Environmental Radon Newsletter

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'Radon Cancer Fears Dismissed' - BBC Headline

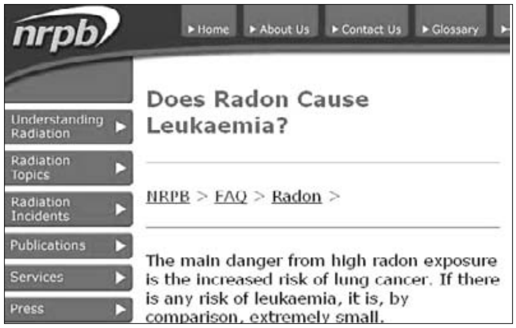
Jon Miles, National Radiological Protection Board

You may have seen headlines like the one above recently, and wondered if the government programme to reduce radon levels in houses and workplaces would now be cancelled. But the headlines were misleading, as they so often are. They were reporting the results of a study of the possible causes of childhood cancer, in particular childhood leukaemia. They have no bearing on the established risk of lung cancer from radon exposure, which is the basis of NRPB and government advice to avoid exposures to high radon concentrations. Adult cancers such as lung cancer were not part of the study.

The results, showing no apparent risk of radon causing leukaemia or other childhood cancer, were no surprise, as shown by the long-standing answer to the FAQ (Frequently Asked Question) on the NRPB website. Radon and its decay products give very much higher radiation doses to the lungs than to any other organ, so it has always been expected that risks of other cancers would be too small to measure accurately.

So what is the current understanding about the risk of lung cancer caused by radon exposure? For many years, the estimates of risk have been based on studies of miners exposed to radon around the world. It is easier to study the risks in miners than in people exposed at home for two reasons: the mine owners keep records of radon levels and working patterns, and the average radon levels in mines are higher than in homes, so the risk is higher. Based on the risks observed in miners, NRPB estimates that the average person has a 3% risk of dying of lung cancer if they live their life in a house at the radon Action Level (200 Bq m^{-3}).

Various epidemiological studies of domestic radon and lung cancer around the world have now been published. The first eight such studies



were summarised in a 'meta-analysis' five years ago, which found that, taken together, the risks found in these studies were consistent with the estimates based on the studies of miners.

Just this year two more studies were published (see below). The first, a study of people exposed to domestic radon in China concluded: 'Results support increased lung cancer risks with indoor radon exposures that may equal or exceed extrapolations based on miner data.' And the second, a review of the measurement methods used in previous epidemiological studies concluded: '. . . our findings suggest that the dosimetry models used by some of the previous residential radon studies may have underestimated the true risk posed by radon progeny exposure.'

So the need to avoid exposures to high levels of radon has not disappeared. Radon remains by far the largest source of radiation exposure and risk to the general public, giving radiation doses more than a thousand times higher than the whole of the nuclear industry.

Residential radon and lung cancer risk in a high-exposure area of Gansu province, China. Z Wang et al. American Journal of Epidemiology, ***55****, 554-564, (2002).*

Residential radon exposure and lung cancer: Variation in risk estimates using alternative exposure scenarios. WR Field et al. Journal of Exposure Analysis and Environmental Epidemiology, ***12****, 197-203, (2002).*

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Radon Exposures from Cooking with Natural Gas

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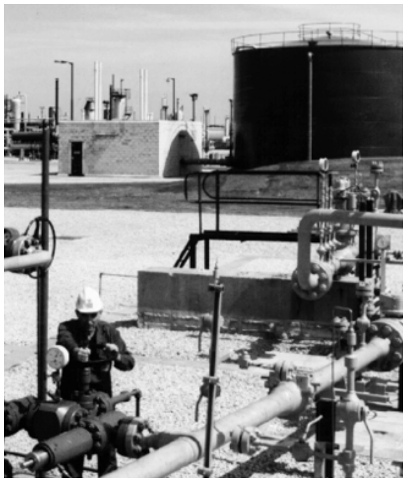
In homes where natural gas (methane) is used for cooking and heating, radon in the gas can make a contribution to the indoor radon level. Trace amounts of radon are carried from the underground source of the gas and released during combustion. Radon is not affected by combustion, and passes through the flame. Occasional studies and measurements of radon in natural gas in many parts of the world show that levels of radon in gas cover a wide range, and that some sources contain substantially elevated radon levels.

The principal route by which the public is exposed to radon from natural gas is the use of gas cookers without a flue, which allow combustion products and radon to be dispersed into room air and inhaled by the occupants. Gas used in heaters, which always have flues, does not contribute to indoor radon. The average level of radon in UK gas has been estimated from measurement programmes at 170 Bq m^{-3}. On the assumption that a household uses about 100 m^3 of gas annually for cooking, natural gas contributes only about 0.2% of the average indoor radon level.

The use of larger quantities of gas and longer exposure times in commercial premises such as kitchens and restaurants could, in principle, lead to higher radon levels. In practice, however, effective fume extraction systems, particularly for larger operations, should prevent virtually all of this additional exposure.

Such low levels are generally considered to be within the range that might reasonably be regarded as trivial. A recent change in UK legislation has raised the threshold at which producers and shippers of gas must implement administrative



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control of the radon content of gas from 0.037 Bq g^{-1} to 5 Bq g^{-1}, corresponding to about 4000 Bq m^{-3} for UK gas. At this threshold, natural gas would contribute about 5% of the average indoor radon level, or 0.5% of the Action Level for radon of 200 Bq m^{-3}.

Although radon levels in virtually all sources of UK gas are currently well below the threshold, the value of surveillance to identify long term trends or sources with particularly high levels is recognised. This is particularly true in the light of the increasing diversity of supply of natural gas and evolution of the supply industry in many countries.

A standard sampling and measurement protocol* has been developed in association with member companies of the oil and gas industry, to assist them to collect and measure samples of gas in a reproducible and consistent manner. Discussions are continuing on the extent to which routine surveillance under the Protocol should be required to support the legislative control system.

** Protocol for the collection and analysis of natural gas samples for radon-222 concentrations. DW Dixon. NRPB-M1211, Chilton (2000).*

Protecting New Buildings from Radon

Chris Scivyer, Building Research Establishment Ltd

Since 1991, precautions have been required to avoid danger to health from radon in new buildings under Requirement C2 of Schedule 1 of the Building Regulations 1991 for England and Wales. This includes new dwellings, work places and extensions. Both the level of protection required and the areas of the country in which measures have to be installed are detailed in Building Research Establishment Report BR211 Radon: guidance on protective measures for new dwellings. The latest edition of BR211 came into force in February 2000.

Suspended concrete floor with cavity tray and underfloor vents installed

Maps in BR211 can be used determine whether protection is required on a particular site. The areas of the country affected by the requirements include the long established areas of Cornwall, Devon, Somerset, Northamptonshire and Derbyshire, as well as newer areas including parts of the Yorkshire Dales, parts of Wales, the Welsh Borders, North Oxfordshire, Lincolnshire, Gloucestershire, the Lake District, and Northumberland, and a few scattered areas in south-east England. The maps not only indicate where measures are required but they also determine the level of protection required.

There are two levels of protection. In areas with a significant radon potential a radon-proof barrier must be incorporated within the construction to provide a barrier to radon across the entire footprint of the building. Typically this can be achieved by providing a well installed damp-proof membrane within the ground floor, linked to a cavity tray through cavity walls (to prevent radon entering the building through the cavity). Sealing of joints in the barrier and sealing around service penetrations are also required. This is known as **basic** radon protection.

For areas where the radon risk is higher, further protection than that offered by basic radon protection will be needed. In addition to incorporating a radon-proof barrier through the ground floor and walls, provision has to be made for future subfloor depressurisation or ventilation. This is achieved by providing either a radon sump or a ventilated subfloor void. If, after occupation, testing demonstrates that the building still has an unacceptably high radon level, an electrically powered fan can be fitted to supplement the rate of ventilation and radon dispersion. The fan is not required to be installed during construction. This is known as **full** radon protection.

Sumps prior to pouring concrete floor slab

BR211: Radon: guidance on protective measures for new dwellings (1999 edition, ISBN 1 86081 328 3, £26) is available from BRE Bookshop, Tel. 01923 664262. Separate guidance is available for Scotland (BR 376) and Northern Ireland (BR413)

Controlling Radioactivity in Building Materials

Gerry Kendall, National Radiological Protection Board

Controls on levels of radon in houses, which mostly comes from the ground underneath buildings, are now well established. Radon and its decay products are alpha particle emitters, and can cause lung cancer when inhaled. But we are also exposed to other sources of radiation, including gamma rays from building materials and cosmic rays from outer space. Gamma rays and cosmic rays, unlike alpha particles, can penetrate through walls and through our bodies.

All materials, including those used for building, contain a certain amount of radioactivity. The largest contributions normally come from natural potassium-40 and natural uranium and thorium and their decay products. Several nuclides in the uranium and thorium decay chains emit gamma rays. If these nuclides are in building materials, then occupants of the building will receive some gamma ray dose from this source, over and above the dose rate outdoors. But the house also partially shields people from some of the cosmic rays to which they would normally be exposed outdoors, so the total dose will not necessarily be increased.

It would be taken as axiomatic that there should be some controls to prevent excessive doses from radioactivity if it originated from an artificial source. An example might be concrete which had been made mildly radioactive in a nuclear reactor and which was now to be re-used. Consistency would require that some thought is also given to the possibility of doses from natural radionuclides. This is advocated in the most recent recommendations of the International Commission on Radiological Protection. It is also explicitly required under a European Directive which specifies Basic Safety Standards for work involving radiation and radioactive materials.

In the case of gamma ray dose from building materials, some guidance has been provided by the European Commision. The guidance takes into account the need to avoid barriers to trade and to harmonise, so far as is possible, control of risks from natural and artificial radionuclides.

The advice is couched in terms of the excess gamma ray dose caused by building materials, given in terms of milliseiverts (mSv). For comparison, the total dose from all sources to the average individual in the UK is about 2.5 mSv per year.

In essence, two levels of dose are specified. If the excess dose is less than 0.3 mSv per year then it is suggested that the material should be exempted from controls and allowed to pass freely between different countries.

If the annual gamma ray dose from building materials exceeds 1 mSv, then controls would normally be expected, though special consideration should be given to any traditional, local materials which lead to doses exceeding this level. It is suggested that national authorities impose controls at some level corresponding to a dose somewhere in the range 0.3-1 mSv per year. The details of such controls are a matter for national governments.

It is hoped that most building materials can immediately be identified as not requiring controls. A screening formula involving the activity concentrations of potassium-40, radium-226 (as the dominant nuclide in the uranium chain) and thorium-232 is suggested as a tool to help in this task.

Inevitably, complex situations can be imagined. If a house is built of two materials with relatively high levels of radioactivity, how much dose should each be allowed to give? The final answer is presumably one for the architect, possibly with specialist advice.

What is to be done in the United Kingdom? It is believed that levels of radioactivity in British building materials are generally low. Any action is likely to await publication of another European Directive, that on construction products, so as to ensure that controls are unified and well-considered.

Radiological protection principles concerning the natural radioactivity of building materials Radiation Protection 112, European Commission Luxembourg, (2000).

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.