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MEASUREMENTS FOR RADON-222 CONCENTRATIONS IN DWELLINGS IN GREAT BRITAIN

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Measurements of radon-222 concentrations were carried out in living rooms in 87 dwellings in Great Britain during 1976. Measurements of the activity concentration of RaA (^{218}Po), both within the room and in the air outside the room, and of the ventilation rate for the room were carried out at various times during the day. From these measurements an estimate of the "radon output" of the room in terms of picocuries of radon-222 emanating from room surfaces per litre of room air (pCi l^{-1} h^{-1}) was calculated. Measurements of RaA concentrations were carried out using an instrument designed by James and Strong (1) using a modified counting regime (2). This instrument has a detector efficiency of 0.2 counts per disintegration and in conjunction with a flow rate of 50 l/m has a sensitivity for RaA of 0.05 pCi/l. Sensitivity is defined as that concentration at which the relative standard deviation is 0.5 (3).

Dwellings studied were at locations ranging from Cornwall (South West England) to Aberdeen (North East Scotland) and varied in age from one to 300 years. The distribution of radon outputs from these dwellings is shown in Figure 1. The distribution is skew and for this reason is plotted to a logarithmic scale. The median value for radon output was 0.32 pCi l^{-1} h^{-1} with a geometric standard deviation of 3.1. The arithmetic mean was 0.60 pCi l^{-1} h^{-1}. The highest value recorded was 5.5 pCi l^{-1} h^{-1} at a dwelling in Cornwall constructed from local granite which is known to have a relatively high radium content (>2.5 pCi/g). Because such dwellings are uncommon and Cornwall is an area of low population density, it is reasonable to exclude this value when attempting to estimate the population exposure to radon-222. With this value removed the arithmetic mean is reduced to 0.54 pCi l^{-1} h^{-1}.

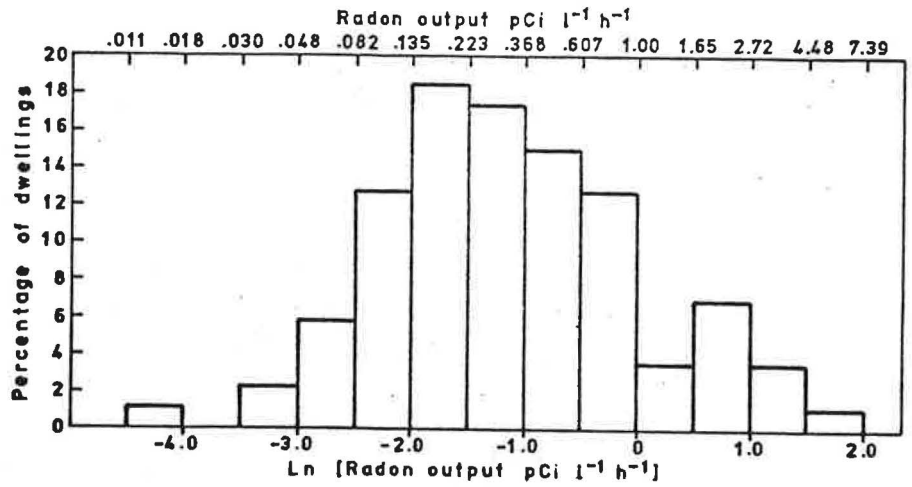

Figure 1. Radon-222 output of living rooms in dwellings in Great Britain

It is generally agreed that the hazard from the inhalation of radon-laden air is predominantly due to the short lived daughter products RaA (^{218}Po), RaB (^{214}Pb), RaC (^{214}Bi), and RaC' (^{214}Po). For a room with a given radon output, the actual concentration of each daughter is strongly dependant upon ventilation rate. Table 1 shows the concentration of daughters in a room emanating 0.54 pCi l^{-1} h^{-1} radon-222 for various ventilation conditions (in room changes per hour).

Considering the case for 1 room change per hour and an occupancy factor of 0.8 in the dwelling, then the average cumulative exposure is 0.15 working level months (WLM) per year including 0.005 WLM received in the outside air. Many workers have attempted to relate exposure in WLM to dose to bronchial epithelium with widely differing results. Toth (4) used a factor of 0.66 rad/WLM and on this basis the average population bronchial epithelium dose is 99 mrad per year (a dose equivalent of 2.0 rem per year if a quality factor of 20 is assumed for alpha particles). Unquestionably the largest single contribution to population bronchial epithelium dose is that from the inhalation of the short-lived daughters of radon.

TABLE 1

Ventilation rate, h^{-1}	Concentration, pCi l^{-1}			Working Level (WL)**
	RaA	RaB	RaC, RaC'	
0.1	5.07	4.76	4.55	0.0471
0.5	1.10	0.85	0.69	0.0081
1.0	0.57	0.37	0.26	0.0035
1.5	0.39	0.23	0.15	0.0022
2.0	0.31	0.17	0.11	0.0016

** WL defined as any combination of the short lived daughters of radon-222 (RaA, RaB, RaC and RaC') in one litre of air that results in the ultimate emission of 1.3×10^5 MeV of potential alpha energy.

References

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3. Thomas, J.W. (1972). Measurement of radon daughters in air, Health Phys. 23:783.

4. Toth, A. (1972). Determining the respiratory dosage from RaA, RaB, and RaC inhaled by the population of Hungary, Health Phys. 23:281.