Controlling levels of radon

Radiation is ubiquitous and all living things have evolved in an environment with low levels of radiation from natural sources. Radon, a natural radioactive gas originating from uranium (which is present in variable amounts in all rocks and soils) contributes part of this natural background radiation. Radon, being a gas, can escape from the rock which contained its parent, uranium. All water and air contains some radon, though levels are usually much too low to be of concern.

Radon in air decays to natural radioactive isotopes of other elements which attach themselves to aerosol particles in the atmosphere. If air containing radon and its decay products is breathed in, the decay products will become trapped and irradiate the lining of the lung; radon gas itself presents less of a hazard. Nevertheless, "radon" is generally used as convenient shorthand for radon and its decay products. High levels of radon have been shown to cause lung cancer and, for many years, measures have been taken to limit exposures.

Radon in air is usually the greatest hazard, but radon is soluble in water and it is now recognised that some private water supplies contain levels of radon which should also be controlled. This is based on the calculation of doses from ingested radon rather than from direct observation of excess cancers as with radon in air.

The way in which radon in water presents a hazard is different from radon in air, where the radon decay products irradiate the lung. Experiments have shown that if water containing radon is ingested, it stays in the stomach for a period during which time the radon irradiates the stomach lining. The gas is then absorbed into the bloodstream and is quickly lost through the lungs. Doses to other body organs are much smaller than that to the stomach.

With many dangerous chemicals it is possible to set a threshold below which no harm will be caused. However, with radiation this is not thought to be the case. All exposures to radiation are assumed to carry some risk, though the risks from very low doses are very small.

Exposures to radon are very variable and official recommendations are designed to reduce the exposures of those at the highest risk. Advice on reducing radon levels is available from Local Authorities, DETR and (for radon in air) the Building Research Establishment.

Controlling levels of radon in air

For many years it has been recommended that, if the concentration of radon in indoor air exceeds the Action Level of 200 Bq m^{-3}, steps should be taken to reduce it. The Bequerel (Bq) is a unit of radioactivity corresponding to one decay per second and the Action level is such that 200 atoms of radon undergo radioactive decay each second per cubic meter of air.

As outlined above, the Action Level does not mark a boundary between safe and unsafe radon concentrations, but rather a level at which action will usually be justified. More information on radon risks is given below. If radon concentrations approach the Action Level the householder is given information to help enable them to decide whether to reduce the radon level.

More information on radon in air is available in publications of the Department of the Environment, Transport and the Regions and the National Radiological Protection Board.

Controlling levels of radon in water

Radon is soluble in water and high concentrations can arise where water encounters uranium containing minerals in the ground, particularly if it is under pressure. This can lead to raised levels of radon in groundwater. Public water supplies normally contain very low levels of radon, but some private supplies are affected. Much of the radon in the water supply to a house will be lost before the water is drunk. In particular, if the water is boiled to make hot drinks most of the radon is lost.

Radon in drinking water could be harmful in two ways. The radon can escape from the water, giving rise to exposure by inhalation. Alternatively, if the water is drunk before the radon degasses, it can irradiate body organs, primarily the stomach.

Radon in room air usually comes mostly from the air in soil below the house rather than from drinking water. However radon given off from water can contribute to the radon in room air. There is a well-established rule of thumb that a concentration of radon in water of 1000 Bq per litre gives rise to about 100 Bq m^{-3} in room air. Doses from this route are normally more important than those from ingestion of water. However, taking the radon out of water is unlikely, on its own to solve a radon in air problem because other sources are likely to be more important.

Radon in air thus usually presents a greater hazard than radon in drinking water. Nevertheless, the European Union is considering a draft recommendation on the protection of the public against exposure to radon in water supplies. Because the way in which radon irradiates the body is quite different if it is swallowed in water than if it is inhaled in air, the Action Level for radon in water is not the same as for radon in air. It has been set so that the risk to a typical person drinking water with radon at this concentration is similar to the risk which would arise from breathing air which contains radon at the Action level of 200 Bq m^{-3}.

The draft recommendation is:

- for private water supplies that are part of a commercial or public activity (e.g. hotel or bed and breakfast) remedial action should always be taken when the radon concentration exceeds an Action Level of 1000 Becquerel per litre

- for individual water supplies (no commercial or public activity) consideration should be given to remedial action when the radon concentration exceeds an Action Level of 1000 Becquerel per litre.

Lifetime risks from radon at the Action Level

If someone were to spend their whole life exposed to radon in air at the Action Level of 200 Bq m^{-3} it is estimated that they would have a risk of developing cancer of about 3-5%. The risks would be higher for smokers (about 10-15%) than for non-smokers (about 1-3%). These estimates of risk are approximate, but they are based to a large extent on observations of radon induced lung cancers in human populations.

There are no direct observations of cancers induced by ingestion of radon. However, there is evidence (primarily from the survivors of the atomic bombs) that radiation can induce stomach cancer. The nature of the radiation exposure of the atomic bomb survivors is quite different from that arising from the ingestion of radon. However, it is possible to calculate the radiation doses involved in both cases and to estimate the risks of ingesting radon in this way. There are substantial uncertainties in several of the steps involved in this calculation. However, the conclusion is that ingesting radon in drinking water at the action level of 1000 Bq l^{-1} would give a lifetime risk of fatal stomach cancer similar to, but probably a little lower than, the risk of fatal lung cancer from inhaling radon at the action level for air.

Further information

"Health risks from radon" A joint publication by the National Radiological Protection Board, The Faculty of Public Health Medicine and the Chartered Institute of Environmental Health. Published by NRPB, 2000. Available from NRPB: tel 01235 822742; email information@nrpb.org.uk

DETR Publications

(available from DETR Free Literature, PO Box 236, Wetherby, LS23 7NB; tel 0870 1226236)

"Radon: A householder's guide" published by the Department of the Environment, Transport and the Regions

"Radon: You can test for it" published by the Department of the Environment, Transport and the Regions

"Radon: A guide to reducing levels in your home" published by the Department of the Environment, Transport and the Regions

"Radon: A guide for homebuyers and sellers" published by the Department of the Environment, Transport and the Regions

Building Research Establishment
(contact Construction Research Communications Ltd, 152 Rosebery Avenue, London EC1R 4QX; tel 020 7505 6622)

"Surveying dwellings with high indoor radon levels: a BRE guide to radon remedial measures in existing dwellings" C Scivyer, Building Research Establishment, BRE BR250 Garston 1993

More detailed information

"Estimates of late radiation risks to the UK population". National Radiological Protection Board. Documents of the NRPB **4**(4), 1993

"Risk of radiation-induced cancer at low doses and low dose rates for radiation protection purposes". National Radiological Protection Board. Documents of the NRPB **6**(1), 1993

"Risk Assessment of radon in drinking water". National Research Council. National Academy Press, Washington DC, 1999.

"Health Effects of Exposure to Radon: BEIR VI". National Research Council. National Academy Press, Washington DC, 1999.