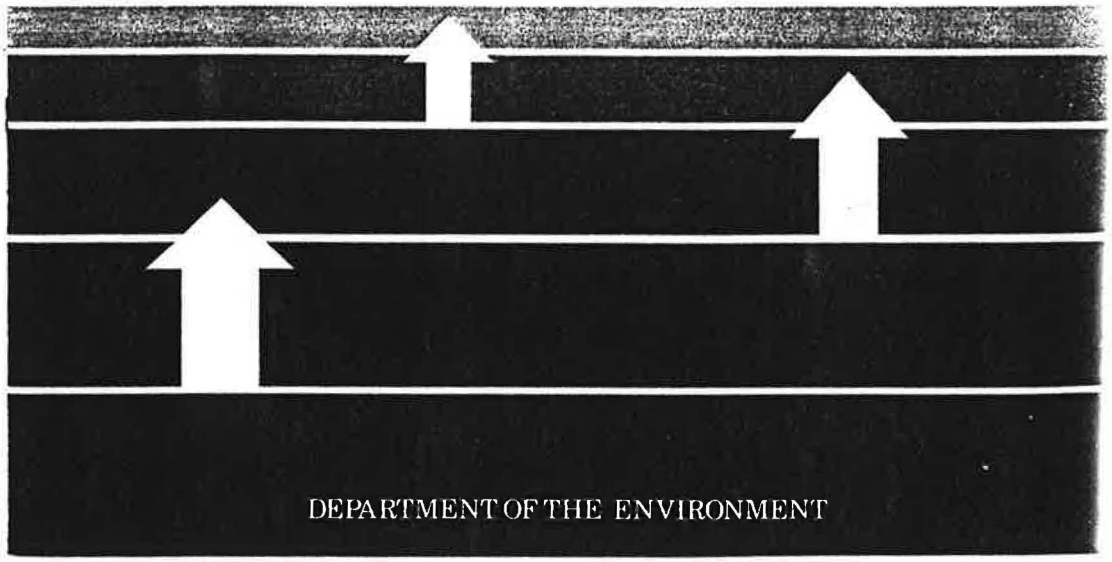
THE HOUSEHOLDERS' GUIDE TO

RADON



DEPARTMENT OF THE ENVIRONMENT

INTRODUCTION

This guide is a follow-up to the leaflet *Radon in Houses* which was issued previously by the Department of the Environment. It is intended for people who live in areas with high levels of radon. It is written particularly for householders whose homes have already been tested and found to have an appreciable level of radon. It explains what radon is, how it gets into houses and what the effects on health may be. It also outlines some of the ways of reducing the level of radon and gives guidance both on how to get the work done and likely costs.

The guide is in two parts. Part 1 answers some questions about radon itself, including how it can be measured. Part 2 tells you what you can do if you have a high level of radon in your home.

If you live in an area which might be affected by radon and want to have your home tested, write to Radon Survey, National Radiological Protection Board, Chilton, Didcot, Oxon OX11 0RQ. They will send you a short questionnaire and from your answers will advise whether the level of radon in your house should be measured. If they think it should because of the nature of your area and of your home, they will carry out the test free. If not, you will have to meet the cost yourself.

WHERE TO GO FOR MORE HELP AND ADVICE

You should initially approach your local council (the Building Control Officer or Environmental Health Officer) for advice.

Some government departments, trade associations, contractors' federations and professional bodies will also be able to advise as described later in this guide.

If you have a complex query about reducing the level of radon you should write to the Building Research Establishment, Garston, Watford WD2 7JR, but if detailed technical issues are involved you may be charged for this service.

OTHER PUBLICATIONS

The Building Research Establishment is preparing a *Builders' Guide to Radon*, which will provide more detailed information.

PART I

YOUR QUESTIONS ANSWERED

WHAT IS RADON?

Radon is a natural radioactive gas which has no taste, smell or colour. Special equipment is needed to detect it.

The level of radioactivity in the air owing to the presence of radon is measured in units of 'becquerel per cubic metre' (Bq/m^3). The average level in UK houses is 20 Bq/m^3.

WHERE DOES RADON COME FROM?

Radon comes from the radioactive decay of radium, which in turn comes from the radioactive decay of uranium. Uranium acts as a permanent source of radon and is found in small quantities in all soils and rocks, although the amount varies from place to place. It is particularly prevalent in granite areas. However, radon levels vary not only between different parts of the country but even between neighbouring buildings.

Radon in the soil and rocks mixes with air and rises to the surface where it is quickly diluted in the atmosphere. Concentrations in the open air are very low. Radon that enters enclosed spaces, such as houses, can reach high concentrations in some circumstances.

HOW CAN RADON AFFECT ME?

When radon decays, it forms minute particles of other substances which are also radioactive. These are called radon decay products or radon daughters. If formed in air, these particles may be inhaled and some will be deposited in the lungs. The radiation emitted by them as they decay can give a high dose to lung tissues and damage them.

Exposure to radon and its decay products increases the risk of developing lung cancer. Not everyone exposed to high levels of radon will develop lung cancer, and many years may pass before the disease becomes apparent. Lung cancer caused by radon is indistinguishable from that caused by other factors, including cigarette smoking. However, there is evidence to suggest that the risk of developing the disease from radon is greater for smokers than non-smokers.

The evidence linking exposure to high levels of radon and increased lung cancers comes mainly from studying the health of underground miners and is supported by tests on animals. For most people, the risk from radon is insignificant compared to the other risks of everyday life, such as fatal accidents indoors. However, some houses in some parts of the country have levels of radon comparable to those found in some mines and therefore the risks are greater.

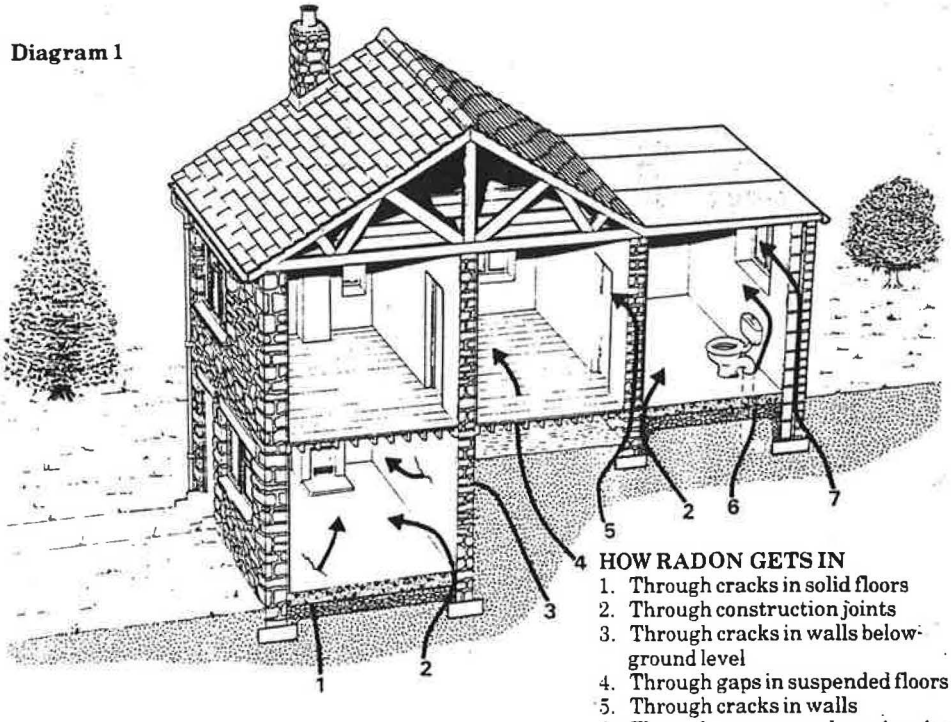
HOW DOES RADON GET INTO MY HOME?

Air from the soil containing radon may enter through any opening that connects the house with the underlying soil or rock. These openings may include very small cracks which can be difficult to find. The air pressure indoors is often slightly lower than that in the soil because of the effect of wind and temperature, so air is drawn from the ground into the house.

Diagram 1 shows how radon can enter a house.

Indoor radon levels that are high enough to cause concern are usually due to radon from the soil. Although building materials such as brick and stone (including granite) also contain uranium and produce radon, the amount they produce is insignificant.

Diagram 1



HOW RADON GETS IN

1. Through cracks in solid floors
2. Through construction joints
3. Through cracks in walls below ground level
4. Through gaps in suspended floors
5. Through cracks in walls
6. Through gaps around service pipes
7. Through cavities in walls

HOW DO I KNOW IF MY HOME HAS A HIGH RADON LEVEL?

A survey by the National Radiological Protection Board (NRPB), the Government's advisors on matters of radiation protection, has shown that the majority of homes in the UK do not have significant radon levels. In certain areas, however, high levels do occur, and many people in these areas have had their homes monitored by the NRPB. Others are currently having radon measurements. These surveys are being carried out for the Government to identify homes with the highest levels.

Wherever you live, if you are worried that your house may have a high radon level, you should write to the NRPB Survey at the address on page 1. The NRPB will send you a short questionnaire. On the basis of your answers, they will advise whether the radon in your home should be measured.

HOW ARE THE MEASUREMENTS MADE?

The NRPB will send you two small detectors, one for the living room and one for an occupied bedroom. The detectors contain special plastic to measure radon and are harmless. They are sent back to the NRPB after three months for processing.

This may show that there is no need to take further action, but in some cases, the NRPB might suggest further measurements of the same type for a longer period, say a year, to get a more accurate estimate of the average radon level in your home.

WHO HAS ACCESS TO MY RADON RESULTS?

The results of measurements by the NRPB and the Building Research Establishment (BRE) are available only to the occupier of the house in most circumstances. However, where the NRPB have surveyed public sector buildings on behalf of the Department of the Environment they are automatically supplying the detailed results to both landlords and tenants. The results will not be disclosed to anyone else.

Tenants will need to consider whether their landlord's responsibilities cover the sort of measures referred to in this guide. In the great majority of tenancies, landlords are responsible for keeping the exterior and interior of the structure in a reasonable state of repair. Landlords may have further responsibilities depending on the precise terms of the tenancy agreement – which also identifies tenants' responsibilities.

It is therefore advisable to discuss the matter with your landlord. You may also need to take legal advice about your particular rights and obligations.

If you are an owner-occupier there is no legal obligation on you to disclose the results to anyone, but if you are selling or buying a property in an affected area, you should take legal advice about any contractual matters.

WHAT SHOULD I DO IF MY HOME HAS A HIGH LEVEL OF RADON?

The risk of developing lung cancer increases as the level of radon and the duration of exposure increases. Radon levels indoors vary considerably during the day, from day to day and from season to season.

It is the average level which is important: short exposures to high levels will not be important for health if the average exposure over a long time is low. Because of this, you should take no action to reduce radon levels until the average has been measured over a long period, preferably a year.

There is a recommended Action Level for radon in existing homes, above which you should take action to reduce it. The Action Level is set at a certain annual radiation dose, which corresponds to an average radon concentration of 400 Bq/m^3 over a full year. You should take action as soon as reasonably practicable. This means that for levels between 400 Bq/m^3 and 1000 Bq/m^3 it would be desirable to take action within a few years. Where levels are considerably higher, that is over 1000 Bq/m^3, you should take action within a year or so.

Part 2 of this guide gives some practical advice on measures that can be taken to reduce radon levels indoors. The purpose of any action should be to reduce the radon level as much as possible below 400 Bq/m^3.

It is easier to design new homes to have low radon levels than to reduce high levels in existing homes. A design level of 100 Bq/m^3 has therefore been set for new houses. The subject is now covered in *Interim Guidance on Construction of New Dwellings*, available from the Building Regulations Division of the Department of the Environment. This information is also relevant to house extensions.

PART 2

MAIN TYPES OF RADON TREATMENT

PREVENTING RADON ENTRY

It is better to prevent the entry of radon into a house than to try and remove it once it is present. In practice this means preventing the radon-laden air from the rocks and soils under the house entering through any openings in the floors and walls – as shown in diagram 1.

For the successful treatment of high radon levels you need to:

- identify the likely radon entry routes, and
- undertake appropriate work to a good standard.

It is beyond the scope of this guide to discuss all the procedures that can be used to identify radon entry routes. Sometimes, in difficult cases, specialist equipment will be needed, but in the majority of houses it is safe to assume that the important entry routes are around and through the ground floor.

Although many householders will prefer to have work carried out by an experienced builder, there is nothing that should prevent a competent do-it-yourselfer from successfully undertaking some or all of the necessary work.

The following sections describe separately the remedial measures for suspended and solid ground floors, since each has different requirements. In some homes built in the vicinity of mine-workings or on reclaimed land, solid floors may be a part of a structural reinforced concrete raft foundation. These should not be disturbed without taking specialist advice. It is important, therefore, to be sure of the type of floor before starting work.

Suspended floors

Suspended ground floors are those with an airspace between the floor and the underlying ground. They are often constructed of timber, but in some modern houses may be concrete.

Timber floors can often be identified by the airbricks around the outside of the house close to ground level which provide ventilation. These floors, even if carpeted, can allow air to pass through cracks and gaps. Because of slight pressure differences between the air in the ground and under the floor, and that in the house, a slight upwards flow of air usually occurs. This carries radon into the house and must be prevented.

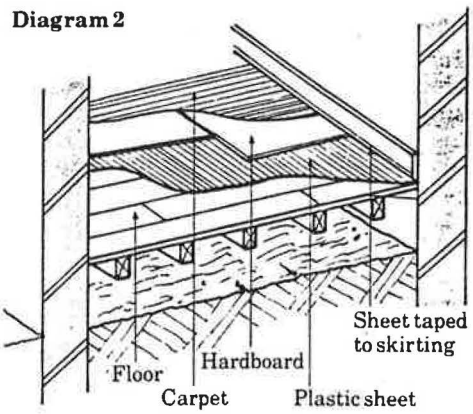
Stage 1

Floors that are covered with a sheet vinyl material, rather than carpet, will only need sealing around the edges and at joints in the vinyl, because the material itself is sufficiently airtight. Otherwise, you can seal the floor by laying a plastic sheet, such as 1000 gauge building polythene, over the timber floor after removing all carpets, underlay and carpet fixing strips. Any joins in the sheet should be lapped and joined with double-sided sticky tape. The sheet should be taped around the edges to the skirting board or walls.

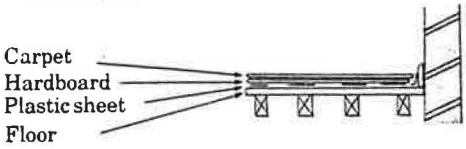
This sealing must be done to a high standard using durable materials and be as airtight as possible. You should then cover the plastic sheet with a layer of hardboard to protect it. It is essential to cut the hardboard to the correct size before laying the plastic sheet, otherwise you are likely to puncture the plastic. A few nail holes through the plastic sheet will not matter too much. Small gaps between adjacent hardboard sheets will allow for any expansion and contraction. You may need to trim the bottom edges of doors before relaying the floorcovering.

You should pay particular attention to floorboards which have been cut short, for example in understairs cupboards, and to service entry points, e.g. pipes, in the floor.

Diagram 2



Suspended timber floor covered with plastic sheet. A plastic sheet can also be used on solid floors as an alternative to sealing cracks if it is sealed well around all its edges.



These gaps should be covered with hardboard or filled with sealant before undertaking the general sealing procedures.

Diagram 2 shows the sealing of a suspended floor.

Stage 2

There are two options at the second stage of this treatment. The first is to ensure that there is good natural ventilation under the floor. This should be the case if there are several clear airbricks on at least two sides of the house fully exposed to the wind. If not, you should install extra airbricks.

The second option is to block up most or all of the existing airbricks and install a fan to draw air from under the floor. This is likely to be more effective in reducing radon levels than natural ventilation, especially if the floor is well sealed. It should also maintain adequate ventilation to prevent decay in the floor, but there will be some running costs. To prevent radon-laden air from entering the building, the fan outlet should be located away from windows or doors.

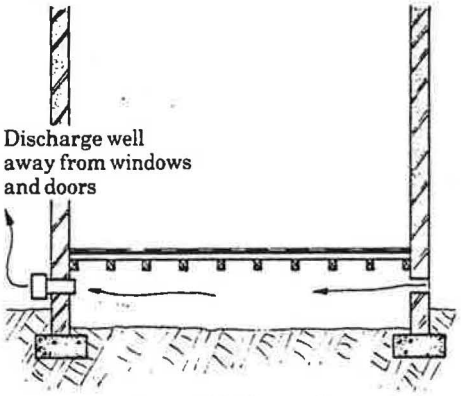
The forthcoming BRE *Builders' Guide to Radon* will provide more detailed guidance.

Concrete suspended floors may be difficult to identify. There may not be any airbricks and the floor may have a cement screed and a variety of coverings. If you are in any doubt, consult a builder. The method of treatment is similar to that for timber floors. Sealing should be done in the same way, paying particular attention to gaps and service entry points. For the second stage, a fan system is the best option.

IN SUMMARY: You should seal suspended floors well, maintaining a high standard of work as a single large gap may seriously affect the overall result. The preferred second stage treatment is to install a fan to draw air from under the floor. If a fan is used without proper sealing, the result will probably be disappointing.

Diagram 3 shows the preferred solution of sealing combined with the use of a fan.

Diagram 3



Increasing the ventilation under a suspended floor with a fan. Most air bricks should be blocked up to enable some depressurisation to be obtained.

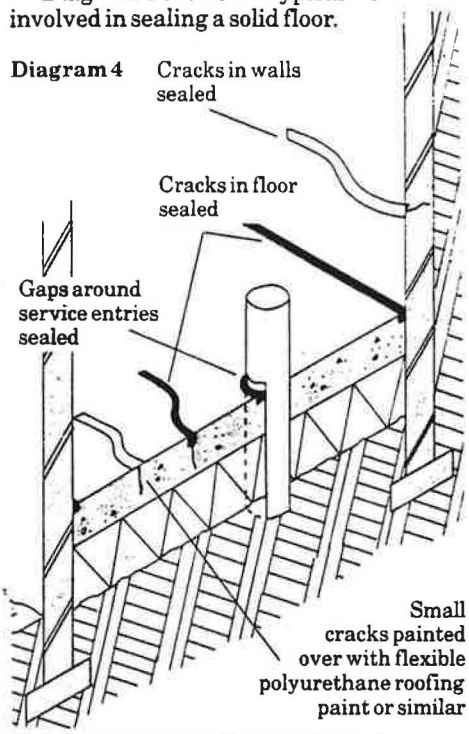
Solid floors

Stage 1

With solid floors, the concrete is usually laid directly on the ground or on a layer of hardcore. If you can inspect the concrete surface and it is in good condition with no visible cracks, sealing can be limited to the joints between the walls and the floor and to other gaps and service entry points. If the floor is in poor condition, major cracks should be sealed. In those houses where the surface cannot be easily inspected, e.g. quarry tiles on concrete, sealing should be limited to gaps and around service entry points. Further sealing with polythene sheet, as for suspended floors, may improve matters, but sealing alone is unlikely to reduce radon levels appreciably.

Diagram 4 shows the typical work involved in sealing a solid floor.

Diagram 4



Painting over or sealing cracks and service entries in solid floors, and cracks in walls against the ground. It is important to achieve an airtight seal.

Stage 2

For this type of floor, it is best to seal the obvious gaps and cracks and then install a sub-floor suction system. This is also known as sub-floor depressurisation. This reduces radon entry by reducing the air pressure in the ground under the house. However, where the house has a reinforced concrete raft foundation, you should get specialist advice before proceeding.

The general approach is to make a small sump under the house from which the radon-laden air can be drawn out through a pipe by a fan. The sump is made by cutting through the floor and digging out a small amount of underfloor material. The pipe can run under the floor or through the roof. A suitable fan is attached to the end of the pipe. You must be careful to repair any damp-proof membrane in the floor and again, you should get specialist advice. These membranes are usually present in modern floors and can act as a barrier to radon if installed to a good standard.

The practical details of this approach depend on the layout of the house, the type of solid floor, the nature of the material under the floor, and the ground level. One 400 mm (16 inch) diameter sump filled with coarse gravel and a 100 mm (4 inch) plastic pipe per house will probably be enough, but sometimes you may need more than one sump. In some cases, sumps may be successful if located next to the outside of the house, in which case it will not be necessary to disturb the house floors or decoration in any way.

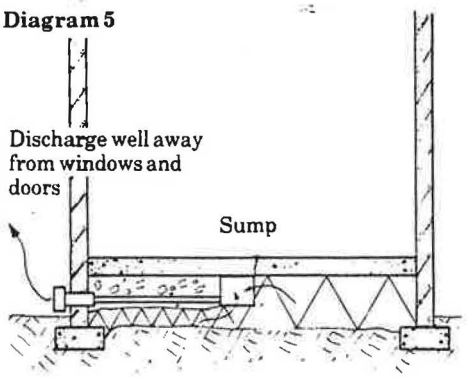
With any fan system it is important to locate the fan outlet away from windows and doors to prevent the radon-laden air entering the building.

Diagrams 5 and 6 show these solutions.

Other structures

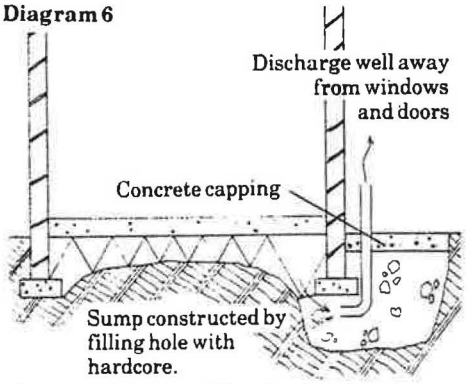
You may need to get professional advice if your house has been extended, has stepped foundations or is unusual in any way. These will be covered in the BRE

Diagram 5



A Radon sump beneath a solid floor with a fan to depressurise the soil.

Diagram 6



A sump constructed by digging down alongside the house.

Builders' Guide to Radon. You can also find some relevant information in the *Interim Guidance on Construction of New Dwellings*.

IN SUMMARY: For solid floors, sealing alone is unlikely to be a sufficient remedy for radon problems. The recommended approach is to seal major cracks and gaps and then install a fan system. The BRE *Builders' Guide to Radon* will provide more detailed advice.

Costs

As a guide to the costs involved, building labour is available for around £6 to £10 per hour. Removing and replacing carpets and furniture (a job best left to specialists if the carpets and furniture are expensive and the carpets particularly well fitted) could take a few hours per room. A 1000 gauge polythene sheet for the average sized room would cost about £5, but laying and sealing it properly could take a day.

Suitable fans cost around £60 each and will use about £30 to £60 worth of electricity per year depending on their rating.

Constructing a sump beneath an existing floor and installing a fan and pipework is unlikely to cost less than £400 and may in difficult situations cost around £1000. If these sums of money are involved it may be worthwhile employing a professional advisor such as an architect or surveyor, but their fees are likely to be over £200 for design and supervision.

REMOVING INDOOR RADON

The preferred approach is to prevent radon from entering the house as described in the previous sections. You should be wary of anyone offering alternative systems as proven and effective methods for reducing radon, or suggesting them as an easy solution to your problem.

Some methods have been proposed for removing radon and its decay products from the indoor air and in most cases these are less certain in their effect. In some circumstances, they may actually lead to higher radon levels.

House ventilation

Adequate ventilation is important in any house to control the level of water vapour, which can lead to condensation and mould growth, and everyday airborne pollutants such as cooking fumes and cigarette smoke. Ventilation with outside air will also dilute radon, but the situation is not clear-cut.

If you have reason to believe that your

house is not sufficiently well ventilated you should take steps to improve the overall level of ventilation. As a general rule, you should provide ventilation on the ground floor (rather than upper floors) and on several walls, since this will tend to prevent lower pressure indoors, which would draw radon-laden air from the ground. The costs of such simple measures are low, but there will be some increase in heating costs.

Extract fans

Although extract fans can be used to increase ventilation, they can reduce the air pressure in some rooms sufficiently to increase the flow of radon through the floor. They are *not* therefore recommended as a means of reducing high radon levels. However, they can be used for short periods to remove cooking smells and moisture but you should provide an easy route for outside air to enter the room containing the fan.

Whole house pressurisation

It is also possible to increase the ventilation by using a fan to blow in fresh air and it may be claimed that this system can pressurise the whole house sufficiently to prevent radon entry. Although this might be achieved with a large fan in a house that was particularly airtight, the effect in most houses will simply be to increase the ventilation with little effect on radon entry. There are other possible drawbacks and you should seek specialist advice before installing one of these systems in your home.

Balanced mechanical ventilation with heat recovery

If your house is already adequately ventilated then increasing ventilation to reduce radon levels will result in increased heating costs in winter. This extra cost can be significantly reduced by installing a balanced mechanical ventilation system with heat recovery. These systems supply and extract air at approximately the same rates and do not therefore depressurise rooms in the same way as extract fans do. Although well engineered systems cost in the region of £800 if professionally installed, they can improve the indoor environment, for example by clearing cigarette smoke and cooking smells more rapidly. However, you are advised to seek expert advice from the BRE before installing one of these systems to help cure a radon problem.

Air cleaners

Commercial devices are available which remove smoke, dust and pollen from the air. One common type works electrostatically by charging and collecting the particles. This device does not always reduce the radiation dose to the lungs from radon decay products and may indeed make matters worse. Other devices for conditioning room air need careful technical evaluation. Contact the NRPB if you want further advice on this subject.

GETTING APPROVAL TO CARRY OUT THE WORK

If you are a tenant, you will need to discuss any work to reduce radon levels with your landlord before you start. You may be allowed to do some of the jobs yourself, but other work may need to be carried out by the landlord, especially if it affects the structure of the building.

If you own your home but have a mortgage, you will need to get the lender's permission before making any major changes to the house, but not for small jobs. If you are not sure of the terms of your mortgage agreement, check with your lender before starting work.

You will not usually need planning permission or building regulations approval for small radon jobs, unless you are making more substantial changes at the same time. Check with the Building Control Officer at your local council.

If your house is in a designated area of outstanding natural beauty, a national park or a conservation area, you may need to get permission for alterations which affect the external appearance of your house. Check with the planning department of your local council.

PAYING FOR THE WORK

Building societies have agreed in principle, subject to the applicant's status, to provide the necessary loan finance for the cost of radon work. In cases of financial difficulty, some local councils might be able to give you a home improvement grant to help towards the cost of the work. However, these grants are discretionary and will vary from area to area. Check with your local council.

CHOOSING A BUILDER

This whole subject is relatively new to the UK and professional expertise is gradually building up, particularly in high radon areas. It is best to employ a builder with a good general reputation who has successfully treated houses with high radon levels. To be effective, radon treatment should be carried out to a high standard using good quality materials. You should obtain several quotations in writing and take time to decide between them.

At the back of this guide you will find a list of trade associations, contractors' federations and professional bodies who will be able to give you a list of members in your area, some of whom may be experienced in radon work. Members of these bodies are committed to carrying out work to a high standard, with the safeguard of an arbitration and complaints procedure. Work may also be covered by an insurance-backed guarantee scheme. Check this before you sign any contract. Remember that oral agreements can form a contract also, but it is best to get everything in writing.

RETESTING FOR RADON

When you have taken action to reduce the radon level in your home, brief tests would be useful to show how successful that action has been. Charcoal detectors may be suitable but long-term measurements to show the true reductions over a full year are best made with plastic detectors. This would require two detectors for two consecutive six-month periods, giving a total of four results. Charcoal and plastic detectors can be obtained from the NRPB Radon Survey.

FURTHER INFORMATION AND ADVICE

Department of the Environment
(General Enquiries: Room A520)
(New Construction: Room B154A)
43 Marsham Street
London SW1P 3PY

National Radiological Protection Board
Chilton, Didcot
Oxfordshire OX11 0RQ

Building Research Establishment
Garston
Watford WD2 7JR

Royal Institution of Chartered Surveyors
12 Great George Street
London SW1P 3AD

Royal Institute of British Architects
66 Portland Place
London W1N 4AP

Federation of Master Builders
33 John Street
London WC1N 2BB

National House-Building Council
58 Portland Place
London W1N 4BU