Radon: a guide to reducing levels in your home

Don’t live with the risk

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This booklet, published by the Department for Environment, Food and Rural Affairs, provides information about methods for radon reduction. Every effort has been made to ensure that the information is accurate, but the Department cannot accept liability for the application of this advice. Defra cannot endorse or recommend any particular supplier, product or service. The information in this booklet applies to England. For specific information applicable to Northern Ireland, Scotland and Wales, write to the addresses given on the inside back cover.
Introduction
Perhaps you have taken the radon test, and found that your home is above the Action level. Perhaps you have heard from a neighbour or friend that they are taking measures to reduce radon in their house, and you’d like to know what you should do if your house requires work. **The good news is – it can be easy and simple to reduce radon in your house to an acceptable level.** This booklet is designed to give you a good understanding of the methods that can be used, so you can decide whether you want to carry out any of them yourself, and can have a useful discussion with a builder if you decide to use professional help.

Radon – back to the facts
In any building, the air changes all the time – leaving and entering through doors, windows, cracks in the walls and through the floors. As you probably already know, radon, a natural radioactive gas that comes mainly from the soil, has been found to cause lung cancer. Radon is found everywhere in the soil and air; more is found in some areas than in others.

How does radon get into my home?
Because of the effects of wind and temperature, the air pressure in your house is usually slightly lower than the air pressure in the soil beneath it. Just as air rushes in to fill a vacuum because the pressure is lower, the same effect happens (much less dramatically) with houses – air from the soil creeps into the lower pressure area of the house through cracks and gaps in the floor or walls. This air contains radon, and in areas where radon levels in the soil are quite high, indoor radon levels can arise above the Action Level (see illustration).

Health studies from around the world have linked radon with lung cancer. Radon is the second largest cause of lung cancer; the first is smoking. People who are exposed to high levels of radon are more likely to get lung cancer, more so if they are smokers. But even if you would find it difficult to cut down on smoking, you can take easy, relatively cheap and permanent steps to ensure that the levels of radon in your house are below the recommended Action Level, and therefore pose an acceptable level of risk.

Test your radon level
Scientists measure radon levels in bequerels per cubic metre (Bq m\(^{-3}\)). The advice of the Government’s independent advisers, the National Radiological Protection Board (NRPB) now the Health Protection Agency (HPA), Radiation Protection Division has led the Government to recommend that if your indoor radon level is above 200 Bq m\(^{-3}\) (the Action Level) you should take steps to reduce it. There is a test that measures levels of radon with a simple safe device for a period of three months. It costs around £36 including VAT for two detectors, and anyone can order it. If you have not taken it and are worried about radon, write to HPA to ask for a leaflet about the test. The address is at the end of this booklet.

Radon testing kits
Advice is available
There is nothing complex about the methods used to bring radon down to below the Action Level. They all involve simple building works. But because widespread knowledge of the risks posed by radon is quite new, in some areas of the country builders may not have worked on radon reduction before. By reading...
In this booklet, you will be able to understand what measures are needed, and even decide whether or not you want to carry them out yourself. If you choose to use a builder, further expert advice is available to help you and your builder.

Three bodies exist that can help you. The Building Research Establishment Ltd (BRE) has developed practical advice about how building work can reduce radon levels to within safe limits. The Health Protection Agency (HPA) advises on health risks posed by radiation and how to guard against them. The Radon Council Ltd, an independent voluntary Regulatory Body, keeps a list of companies that are experienced in radon reduction work. Addresses and other information available (including two telephone hotlines) are listed at the end of this booklet.

**Five ways to reduce radon**

It is best to stop radon entering a house or, if that is not practical, to try to remove it if it gets in. The aim in both cases should be to reduce indoor radon levels to significantly below the Action Level. There are five main ways to achieve this. Depending on the kind of house you live in and the amount of radon reduction you need to achieve, you can discuss the five ways with your builder – then find the one that best suits you, your house and your radon level.

A **install a radon sump system**

If you need to reduce your indoor radon level by a large amount, and your house has a solid concrete floor, this method can be very effective and is usually the best choice. In many cases it reduces indoor radon levels by as much as 90 per cent. The average cost of installing this system is around £750 – £1,000, and work can be completed in as little as one or two days. The fan it needs will probably cost you around £50 – £60 a year to run, and you might have to replace it after about five years at a cost of around £140.

B **improve ventilation under suspended timber floors**

C **use positive ventilation in your house**

D **seal cracks and gaps in solid concrete floors**

E **change the way your house is ventilated**

The most effective (and usually most expensive) choice starts the list; the other choices vary in cost according to individual house needs, so they cannot be put in a strict order. Don’t forget that if your home’s indoor radon level is not very far above the Action Level, one of the simpler choices may be adequate for your needs.

BRE, HPA, and the Radon Council provide advice which will help you and your builder decide what type of radon reduction work will be most effective for your home.

BRE also publish a range of reports, booklets, and leaflets that give practical and effective advice about the construction work to reduce radon levels discussed in the following pages. For further details see the end of this booklet.

This chart will help you to assess the different choices in the light of your radon test results:

After installing your chosen system, you should take the radon test again for three months. You will then be reassured of your system’s effectiveness.

**Choice A – you can install a radon sump system**

If you need to reduce your indoor radon level by a large amount, and your house has a solid concrete floor, this method can be very effective and is usually the best choice. In many cases it reduces indoor radon levels by as much as 90 per cent. The average cost of installing this system is around £750 – £1,000, and work can be completed in as little as one or two days. The fan it needs will probably cost you around £50 – £60 a year to run, and you might have to replace it after about five years at a cost of around £140.
How does it work?
A sump (an empty space about the volume of a bucket) is dug out under your solid floor, and a pipe is routed from it to the outside air. The sump and a fan alter the air pressure below your solid floor – very slightly, but enough to reduce the amount of radon entering your house. Radon passes through the pipe and is released into the atmosphere, harmlessly diluted. The fan usually sucks, but systems that blow (which ensure that the radon remains in the soil) are also available.

What needs to be done?
A small sump is dug under the house, and a pipe routed from it. In many cases there will be no need to carry out building work inside your house – the builder digs from the outside to create the sump space under your floor, which is quicker, less disruptive and cheaper. See illustration 1.

Routing the pipe
A pipe is attached to the sump, and the radon-laden air is drawn out by a small fan. The best place for the pipe outlet (where the radon is released) is high up, preferably above the eaves of your house. The pipe outlet should certainly not be near a window or door. But if there are no doors, windows or vents on one side of the house, the system can exhaust at ground level, thereby avoiding the need for unsightly pipe work.

If the pipe runs up the outside of the building, it will probably need to be fitted with a condensate drain, to stop condensation running onto the fan.

Is one sump enough?
This depends on the layout of your house, what kind of solid floor you have, and the slope of the ground. One sump is usually enough, but if your floor area is very large, the soil or fill under it is not very permeable, or there are walls that divide up the space beneath your floor, then you may need more than one sump.

Another possibility you might consider is sharing a sump system with your neighbours as a way of bringing down installation, running and maintenance costs. (Information can be obtained from BRE).

Open flues and open fires
In some extreme cases, where houses have open-flued appliances or open fires and are very airtight, there is a risk that your sump could draw dangerous combustion gases back into the house. Further research is being carried out about this problem, and you can get a BRE leaflet about it. In the meanwhile, BRE recommend that you do not locate a sump beneath a room with an open-flued appliance or an open fire, and that you take care not to install an over-powerful fan. Again, when considering how powerful a fan you should install, be guided by BRE’s publications or hotline.
Positioning the fan

The fan can usually be fitted unobtrusively outside your house, perhaps covered with a box. The noise it creates will be minimal, but since it will have to run day and night it is best sited away from bedrooms where it might disturb you. In cases where you place the fan in your loft, its pipe outlet should still be outside the loft and high up, and again you should consider which rooms are underneath the fan; any noise it creates will be less of a problem in, for example, bathrooms and kitchens.

Passive sump systems

You might not need to install a fan. If the pipe is routed up the inside of the building, the radon-laden air can sometimes be drawn out of the pipe naturally. The passive stack (pipe) draws the air out by a combination of the natural effect of warm air rising in the building and the suction effects of wind over the pipe outlet. This system is called a passive sump.

On the one hand, a passive sump (in cases where it is likely to work) is less effective than fan-assisted systems and is probably only appropriate if your indoor radon level is under 400 Bq m⁻³. On the other, it has no running costs, is completely silent – and if when you test your indoor radon level it is still higher than you would like, you can easily upgrade the system by installing a fan.

Choice B – you can improve ventilation under suspended timber floors

This method not only reduces radon, but is also good for your house. By increasing the circulation of air beneath your floor, you dilute the radon and let it pass out into the atmosphere, and also reduce the likelihood of stale, moist air causing timber decay.

Costs for this work can be as little as £20-£50 per air brick if you get a builder to do the work (and very much less if you do it yourself) – but again depends on your house and its indoor radon level.

How does it work?

Installing air bricks may be sufficient for houses with relatively low indoor radon levels; if levels are higher, a fan can be used to increase air movement. The aim is to dilute or suck out the radon-laden air under your house (see illustration below).

What needs to be done?

It’s possible that you already have air bricks just above ground level in your house; your first task is to check that they are unblocked, and to clear away any nearby plants or bushes that might make them less effective. Modern plastic air bricks can be added, and should be used to replace old air bricks in poor condition. Air bricks are needed in both sides of the house to ensure a flow of air.

If air bricks alone do not reduce indoor radon levels enough, a fan can be added at a cost of around £130. The noise it creates will be minimal, but since it runs day and night it is best sited away from bedrooms where you might be disturbed.

Systems that blow and systems that suck

For some houses blowing air is more appropriate than sucking, but it may bring disadvantages. Heat loss will be a little greater than with suction fans, and there is a danger that underfloor water pipes may freeze in winter. You can avoid this by lagging the water pipes.
Open flues and open fires

In some extreme cases, where houses have open-flued appliances or open fires and are very airtight, there is a risk that a suction fan could draw dangerous combustion gases back into the house. Further research is being carried out about this problem.

In the meanwhile, BRE recommend that you do not locate a suction fan beneath a room with an open-flued appliance or an open fire, and that you take care not to install an over-powerful fan. Again, when considering how powerful a fan you should install, be guided by BRE’s publications or hotline.

A sump for concrete-covered soil under suspended floors

If you have a suspended timber floor, and the soil below it is covered with concrete, you might prefer to put in a sump system to supplement your increased ventilation. (This will normally only be necessary if the indoor radon level is very high, or ventilation arrangements have not reduced the level enough.) If you are installing a sump system for concrete-covered soil under suspended floors, read the explanations and recommendations given for Choice A.

Sealing your suspended timber floor

Obviously, indoor radon levels will be reduced further still if you can do some sealing work on the suspended timber floor itself. Sealing the large holes and cracks only is safe and recommended, but entirely covering a timber floor with polyethylene or other waterproof preparations, or edge sealing, are not recommended – as sealing the timber increases the risk of dry rot and other forms of timber decay, which could have dangerous results.

Choice C – you can use positive ventilation in your house

This method which involves blowing air into the house, dilutes the radon entering the house and will help to reduce the amount of air sucked into the house from the ground. It is sometimes called ‘positive pressurisation’, but this raised internal air pressure only occurs in houses that are very airtight. In less airtight houses the system still has the useful effect of diluting radon-laden air with ordinary air and so reducing the indoor radon level. For an average house it is suitable if the indoor radon level is up to two or three times the Action Level, but not for higher levels.

The average cost of a system is around £500 – £600.

How does it work?

A specially-installed fan unit blows fresh air (or air from the loft space) into the house. Radon-laden air is diluted to safer levels, and radon entry is reduced.

What are the advantages and disadvantages?

The fans often have the advantage of reducing condensation problems at the same time as indoor radon levels. However, you might find an isolated cold draught near the fan, and have to pay slightly higher heating costs. Despite this many householders find the system acceptable and effective.

Choice D – you can seal cracks and gaps in solid concrete floors

This method reduces the amount of radon that passes through the floors, so that most of it passes safely into the outside atmosphere. If your indoor radon level is not far above the Action Level, it may well be right for you; but it usually needs to be combined with other methods. However, it is essential that all cracks are sealed. This will involve removing, for example, carpets and skirting boards. Sealing only say 90 per cent of cracks is likely to have very little effect on radon levels. It is suitable for use on solid concrete floors, but NOT on suspended timber floors, because it might make the timber rot, and the floor could collapse.

You might be able to complete the job yourself, in a few hours, for less than £25, but the expense and time involved depend on factors such as the condition of your floor, and whether you have to remove carpets, skirting boards and boxing around pipes.
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How does it work?
You use flexible watertight compounds (a polyurethane roofing paint or similar) to paint over small cracks, and flexible filler to seal larger cracks before you paint over them in the same way. The aim is to create an airtight seal over all the cracks, forming a barrier that prevents radon entry.

What needs to be done?
This depends on the type of floor you have and its condition.

• Floors in good condition
In most modern houses (and older properties in which floors have been replaced in recent years) solid concrete floors will be dry, free from visible cracks and settlement and in generally good condition. Where this is the case, you may only have to seal the edges between the walls and floors (although this may involve removing the skirting boards and boxing around pipes) and seal around the service entries – gas and water pipes, etc. Small cracks can be sealed with roofing paint (see illustration).

If your floor is in generally reasonable condition but has some larger cracks in it, you should clean them thoroughly, then repair them with a suitable flexible filler (not with a hard-setting filler – the floor crack might have been caused by slight seasonable movement, and your filler will need to adjust to future movement). Some paints and fillers may react with vinyl floor coverings.

• Floors in poor condition
In extreme cases where the main concrete base of your floor is badly cracked and in poor overall condition you may need to replace it. If you do this, you might like to take the simple and cheap precautionary measure of putting in a radon sump with a pipe routed to an external wall, during the floor replacement work. On completion of the works you will take the radon test again, and if your indoor radon level is not as low as you would like, you can easily install a fan to make use of the sump.

• Concrete raft floors
These are relatively rare, and you will need expert advice to be sure that you have a floor of this type. A concrete raft floor is a reinforced concrete slab that carries the entire structure. The slab has been thickened out with extra reinforcement below load-bearing walls. There should be few gaps between the underside of the slab and the inside of the house; sealing should only be necessary around service pipes or other openings, or construction joints.

• Suspended concrete floors
There is a variety of these floors; builders have been constructing them for some years now. The commonest form of suspended concrete floor has precast concrete beams supporting concrete blocks; it is often known as a ‘beam and block’ floor. Beneath the floor coverings it will be covered with either a cement/sand screed or chipboard flooring, and beneath this you might find a layer of thermal insulation and/or a damp-proof membrane.

If your floor has a screed, you can treat it as indicated in ‘Floors in good condition’ above. If it is covered in chipboard, seal the joints with tape or flexible sealant. Seal its perimeter edges only with flexible sealant; this will allow for expansion and contraction of the chipboard.

Choice E – you can change the way your house is ventilated
It must be stressed that this is the least effective system of reducing indoor radon levels, and so although it can be useful with other measures, or if your indoor radon level is very close to the Action Level, you should be very sure that it is right for you before relying on this method alone.
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How does it work?
Increasing the ventilation inside your house can bring about a small reduction in radon levels by diluting the radon-laden air.

What needs to be done?
These measures can help:

• install trickle ventilators into downstairs windows;
• cap off and seal unused chimneys; avoid use of open fires and solid fuel-effect open fires or provide additional through the wall ventilation;
• avoid continuous use of extractor fans in kitchens, bathrooms and WCs; and/or
• ensure loft hatches are sealed with draft strips and pull down catches.

Opening upstairs windows can increase your indoor radon levels; avoid doing so. Unfortunately, if you open downstairs windows and don’t use extractor fans for extended periods, you may suffer problems with cold draughts or lingering odours and even condensation. So the last two points are not strongly recommended. The items in the first point will have a small effect, and should only be used alone in houses that have indoor radon levels close to the Action Level.

Time for action
Now that you have read about the five choices, and understood how they work, how much they cost, and what levels of alterations they require, it’s time for you to think about which you want to use and take steps to get the work done. If you don’t know the radon level in your home and are worried, take the test. Remember that the Government, the HPA and the BRE all recommend that if your indoor radon levels are above the Action Level, you should take radon-reducing measures as soon as practical – and then take the test again to give yourself peace of mind.

If you are worried about costs, remember:

• many of the methods explained above are simple, and do-it-yourself-work can reduce costs enormously;
• the building societies have agreed in principle to provide loan finance for radon work, subject to the applicant’s status;
• if you cannot afford to pay for the work, it may be worth speaking to your local authority. Discretionary ‘house renovation’ grants may be available. The authority will assess your eligibility and will determine how much, if any, of the cost you will have to pay.

As well as the explanations and recommendations that apply to individual methods, there are three extra points you should consider:

Chimneys and heating
If you have chimneys you don’t use, it is better that you block them up: chimneys tend to draw air out of a room. If you decide to block a chimney permanently, you need to stop condensation from building up inside. Cap the stack with a chimney-pot hood and provide a small ventilation opening of about 50 x 20 mm in the blocked fireplace.

If you have an open-flued gas, coal or oil-fired heater, make sure that enough fresh air gets into the room from outside the house. Open coal or wood fires draw large volumes of air out of a room, even when the fire has a direct underfloor supply of air. If you can heat your room without an open fire, you should consider blocking up the chimney.

If you are planning to put in or renew a boiler or fire, ask your supplier to recommend a ‘balanced-flue, room-sealed’ type. This kind is helpful for people taking measures to reduce indoor radon levels, because the boiler or fire takes all the air it needs for combustion – and lets out the exhaust gases –
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through one metal grille in an outside wall, drawing no air from inside the house. If replacing your boiler you might have to change its location, in which case professional advice would be helpful.

Landfill gas

In the very rare cases where a house needing radon work is on or next to a landfill site or old coal mine, additional precautions may be needed to deal with methane that rises from the site. If you have any reason to think that this applies to your house, ring your local authority’s Environmental Health Department to check. If there is a problem, you will be able to get expert advice from BRE’s radon hotline.

Gaining approval for radon reduction measures

- If you own your home but have a mortgage you may need the lender’s permission before carrying out major changes to the house. Your lender will be able to tell you what the mortgage agreement says and you should check this before starting work.

- If you are a tenant you will need to discuss the work with your landlord before you start. You may be able to carry out some of the jobs yourself, but others, especially if they affect the buildings structure, might have to be carried out by the landlord.

- Planning permission or Building Regulations approval are not usually necessary for small radon reduction jobs (unless you are making bigger changes at the same time). Your local council’s Building Control Officer can give you the advice you need. However, if your house is a listed building, or in a designated area of outstanding natural beauty, a national park or a conservation area, you may need permission for any work that alters its external appearance. Check with the Planning Department of your local council.

Further information

Having read this booklet, you may well have further questions.

Defra can answer most of these questions. The other organisations listed here can provide more detailed information of the radon problem.

To contact Defra

Radioactive Substances Division
Defra
Zone 4/F7
Ashdown House
123 Victoria Street
London SW1E 6DE
Web: www.defra.gov.uk/environment/radioactivity/radon

Defra has several publications including:

Radon: you can test for it
(Publication code PB10438)

Radon – a householders guide
(Publication code PB9442)

Radon – a guide for homebuyers & sellers (Publication code PB10439)

You can get free copies of the publications by contacting:

Defra Publications
Admail 6000
London
SW1A 2XX
Tel: 0845 955 6000
Fax: 020 8957 5012
e-mail: defra@iforcegroup.com

HPA can provide an information pack on radon in the home, with advice about radon, its health risks, and details of how to order the test.

HPA offer a range of leaflets, reports and a video on radon matters. Single copies of many leaflets are free. The reports and video are on sale at prices between £2 and £20.

To contact HPA:
HPA
Radiation Protection Division
Chilton
Didcot
Oxon OX11 0RQ
Radon Freephone:0800 614529
Web: www.hpa.org.uk/radiation/radon/index
BRE can provide practical and effective advice about construction work to reduce radon levels. They also publish a range of easy to follow guides, (see below) and a video, for builders and householders on how to tackle radon levels in existing homes.

To contact BRE
Radon Advice
Building Research Establishment Ltd
Garston
Watford WD2 7JR
Web: www.bre.co.uk/radon

More information about the guides and the video are available from:

Construction Research Communication Ltd
151 Rosebery Avenue
London EC1R 4QX
Tel: 020 7505 6622
Fax: 020 7505 6606
e-mail: enquiries@bre.co.uk
Web: www.brebookshop.com

The following professional organisations unite and regulate members practising their respective trades:

Builders Federation of Master Builder
Gordon Fisher House
14/15 Great James Street
London WC1N 3DP
Tel: 020 7242 7583
Fax: 020 7242 0296
e-mail: central@fmb.org.uk
Web: www.fmb.org.uk

The Construction Confederation
56-64 Leonard Street
London EC2A 4JX
Tel: 020 7608 5000
Fax: 020 7608 5001
e-mail: enquiries@mecc.org.uk
Web: www.constructionconfederation.co.uk

Architects Royal Institute of British Architects
66 Portland Place
London W1N 4AD
Tel: 0906 302 0400
e-mail: info@inst.riba.org
Web: www.riba.org

Quantity Surveyors Royal Institution of Chartered Surveyors
Contact Centre
Surveyor Court
Westwood Way
Coventry CV4 8JE
Tel: 0870 333 1600
e-mail: contactrics@mis.org
Web: www.rics.org

For a list of companies experienced in radon reduction work, and for details of companies who can offer short term tests, contact the independent voluntary regulatory body:
The Radon Council Ltd
PO Box 39
Shepperton
Middlesex TW17 8AD
Tel: 01932 221 212
Fax: 01932 229 779
e-mail: radoncouncil@radon-uk.demon.co.uk
Web: www.radonhotline.org

The information in this booklet applies to England. Readers in Northern Ireland, Scotland, and Wales should write to:
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Northern Ireland
Northern Ireland Assembly
Environment and Heritage Service
Calvert House
23 Castle Place
Belfast BT1 1FY
Tel: 02890 254 709
Fax: 02890 254 700
e-mail: ipri@doeni.gov.uk
Web: www.ehsni.gov.uk

Scotland Scottish Executive
Housing 2
First Floor East
Victoria Quay
Edinburgh EH6 6QQ
Web: www.scotland.gov.uk

Wales Environmental
Science Advisor
National Assembly for Wales
Cathays Park
Cardiff CF10 3NQ
Tel: 029 2082 3178
Fax: 029 2082 5008
Web: www.wales.gov.uk

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