#630

A TECHNIQUE FOR MEASURING AIRBORNE CONCENTRATIONS OF DAUGHTERS OF RADON ISOTOPES*

Summary Only

See JB

P.T. Perduc, R.W. Leggett, and F.F. Haywood

Oak Ridge National Laboratory
Health and Safety Research Division
Post Office Box X
Oak Ridge, Tennessee 37830, U.S.A.

For over five years the surface-barrier silicon diode has been used to measure the daughters of radon-222 and radon-220 using methods suggested by Martz et al. (1) and by Duggan (2). Various aspects of this technique have been published (3,4,5,6). A basic assumption has been that alpha energies detected in certain energy regions belong to daughters of radon-222 and/or daughters of radon-220 Recently, however, the presence of large quantities of daughters of radon-219, with alpha energies similar to those of daughters of radon-222 and/or radon-220, has been confirmed in a building contaminated with raffinates from uranium ore processing. These raffinates showed concentrations of actinium-227 as high or higher than the normally more abundant isotopes radium-226 and thorium-232. Since many sites have come in contact with actinium-bearing raffinates it appeared worthwhile to develop a method for the simultaneous measurement of daughters of all three radon isotopes in air.

The method which has been developed for this simultaneous measurement depends on the following basic assumptions: (a) that the ratio of the alpha emission of ^{212}Bi to that of ^{212}Po is fixed (36:64); (b) that the ^{212}Po alpha particle (8.78 MeV) can be resolved from all the other alpha particles, even with excessive dust on the collection filter; (c) that only insignificant quantities of parent isotopes (including ^{226}Ra, ^{232}Th, and ^{227}Ac) are airborne; (d) that the activity of ^{218}Po (3.05 min. half life) on the collection filter is negligible 25 minutes post sampling; (e) that the ratio of the alpha emission of ^{211}Bi to that of ^{211}Po is fixed (100:0.28); (f) that alpha emissions from ^{215}At (0.00023% yield) are insignificant and may be ignored; and (g) that the 6.28 MeV and 6.62 MeV alpha emissions from ^{211}Bi are distinguishable from energies associated with ^{222}Rn daughters and ^{220}Rn daughters.

At the place of sampling, air is flowed through a millipore filte for five to ten minutes at approximately 12 liters per minute. Then the filter is counted during the period two to twelve minutes post sampling; the counts are integrated over each of four regions (A) 5.20 to 6.16 MeV; (B) 6.16 to 6.75 MeV; (C) 6.75 to 8.10 MeV; and

(D) 8.10 to 9.50 MeV (see Fig. 1). A second count is made for the same regions during the period 15 to 30 minutes post sampling. From these two counts the activities of ^{211}Pb, ^{211}Bi, ^{218}Po, ^{214}Pb, and ^{214}Bi can be calculated, and the number of working levels of ^{222}Rn daughters can be determined. If the activities of ^{212}Pb and ^{212}Bi are to be determined, then a third 10 to 20 minute count for the 8.10 to 9.50 MeV region must be made at least 200 minutes post sampling. In the case of ^{218}Po in Region A, there can be some interference with the 6.0 MeV peak and the low energy portion of the distribution from ^{211}Bi, which has two alpha-particle energies, 6.28 MeV and 6.62 MeV. This overlap from ^{211}Bi can be calculted from the second count of Region A, since almost all ^{218}Po atoms will have decayed by this time. Although energies associated with ^{212}Bi and ^{218}Po overlap in Region A, the counts for ^{212}Bi can be subtracted since they are approximately equal to 0.56 times the simultaneous counts in Region D. Similarly, the usually small amount of ^{211}Po which shows up in Region C (the region for ^{214}Po) can be estimated by multiplying the simultaneous counts in Region B by 0.0028.

All counts and counting times are entered into a BASIC computer program which is a combination of a program written by Kerr (5) for analyzing data for daughters of ^{222}Rn, another program written by Kerr and Ryan (7) for analyzing data for daughters of ^{220}Rn, and a third routine which is a modification of the Kerr-Ryan program and which analyzes data for ^{219}Rn daughters.

References

1. Martz, D.E., D.F. Holeman, D.E. McCordy, and K.J. Schiager (1969). Analysis of atmospheric concentrations of RaA, RaB, and RaC by alpha spectroscopy, Health Phys. 17:131.

2. Duggan, M.J. (1973). Some aspects of the hazard from airborne thoron and its daughter products, Health Phys. 24:310.

3. Kerr, G.D. (1973). Measurement of radon progeny concentration in air, Trans. Amer. Nucl. Soc. 17:541.

4. Perdue, P.T., W.H. Shinpaugh, J.H. Thorngate, and J.A. Auxier (1974). A convenient counter for measuring smears and air samples, Health Phys. 26:114.

5. Kerr, G.D. (1975). Measurement of radon progeny concentrations in air by alpha-particle spectrometry, Report ORNL/TM-4924, Oak Ridge National Laboratory.

6. Haywood, F.F., G.D. Kerr, W.A. Goldsmith, P.T. Perdue, and J.H. Thorngate (1977). Measurements of Radon Daughter Concentrations in Structures Built on or Near Uranium Mine Tailings, Personal Dosimetry and Area Monitoring Suitable for Radon and Daughter Products, Proceedings of the Nuclear Energy Agency Specialist Meeting, Elliot Lake, Canada, ISBN 92-64-01603-1, OCED-NED Publication.

7. Kerr, G.D., M.T. Ryan, and P.T. Perdue (1978). Measurement of Airborne Concentration of Radon-220 Daughter Products by Alpha-Particle Spectrometry, Submitted to the Eleventh Midyear Topical Symposium of the Health Physics Society, San Diego, California, U.S.A.

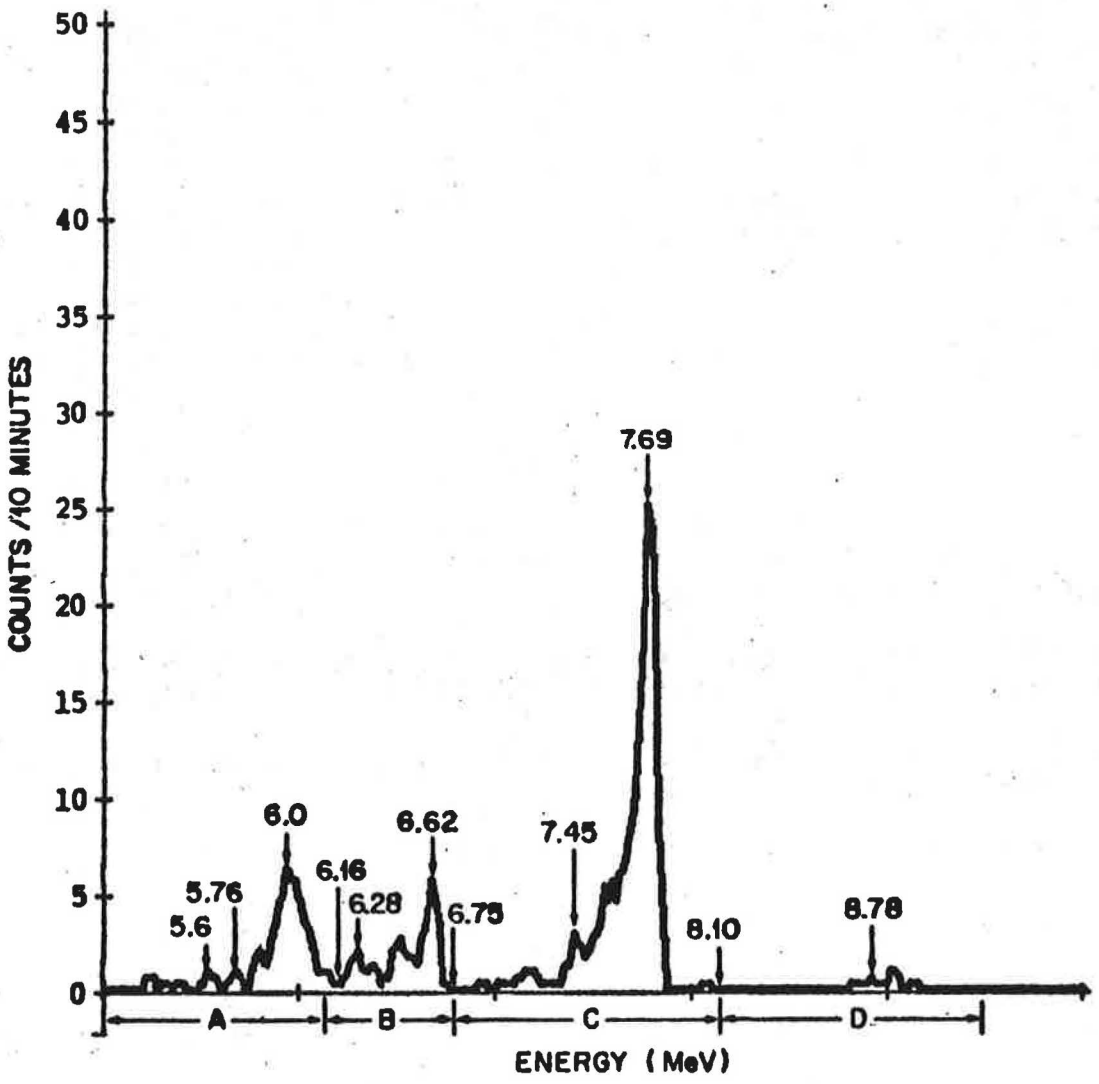

Fig. 1. Energies of short-lived alpha emitters observed in air sample taken in building contaminated with uranium ore raffinates.