RADON EXPOSURES IN THE UK

TO BE READ AT IRPA 8 MAY 1992

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ABSTRACT

Public and occupational health protection against radon is provided in the UK. Protection is advised where geological conditions cause high concentrations in domestic and commercial buildings. These circumstances are described and the resulting exposures reviewed. An account is given of the limitation scheme for radon in the home and the regulatory scheme for radon at work, the manner in which they are implemented, and the degree to which they are successful.

INTRODUCTION

Radon is the dominant source of human exposure to ionising radiation in every country of the world. It is dominant in most circumstances - at home and at work, for individual persons and for whole populations. The worst characteristic of radon, apart from its carcinogenicity, is its ubiquity: one of its few redeeming properties is lack of smell. We might also say in its favour that it is unlikely to reach such high concentrations as to cause acute clinical effects, although the doses to lung tissue in perfectly ordinary circumstances can indeed be considerable.

BACKGROUND

Virtually all of the 21 million dwellings in the UK are made of masonry and do not have basements. About one half are detached or semi-detached houses, about one third are terraced or row houses, and the remainder are flats or apartment buildings with multiple occupancy. Half of the housing stock has been renewed since the second World War. Commercial buildings vary from small converted houses to tall office blocks and large warehouses.

It is also necessary to describe the geological setting. There is a clear division between the igneous and metamorphic areas of the north and west and the sedimentary areas of the south and east that is most of England. Intrusive rocks often imply high radon levels, metamorphic and sedimentary rocks range from high to low, and extrusive rocks usually mean low levels.

CONTROLS

As in other countries, we in the UK have different approaches to the control of radon exposure in homes and places of work; our modus operandi is shown in Table 1. For householders, the commitment to measure and take action against radon is completely voluntary. Employers, on the contrary, are obliged to comply with statutory controls on occupational exposure in all places of work - schools, offices, factories and so on. Government employs encouragement in the first circumstance and enforcement in the second.

The Action Level for existing dwellings is 200 Bq m^{-3} of radon in air averaged throughout the year. New dwellings are to be designed so that levels are as low as reasonably practicable and not, of course, above the Action Level. The dose limit for workers is still 50 mSv a year, but employers are required by occupational legislation to prevent doses continually approaching it, and we have adopted a constraint of

15 mSv a year, on the average, in anticipation of the new ICRP recommendations. When the annual effective dose equivalent from radon is less than 5 mSv (which corresponds to an average 400 Bq m^{-3} when temporal occupancy is considered) the enforcement agency does not require action by the employer.

DWELLINGS

By early 1992, around 110,000 dwellings in the UK had been surveyed for radon. As can be seen from Table 2, these measurements are mostly made at the request of householders. Virtually all are at public expense, the major source of funds being central Government. At an early stage in the radon programme, a positive decision was made to provide free measurements for householders who might have cause for concern about radon.

An initial survey by NRPB had two purposes, one to determine the distribution of indoor radon concentrations in a systematic manner and the other to discover the most radon-prone regions of the UK guided by limited radiological and geological information. The exercise was successful in that subsequent surveys have not confounded the initial findings.

Once the overall picture was clear, it was possible to adopt an intervention policy with known - and acceptable - implications. The key element was the delineation of so-called Affected Areas, where the probability of finding a dwelling above the chosen Action Level was one per cent. Within such areas, two significant steps would be taken: first, a campaign would be mounted to persuade householders to apply for free measurements; second, the building authorities would delimit localities within which new dwellings would require preventive measures. The latter requirement was not to apply to non-residential buildings.

So far, two administrative counties in the southwest of the country have been formally designated. Over three-quarters of the demand for measurements have arisen there, mostly as a result of the direct mailing of a radon leaflet to all householders. Nevertheless, the response was only one in eight, so more persuasive tactics will need to be tried. Government has indicated that similar plans will be carried through in other affected areas when these are defined.

Table 3 has a summary of the most significant results. In the first Affected Area, the average indoor concentration of radon is about five times the population-weighted value for the UK as a whole. In round terms, about 100,000 dwellings in the UK, or 0.5% of the housing stock, are estimated to be above the Action Level. So far, some 12,000 of these have been discovered, mostly in the first Affected Area. The radon-prone parts of the country are rural and much less densely populated than average: an appreciable fraction of the land area may eventually be designated.

WORKPLACES

There are, of course, far fewer workplaces than dwellings: Table 4 has the important statistics. Surveys of radon in places of work, initially funded by the Health and Safety Executive, now arise mainly from direct requests by employers. Not surprisingly, much of the demand comes from those regions of the country where raised radon levels occur in dwellings.

We estimate, again in round terms, that there may be about 50,000 places of work in the likely Affected Areas throughout the UK of which

one tenth may have radon levels above 400 Bq m^{-3}; perhaps as many as 75,000 workers may therefore receive annual doses greater than 5 mSv. These estimates are based on surveys in 3000 premises, some 10% being found subject to the regulations. The maximum dose discovered to date is 45 mSv in a year, and only a few per cent of workers receive more than 15 mSv in a year. Radon levels in house-like places of work are similar to houses: levels in large industrial buildings are generally much lower.

INTERVENTION

Employers have a considerable incentive to reduce radon levels because by doing so they can avoid the necessity of mounting radiological surveillance in their premises and of complying with other regulatory requirements. About half of the workplaces initially found subject to the regulations, 150 or so, have subsequently had satisfactory remedial measures, mostly by sub-floor suction. Very few new commercial buildings have had preventive measures built in, however, because developers are not required to do so by law.

Householders, on the other hand, have some disincentive: if they decide to take remedial action, it is likely that they will have to pay since Government grants are restricted to those who do not have the means. This may explain why only 250 or so dwellings above the Action Level have been remedied so far. Various techniques such as floor sealing and positive pressure have been tried, but the most effective method is sub-floor suction especially for appreciable reductions. Since anti-radon measures become mandatory for new dwellings in certain localities, some 4000 have been built in line with developing technical guidance issued by Government which has proved to be quite effective.

DISCUSSION

This brief paper scarcely does justice to the radon programme in the UK which also embraces mining, geology, dosimetry, epidemiology, and metrology. Attention has rather been focussed on the determination and limitation of indoor exposure: some degree of success can be claimed for the few years in which the programme has been running. We have a coherent and judicious system of controls. We know what the general exposure levels are at home and at work and where raised values are most likely to be found. Our Government provides free measurements on a generous scale to householders in radon-prone areas so as to push the programme forward.

As a result, we have discovered about one tenth of the dwellings and workplaces throughout the UK that we believe to be adversely affected by radon. National policy is directed towards the goal of identifying most radon-affected homes by the end of the decade; to eliminate excessive exposures, it will therefore be necessary to redouble our efforts in the coming years. Many more householders and employers must be persuaded to make radon measurements, and having made them, to take whatever action is required to minimise the risk from radon. We are sanguine about the prospects.

ACKNOWLEDGEMENTS

The work described in this paper was variously supported by the Department of the Environment, Welsh Office, Scottish Office, Northern Ireland Office, the Health and Safety Executive, and the Commission of the European Communities. It was performed by various members of staff of the National Radiological Protection Board including R A Algar, K D Cliff, D W Dixon, B M R Green, T D Gooding, P R Lomas, J C H Miles, K Whysall. A list of staff publications on radon is available.

TABLE 1

Nature and structure of UK controls

Circumstance	Commitment	Control
Domestic	Householder, voluntary;	Action Level 200 Bq m^{-3}
	Government, encouragement	Design target ALARP
Occupational	Employer, obligatory;	Dose limit 50 mSv y^{-1}
	Government, enforcement	Non-action dose 5 mSv y^{-1}

TABLE 2

Surveys of UK dwellings to early 1992

Type	Purpose	Dwellings
Initial	Discovery of national & regional levels	3,000
Directed	Delineation of some affected areas	7,000
Requested	Satisfaction of public demand	100,000

TABLE 3

Results for UK dwellings to early 1992

Parameter	Value
Arithmetic mean for the United Kingdom, Bq m^{-3}	20
Arithmetic mean in first Affected Area, Bq m^{-3}	100
Highest value observed in dwellings, Bq m^{-3}	10,000
Dwellings discovered above Action Level	12,000
Estimated above Action Level in United Kingdom	100,000

TABLE 4

Statistics for workplaces to early 1992

Parameter	Value
Total number in the United Kingdom	1,700,000
Estimated number in all Affected Areas	50,000
Estimated number subject to regulations	5,000
Number surveyed for radon in the UK	3,000
Number found subject to regulations	300