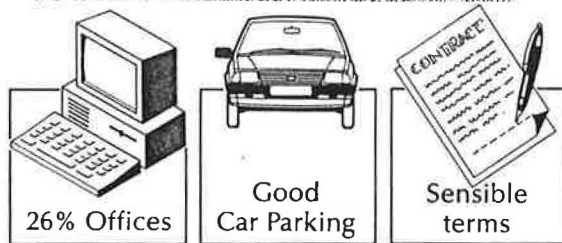


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**Dealing with radon
gas**

To what extent is radon gas present in dwellings in the UK? What is the risk to occupants and are there remedial measures available?

Radon is a natural gas which is formed in the ground by the decay of small amounts of uranium. It is radioactive and has no taste, smell or colour. The gas rises to the surface and can percolate into buildings. The risk of a person developing lung cancer is increased by exposure to radon and its decay products (known as radon daughters).

The activity of radon is measured in units of becquerel (symbol Bq). Results from two surveys by the National Radiological Protection Board (NRPB) indicate that the average level in dwellings in the UK is about 20 Bq/m³. One survey took radon measures for 2,300 dwellings chosen at random and representative of the UK. The other survey, of 700 dwellings, was made in areas where the geology was expected to give high levels of radon. In these areas especially it is important to consider each dwelling individually as no two houses can be taken as alike.

It is recommended by the NRPB that radon activity of 400 Bq/m³ is the maximum which should be allowed in existing dwellings before it is lowered by remedial measures. The limit set is called the "action level" and is the average radon concentration for a year. Roughly 20,000 dwellings in the UK were initially expected to exceed this level. The first phase of systematic surveys by NRPB to identify houses at risk is now nearly complete. The NRPB recommend that for future dwellings a limit, known as the Upper Bound, is set at 100 Bq/m³. In parts of the country where radon levels are expected to be high, this limit is advocated as the basis for changes in building methods.

The NRPB found that in 27 of 66 counties surveyed the mean concentration of radon activity was above the national average. Devon and Cornwall were, on the basis of predictions from the samples, likely to have a considerable number of dwellings above the action level, many more than elsewhere.

Underlying igneous rocks, particularly granite in south-west England, were generally, but with some exceptions, found to be linked with the highest radon concentrations in dwellings. Igneous rocks are rocks formed by great heat. Dwellings in Cornwall or Devon built on granite gave results which were 10 times the national average radon concentration.

High concentrations are not only linked to igneous rocks or the South West. Above-average levels were also found with many different sedimentary formations — an exception being clay.

Other factors affect radon levels in dwellings. The NRPB found that concentrations in upstairs bedrooms, in two-storey houses, were, on average, only 65% of that in ground-floor living areas. In bungalows, radon concentrations in bedrooms were only a little less than in living areas. The view was reinforced that the ground is

generally the main source of radon found in dwellings.

Radon concentration tends to be increased by about 50% if either secondary glazing or draught proofing is installed. The reduction in ventilation rate seems to be the cause. On the other hand, radon levels were 30% higher, on average, in living areas with open chimney flues than was the case when there were no flues. It appears that there is a tendency for radon to be drawn up from the ground by an open flue. The value of the extra ventilation appears to be more than outweighed by the radon it attracts.

The risk of increased lung cancer in persons exposed to radon and its daughters can be estimated. No conclusive evidence has been obtained from groups exposed to high concentrations in dwellings. Positive results from studies of animals exposed in experiments were obtained. Estimates can be made from the higher incidence of lung cancer among uranium and other miners exposed while working. Indirectly, estimates can also be made from studies of the atom bomb survivors in Hiroshima and Nagasaki.

It has been estimated that 2,500 people may die each year in the UK because of indoor exposure to radon and its daughters. The numbers of premature deaths that can reasonably be avoided are a small proportion of this total. Mortality statistics show that deaths due to accidents in the home total 5,500 annually. For the same period, lung cancer deaths, mainly resulting from smoking, number 40,000.

There is a probable interaction between smoking and deaths from radon and it is envisaged that 75% of those dying would be smokers. It is estimated that smokers, on average, are likely to face a 10 times greater risk than non-smokers from a particular level of radon.

The NRPB recommend that the urgency of measures taken to reduce radon levels should relate to the amount of the annual dose received. Lengthy exposure of individuals for many years at high radon levels is the prime concern, however. All doses corresponding to the action level of 400 Bq/m³ should, it is advised, be reduced by remedial measures as soon as it is reasonably practicable. Action is advised within a few years for levels of 400 Bq/m³ to 1,000 Bq/m³. For higher levels, over 1,000 Bq/m³, action is advised within a year.

Generally, the higher temperatures within dwellings and the influence of wind can slightly reduce indoor atmospheric pressure compared with that in the ground. The effect may be to cause radon to spread up from the ground into the dwelling. Ground which has a high amount of uranium and is reasonably permeable may lead to substantial concentrations of radon, in a normally ventilated dwelling, unless the floor checks the flow.

Radon levels may be lowered by increasing natural ventilation. Mechanical ventilation methods may also be used so long as pressure differentials are not increased. The most satisfactory approach, however, is to reduce the flow of radon into the dwelling by making the ground floor a more efficient barrier. The methods used are affected by the type of ground floor and whether the dwelling is existing or at the design stage.

The Department of the Environment has published a leaflet giving guidance on radon. Aimed at people living where radon levels are high, it was written particularly for those whose homes have been found to have an appreciable amount. It is advocated that, in this situation, suspended floors should be sealed, a fan can, as one option, then be installed to draw air from the space underneath. Surveyors will be inclined to view this as an impractical solution. However, as an alternative, the advantage of additional air bricks will be obvious. The Building Research Establishment (BRE) are currently studying whether further guidance may be necessary on methods of sealing timber floors. The object is to overcome potential problems from timber decay. Solid floors should also be sealed, but here it may be necessary to construct a subfloor suction system.

FIG.1 METHOD OF REDUCING RISK FROM RADON PROPOSED FOR NEW DWELLINGS IN WORST AFFECTED ZONE IN S.W. ENGLAND

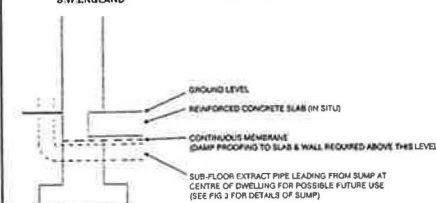
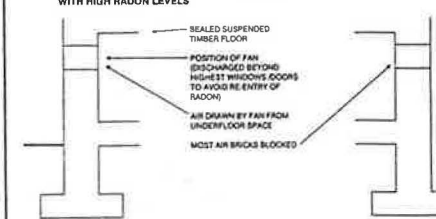


FIG.2 USE OF FAN SYSTEM TO EXTRACT AIR UNDER AN EXISTING RAISED TIMBER FLOOR IN DWELLING WITH HIGH RADON LEVELS



Reducing radon levels in existing dwellings is harder than designing new homes so that only low levels will be reached. For future dwellings, it will be recalled, the limit for radon concentration was set at 100 Bq/m³, rather less than the 400 Bq/m³ maximum for existing homes. Interim guidance has been given in a document produced by the Department of the Environment for reducing the risk from radon in new dwellings under Part C of the Building Regulations 1985.

The approach proposed in the construction of new dwellings is that precautions should be taken in areas where problems are most likely. Pending further research, the location of the worst places in these areas is still uncertain. At present, the interim guidance affects only Cornwall and parts of Devon. On a map, the zone where the vast majority of problems are likely is shown. The

suggested method (Fig 1) of preventing the passage of radon in this zone is by a continuous membrane across the floor and the wall. It should also be possible to extract radon from under the floor, if necessary, later. Outside the zone, in the rest of Cornwall and in some localities in Devon, provision for future subfloor extract only is suggested, without a membrane. There may be high radon levels outside the perimeter of the zone.

In more detail the DOE recommendations for existing dwellings include the following:

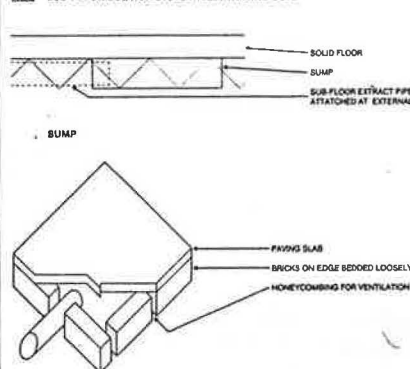
Sealing suspended timber ground floors finished with sheet vinyl is quite simple. Only the edges and joints need to be sealed as the plastic itself is an adequate barrier to the air flow which carries radon up into the building. The work being undertaken by the BRE on methods of sealing timber floors and on potential problems from timber decay has been mentioned previously.

Where the floor is finished in other ways, it can be sealed by laying a plastic sheet over the timber. A suitable material would be 1,000 gauge building polythene. All carpeting and carpet fixings should be removed before the sheet is laid.

Joints in the sheet require lapping and securing with a durable form of double-sided sticky tape. BRE are investigating methods of jointing polythene sheet. Taping to seal the joint around the edges is needed. A layer of hardboard should be laid over the plastic to give it protection. Floorboards which have been cut short or service entry points through the floor form gaps which need to be closed

before overall sealing is carried out. Hard-board or sealant can be used for this purpose. After floor sealing, two options are available for remedial work to suspended timber ground floors. One approach is simply to make sure that natural ventilation under the floor is sufficient. To do this may require extra air bricks. The second method (Fig 2) is to use a fan to draw air from the underfloor space after blocking most or all of the air bricks. The risk of decay to timber is likely to concern surveyors here, however. To avoid re-entry of radon, the fan outlet should be well away from doors and windows. Sealing of suspended concrete floors should be done in the same way as timber. If the floor is screeded, sealing around the edges only may be sufficient. The use of a fan system or reliance on natural ventilation through air bricks are suggested

FIG 2 SUB-FLOOR SUCTION SYSTEM ILLUSTRATING SUMP



treatments for the subfloor space. It is not clear which is the best treatment for this space or the subfloor area under suspended timber floors.

Solid floors, where the concrete can be inspected and is without visible cracks, need have only limited sealing. Joints between walls and floors and any other gaps and points where services enter should be sealed. If the concrete floor slab is in a bad condition, major cracks will require sealing. An approach involving limited sealing can be adopted where the floor finish prevents an inspection of the concrete. While further sealing of solid floors using polythene sheeting may be helpful, sealing alone cannot be guaranteed to lower radon levels significantly. As a second stage it is best to construct a subfloor suction system (Fig 3). Air pressure in the ground is lowered, thereby reducing radon entry. A small sump (sometimes more than one) is formed generally under the dwelling, from which radon-bearing air is drawn out through a pipe by a fan.

In sum, therefore, it can now be said that the surveying profession is becoming well aware of the problem of radon gas in dwellings in the UK. However, further research is clearly needed. On present evidence, there is cause neither for unnecessary anxiety, especially among non-smokers, nor for undue complacency.

Applications may be made to the NRPB, in writing, for advice and surveys, often free in areas with high radon levels. The address is: NRPB, Chilton, Didcot, Oxon OX11 0RQ.

Law of Property (continued from p 46)

are not intended to be binding, should contain the expression "subject to contract".

Agreements by way of variation should incorporate by reference, at least, the provisions of the original agreement as varied.

Acceptance of offers must be framed so as to comply with the new rules. A letter of acceptance is not sufficient. A contract in one document must be signed by or on behalf of all parties. The offer should be drawn in the form of the intended contractual document, and a duplicate of the signed offer should be signed by the offeree or his agent, and sent to the other party, or the offer itself should bear the signature of both parties, or of agents on their behalf. This is of particular importance to agents in the case of tenders.

Although conveyances, leases and mortgages are dispositions themselves, and not usually contracts for dispositions, sometimes they may be. For example, in mortgages there are frequently agreements for the giving of further security subsequently, which makes them contracts in that respect for a disposition of an interest in land. The disposition in any such case must be

signed or executed by all parties, otherwise the agreement in the mortgage for the further disposition will be ineffective. It is frequently the current practice of mortgagees not to execute mortgages.

Equitable estoppel

Nothing in the Act affects the operation of the doctrine of equitable estoppel. This may apply where a person has incurred expenditure, or otherwise prejudiced himself, in the mistaken belief that he has an interest in land, or that he would obtain such an interest, and has been actively or passively encouraged in that belief by the owner or intended grantor of the relevant interest in land. In those circumstances, equity will act to restrain unfairness, sometimes to the extent of conferring title. Until the courts are confronted with a claim for proprietary estoppel, and the enforcement of the terms of an ineffective "contract" for the sale or other disposition of an interest in land, opinion must be reserved. The likelihood is that, if the doctrine were applied, it would not necessarily be upon the

terms which were expressly agreed by the parties, but contained in the void "contract". The operation of the doctrine may offer some comfort, but the disappointed party may well be scraping at the bottom of the barrel.

A parting comment

The new rules are sensible, and well thought out. The need for certainty is paramount. A contract in one definitive document is desirable. Signature by all parties seems apposite. They should not slip by accident into contracts relating to land. Once practitioners realise that the methods of operating in this area have fundamentally changed, and that they fail to comply at their peril, the new rules will be simple to operate.

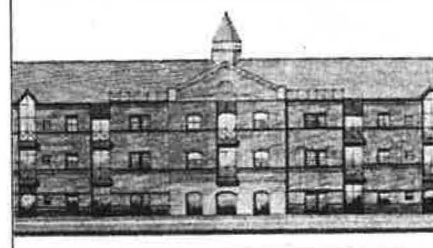
But what a pity no one saw the need to warn practitioners of the pitfalls in the changes! Would it not have been preferable to have commenced the operation of the section by statutory instrument after time had been allowed for the assimilation of the new rules, and the preparation of practising techniques so different in their operation from those formerly employed?

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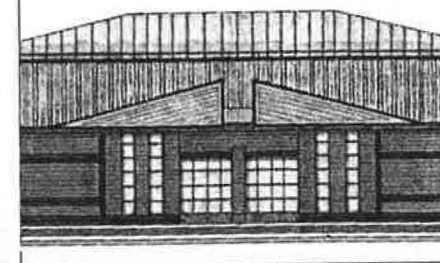
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