Environmental Radon Newsletter

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Interpreting BR 211

Jon Miles, National Radiological Protection Board

The procedures in the 1999 edition of BR 211* for determining the level of radon protective measures in new dwellings are more complex than before. For this reason, a flow chart was provided to guide the reader through the two sets of maps that need to be considered.

To simplify the application of the report, the table below has been drawn up. This contains every possible combination of shadings that a 5 km grid square could have on the maps in Annexes A and B. All the user has to do is to locate their building site on the maps, and find the shading in both Annexes. The table will then tell them what radon protection measures are indicated, or whether a geological report might allow them to use a lower level of protection.

Of course it is open to a builder, if they do not want to seek a geological report, to apply the higher level of protection indicated for that combination of shadings.

Radon protective measures which should be provided in new dwellings, depending on the shading found in grid squares on maps in Annexes A and B of BR 211 (1999 edition)

		Shading of maps in Annex A		
		White	**Light brown**	**Dark brown**
Shading of maps in Annex B	**White**	None	Basic	Full
	Light grey	Basic, unless geological report indicates None	Basic	Full
	Dark grey	Full, unless geological report indicates Basic or None	Full, unless geological report indicates Basic	Full

* BR 211: Radon: guidance on protective measures for new dwellings (1999 edition, ISBN 1 86081 3283, price £26). Copies are available from CRC Ltd., 151 Rosebery Avenue, London, EC1R 4GB.

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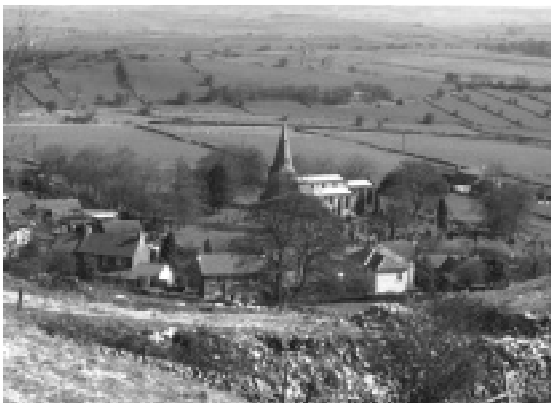

Following the retirement of John Hague, I was asked to take over chairmanship of the Derbyshire Radon Steering Group. The Group has for many years provided an important local focus for radon issues and has been well supported by many local Councils as well as other bodies such as the County Council and local Health Authorities. The radon programme has evolved considerably and there is now greater scope than ever for the group to play a formative role on the direction and effect of the local radon programme.

Feedback from members of the Group suggests that they attend the meetings because they value the opportunity to hear about progress and developments from national bodies such as the DETR, BRE, BGS and NRPB and to share experiences and views on radon issues with colleagues from neighbouring authorities. The aim of the Group in the future will be to consolidate and develop this role. One of the topics of continuing interest is the progress with the radon pilot studies supported by DETR, and the potential for local Councils to develop and participate in the roll-out programme.

Some Councils do not send representatives to our meetings because they have quite small radon prone areas and perceive little local concern. However, rising awareness about radon amongst the public and professionals means that increasing numbers of Councils are likely to receive enquiries. It is particularly those with little experience of radon enquiries that will have the greatest need for information and knowledge about local sources of knowledge. Invitations have therefore been sent to many Councils that do not normally attend with a view to broadening its representation.

Radon folder

Recently a 'radon folder' has been developed (with the assistance of NRPB) to try to meet the information needs of local Councils. This consists of a distinctively marked ring binder with information that can be held by local officers as a current and authoritative source of data. The folder contents have been designed to answer common questions about for, example, risks from radon, how to measure it and what to do if the result is high. The folder was issued at the most recent meeting and was very well received.

Other plans for the Steering Group include a change to the format of meetings to include a session with a speaker and discussion about specific topics of interest. One such session might, for example, explore issues concerned with radon in workplaces, at which the County Health and Safety groups might be asked to express their views on priorities or report progress with local initiatives. It is hoped that these events will promote greater awareness, prompt new initiatives on radon and encourage the spread of best practice amongst Councils. I am also keen to forge links with local Health groups such as the Primary Care Groups.

The Derbyshire Steering Group provides a valuable opportunity to identify issues of local importance and to develop solutions or strategies that reflect local needs and to ensure a high level of service to local people. In addition the close liaison and interaction provided by the Group enable it to play an influential and constructive role in the National programme on radon. The strength and authority of the Group relies on its members and it will continue to expand and diversify its activities in response to local and national demands.

Identifying High Radon Areas`

Jon Miles, National Radiological Protection Board and *Don Appleton*, British Geological Survey

The National Radiological Protection Board (NRPB) has the results of more than 400,000 measurements of radon levels in houses in England, mostly funded by the Department of the Environment, Transport and the Regions (DETR). These results have been used to map radon potential around the country, as shown in BR 211 (see *Environmental Radon Newsletter 22*). It was realised that some parts of the country could be mapped in more detail, and this would help in identifying more of the houses in England above the radon Action Level. DETR awarded contracts to NRPB and the British Geological Survey (BGS) to carry out research on more accurate mapping, and to apply the methods developed*.

Two approaches to mapping using house radon data were used: grouping data by geological boundaries (carried out by BGS), or grouping the data by 1 km grid square (carried out by NRPB). Grouping house radon data by geological boundaries appears the most logical way of grouping data, as radon potential clearly differs between geological units. Geological radon potential is determined from house radon measurements grouped according to the solid and drift geological units underlying the houses.

Twenty geological maps at 1:50,000 scale were used to map radon potential of different rock types. This work requires the boundaries of geological units to be available in digital form. Some of the 20 maps were not in this form, and so digitisation was carried out where necessary. Lognormal modelling of the indoor radon data produced estimates of the percentage of the housing stock above the UK Action Level for each combination of bedrock (solid geology) and drift (unconsolidated deposits, such as glacial sand and gravel, till, etc).

Grouping house radon data by 1 km grid square (without making assumptions about the location of boundaries between areas with different radon potential) has different advantages from grouping by geology. This method can show up variations that are obscured by geological grouping, such as variations in radon potential within a geological unit, or variations caused by mineralisation cutting across geological units.

The 1 km mapping method developed in this research is to allocate a radon potential to a 1 km grid square on the basis of the nearest 'n' measurements to that square, where 'n' is a number found experimentally or on statistical grounds to be sufficient for an accurate estimate of radon potential.

Simulated radon data were used to determine whether a distance-weighted or unweighted mean would give better results, and to determine the best value for 'n'. The 1 km mapping method was then applied to the house radon data in England southwest of the grid co-ordinate 300 100, and the percentage of homes above the Action Level calculated for each target square using the lognormal model.

The estimated proportions of houses exceeding the Action Level in areas defined by geology (within 20 geological map sheets) or by grid square (in southwest England) were used by NRPB to identify addresses, grouped by the categories 5-10%, 10-30% and >30% of houses above the Action Level. These outputs from the research may be used to identify with greater precision the location of homes likely to be above the radon Action Level and can be used to inform future radon monitoring campaigns. It should be noted that these data only indicate probabilities of houses exceeding the Action Level. It is not possible to estimate the radon level in an individual house without making a measurement in that house.

This research also allowed a comparison of grid square mapping and geologically based mapping in some areas, that allowed the strengths and weaknesses of the two methods to be understood more clearly, and to suggest how the two methods could be combined to give more accurate mapping than either separately.

The reliability and spatial precision of both mapping methods is, in general, proportional to the measurement density. It is, however, re-assuring to note that even when the measurement density is as low as the minimum for 5 km grid square mapping, geological radon potential mapping discriminates between geological units in a logical way. These relationships can be explained on the basis of the mineralogy, chemistry and permeability of the rock units and are confirmed in adjoining map sheets with higher measurement densities.

Conversely, it was found that variations within geological units can cause geological radon potential mapping in some parts of England to miss significant areas of high radon potential which are shown up on 1 km grid square mapping.

The two methods are likely to be most powerful when used in a complementary fashion, by comparing maps produced by the two methods, and by grouping results both by geological unit and by grid square. It is recommended that this line of investigation should be pursued.

* DETR Report: Identification of localised areas of England where radon concentrations are most likely to have >5% probability of being above the Action Level. DETR/RAS/00.01, 2000. Available from Mr A Brown, DETR/RAS, 4/E7 Ashdown House, 123 Victoria Street, London SW1E 6DE.

Doses From Radon to Organs Other Than Lung

Gerry Kendall, National Radiological Protection Board

It was clear that there was a link between radon and lung cancer long before it was understood how radon caused cancer. It was difficult to understand the link because radon is a noble gas, and most of the radon which is inhaled will simply be breathed out again before it has time to decay. The resulting radiation doses would be too low to account for the observed levels of lung cancer.

The explanation for this conundrum is that the damage is done not by radon, but by its immediate decay products. These are short-lived isotopes which attach themselves to natural aerosol particles. When the aerosol is breathed in, most is trapped in the lung. Although there are natural clearance mechanisms, they are too slow to remove the material before most of it has undergone radioactive decay, delivering a dose to the sensitive cells of the lung.

In some circumstances radon decay products can also deposit on skin in sufficient quantity to give significant doses. This is particularly important where the skin is thin, for example on the face. If the sensitive basal cells are irradiated a risk of cancer will follow. However, very few of these cancers will prove fatal.

But it would be wrong to conclude that radon decay products are always the hazard and that the gas can simply be ignored. This applies in particular to radon dissolved in drinking water. A number of investigators have concluded that, when such water is drunk, the gas remains dissolved until the water reaches the small intestine, where most absorption takes place. This means that the stomach receives a significant dose during the hour or so that the water remains here before being transferred to the small intestine. Detailed calculations of the doses to a number of tissues and organs from radon in drinking water have been carried out.

These confirm that much the largest dose (over 90% of the effective dose) is to the stomach, with at most a few percent to any other organ. However, radon levels in public water supplies are so low that no significant hazard arises.

But the story does not end when radon reaches the bloodstream. Radon is more soluble in fat than in water. Most of it will be lost through the lungs very quickly, but some will build up in tissues with a relatively high fat content. Fat itself is not thought to be sensitive to radiation. But some tissues, in particular red bone marrow, contain a mixture of fat and of sensitive cells.

The table illustrates the doses calculated to result from breathing radon (and its short lived decay products) for a year at the UK mean concentration of 20 Bq m^{-3}. Much the largest doses are to the lung, followed by the skin. The skin doses are very variable and can, in some circumstances, be even larger than those to lung. However, the red bone marrow can receive a dose several times that to other tissues.

Doses to various tissues from one year's exposure to radon and decay products at 20 Bq m^{-3}

Tissue	Dose (microsieverts)
Lung	10,000
Skin	2,500
Red bone marrow	70
Liver	50
Typical other tissue	20

This newsletter is prepared for the Chartered Institute of Environmental Health by the National Radiological Protection Board. It is published quarterly as an insert in Environmental Health and distributed by the Royal Environmental Health Institute for Scotland. Any suggestions for topics for future issues should be sent to Jon Miles at NRPB (see address on page 2). The views expressed in the contributions here are not necessarily those of the Chartered Institute of Environmental Health, the Royal Environmental Health Institute for Scotland or the National Radiological Protection Board.