 58, 515-518, 1990

Harley, Terilli
Predicting Annual Average 222Rn Exposure
Health Physics 59, 205-209, 1990

Harley
Methodology issues in risk assessment for radon
Env. Health Perspectives, 90. 177-180. 1990

Scarpitta, Harley
Adsorption and desorption of noble gases on activated charcoal: I. ^{133}Xe studies in a monolayer and packed bed
Health Physics 59, 383-392, 1990

Scarpitta, Harley
Adsorption and desorption of noble gases on activated charcoal: II. ^{222}Rn studies in a monolayer and packed bed
Health Physics 59, 393-404, 1990

Spencer, Osis, Fisenne, Perry, Harley
Measured Intake and Excretion Patterns in Humans for Naturally Occuring ^{234}U and ^{238}U
Radiation Research 124, 90-95, 1990

Harley
Does 4 eaual 2? Decisions based on radon measurements.
Am. J. Public Health, 80, 906-906, 1990

Harley, Harley
Potential lung cancer risk from indoor radon exposure
CA- A Cancer Journal for Clinicians, 40 (Sept-Oct), 265-275, 1990

Scarpitta, Harley
An improved ^{222}Rn canister using a two-stage charcoal system
Health Physics, 60, 177-188, 1991

Harley
Radon levels in a high-rise apartment
Health Physics 61, 263-265, 1991

Litt, Waldman, Harley, Chittaporn
Validation of a personal radon monitor for use in residential exposure studies
Health Physics 61, 727-735, 1991

Harley, Chittaporn
Personal and home radon and gamma-ray measured in 52 dwellings
Health Physics 61, 737-744, 1991

Harley, Harley
Indoor Radon: A natural risk
Nuclear Safety, Fall 1991

Harley
Methodology issues in risk assessment for radon
Environmental Health Perspectives 90, 177-180, 1991

Harley, Meyers, Robbins, Biomodeling of ^{222}Rn decay product dose.
Submitted to Health Physics.

Harley, Robbins, ^{222}Rn alpha dose to organs other than lung.
submitted to Rad. Prot. Dosimetry, 1991.

Harley, Meyers, Robbins, ^{222}Rn dosimetry in the dog lung.
submitted to Rad. Prot. Dosimetry, 1991.

END

DATE FILMED

2/28/92