POTENTIAL SUPPLIERS OF RADON SUMP EXTRACT FANS

#10208

Some companies listed may not yet be able to supply suitable equipment and there are bound to be other companies which do not appear on the list. The companies listed must not be regarded or referred to as recommended suppliers. The Building Research Establishment cannot accept any responsibility for matters arising from use of this list.

The list is in alphabetical order by company name. Any company which claims to sell suitable equipment may contact the radon team at BRE (Mr M J Woolliscroft, Environmental Physics Division) and ask to be put on this list.

Air Control Environmental Services, Manufacturing, No 6 Chapman Road, Canvey Island, Essex, SS8 7QS
Tel: 0268-510184

Airflow Developments Ltd, Cressex Industrial Estate, Lancaster Road, High Wycombe, Buckinghamshire, HP12 3QP
Tel: 0494-25252/443821 Fax: 0494-461073

APV Vent-Axia Ltd, Fleming Way, Crawley, West Sussex, RH10 2NN
Tel: 0293-526062 Fax: 0293-560257

Kiloheat Ltd, Enterprise Way, Edenbridge, Kent, TN8 6HF
Tel: 0732-866000 Fax: 0732-866370

Metrico Industrial Fans Ltd, Andrews House, 7 Portland Place, Stalybridge, Cheshire, SK15 3AD
Tel: 061-303-8391 Fax: 061-303-2830

Novenco Aerex Ltd, Engart Products, Hirwaun Industrial Estate, Aberdare, Mid-Glamorgan, CF44 9YA
Tel: 0685-811811

Radial and Axial (Fans) Ltd, Radial House, Coldharbour Lane, Harpenden, Hertfordshire, AL5 4UN
Tel: 0582-460624 Fax: 0582-460629

Roof Units Group Ltd, Peartree House, Peartree Lane, Dudley, West Midlands, DY2 0QU
Tel: 0384-74062 Fax: 0384-70435

Woods of Colchester Ltd, Tufnell Way, Colchester, Essex, CO4 5AR
Tel: 0206-44122 Fax: 0206-574434

There are many more fan manufacturers, wholesalers and local distributors around the country — see Yellow Pages, H and V buyers guides, etc, for details of these. Trade associations may also be able to help — details of these can often be found in main libraries.

Building Research Establishment
November 1991

Building Research Establishment Report

Radon sumps:
a BRE guide to radon remedial measures in existing dwellings

Building Research Establishment
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Watford
WD2 7JR

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CONTENTS

INTRODUCTION

This report is one of a series giving practical advice on methods of reducing radon levels in existing dwellings. It deals specifically with the radon 'sump', a device for creating a low pressure beneath solid floors or oversite concrete. Other guidance is available in *The householders' guide to radon*[1] obtainable from Environmental Health Officers or direct from the Department of the Environment.

This report has been prepared on the basis of the experience gained so far. Work is continuing, and the results will be incorporated into revisions of this report as they become available.

What is radon?

Radon is a colourless, odourless radioactive gas. It 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 but not exclusively so. 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 dwellings, can reach relatively high concentrations in some circumstances.

The floors and walls of dwellings contain a multiplicity of small cracks and holes (Figure 1) arising during construction and due to, for example, service entries. The air pressure in a dwelling is slightly lower than that outside because of the heating of the dwelling and the effect of the wind. The fact that the air pressure in the soil is higher than that in the dwelling causes radon-laden air to flow through the cracks and holes from the ground into the dwelling.

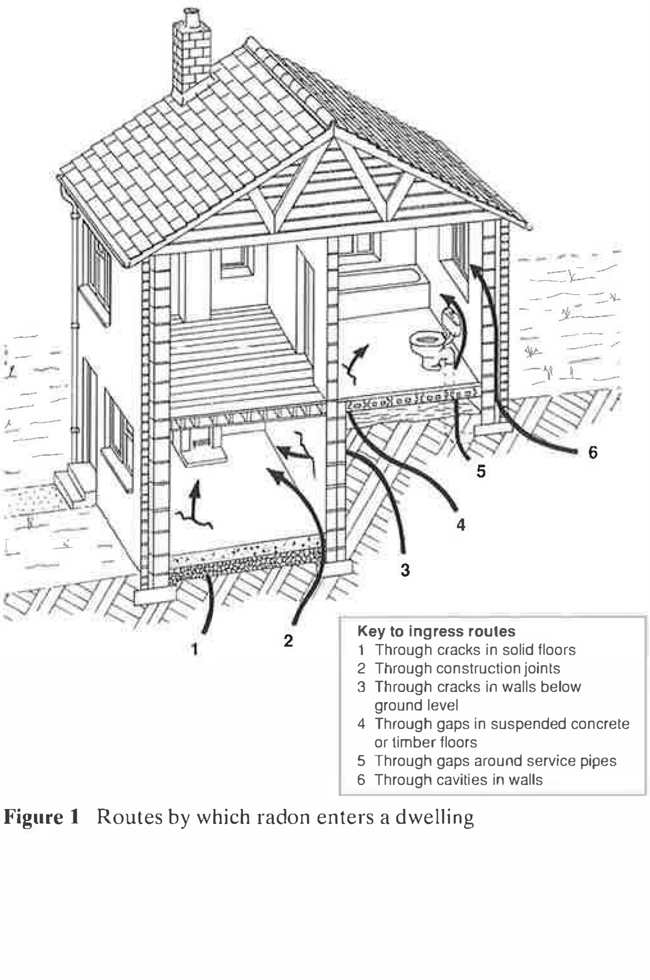

Figure 1 Routes by which radon enters a dwelling

What is a radon sump?

The purpose of the radon sump is to reverse the air pressure between the soil and the dwelling and to stop the radon-laden air from entering the dwelling. The radon sump is essentially a hole in the ground with a suitable fan connected to it sucking from the hole and thus producing a negative pressure in the hole. This negative pressure spreads through the pore spaces in the material under the floor. The more permeable this material, the more effective the sump. The effect of a radon sump is shown in Figure 2.

The standard sump is shown in Figure 3. It consists of a paving slab 600 mm × 600 mm with a few rows of

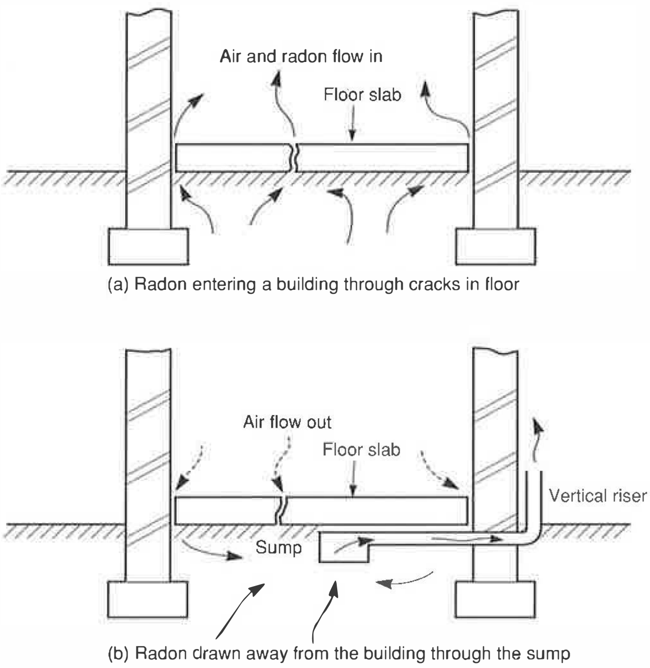

Figure 2 The effect of a radon sump

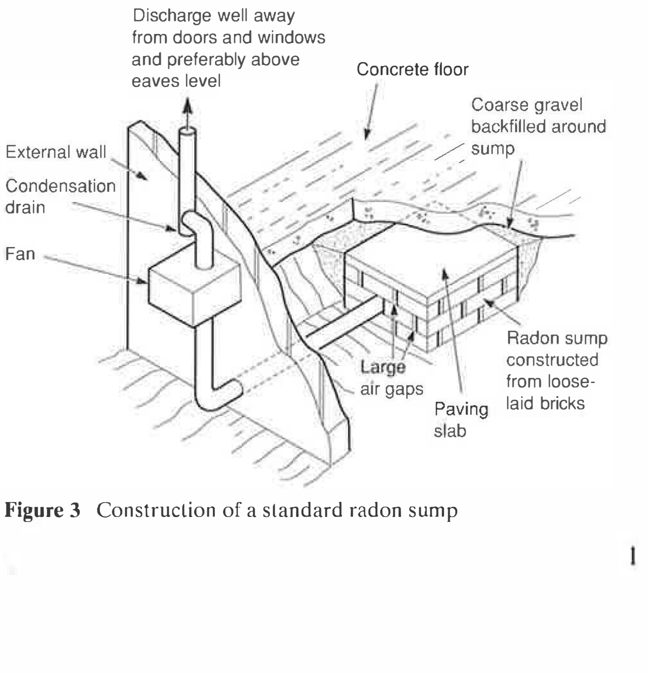

Figure 3 Construction of a standard radon sump

bricks below with air gaps left between the bricks. The purpose of this open brick box is to prevent the suction pipe getting blocked and also to spread the pressure field. As an alternative to the standard sump a plastic box with holes in it may be used (Figure 4). In some cases, particularly the small family dwelling with a concrete floor and a permeable layer of, for example, hardcore underneath, it may be sufficient to make a hole for the extract pipe, clearing out a space of about 200 mm radius around it to form the sump. This is often known as a mini-sump (Figure 5).

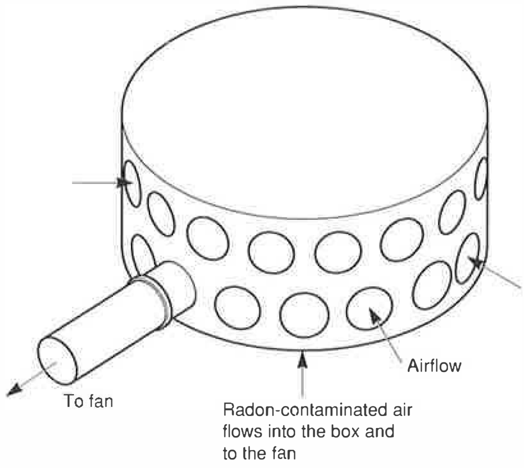

Figure 4 Plastic box sump

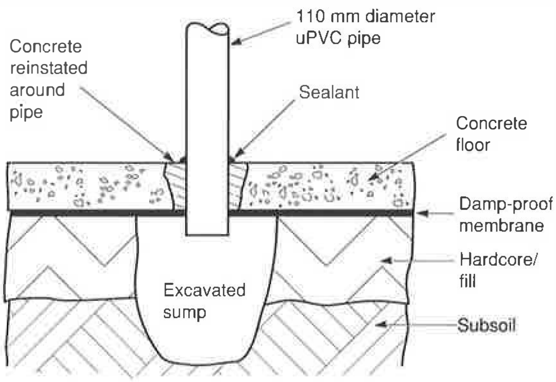

Figure 5 The mini-sump

TECHNICAL DETAILS AND INSTALLATION OF SUMPS

This section gives detailed guidance to builders on the design and installation of a radon sump, including the choice of the most suitable type of sump, problems likely to be encountered in breaking through floors, the routing of pipework and the choice and positioning of fans. Guidance is also given on the likely effectiveness of a sump.

The choice of sump and where to place it

Sumps may be categorised as:
- Internal with internal pipework
- Internal with external pipework
- Externally excavated
- External

They are illustrated in Figures 6 to 9.

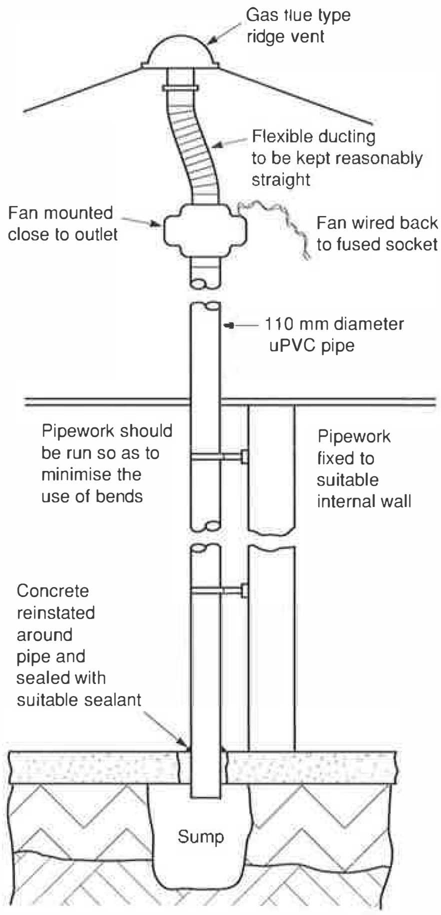

Figure 6 The internal sump with internal pipework

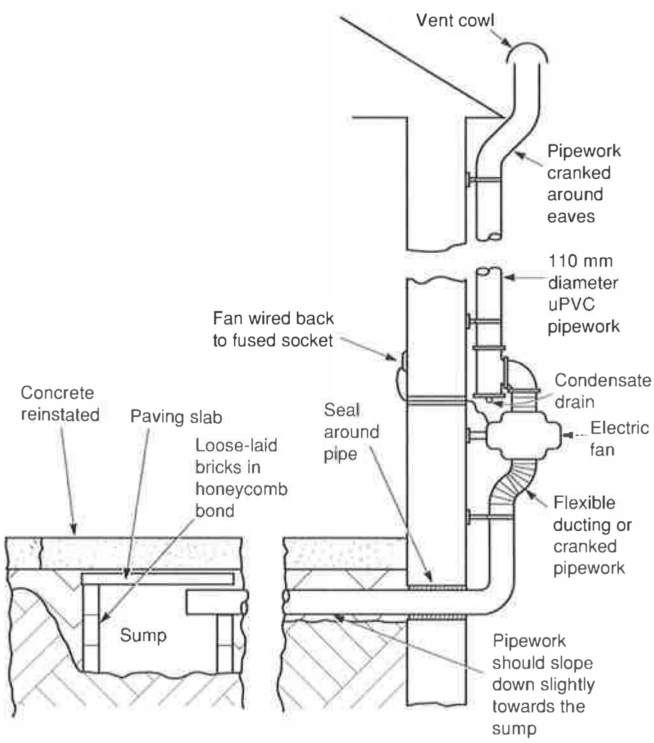

Figure 7 The internal sump with external pipework

Clearly an internal sump will generally be more effective than an external sump but there is often appreciable disruption to the dwelling during the installation. Dust and dirt will be produced and it may often be difficult to find a suitable route for the pipe through the dwelling.

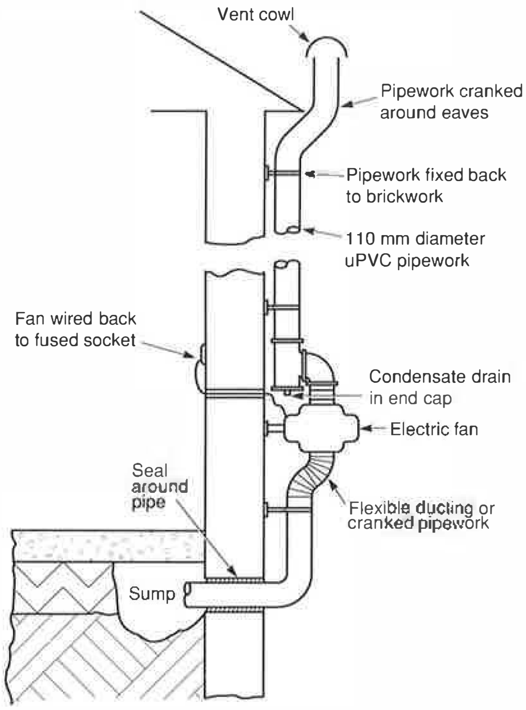

Figure 8 The externally excavated sump

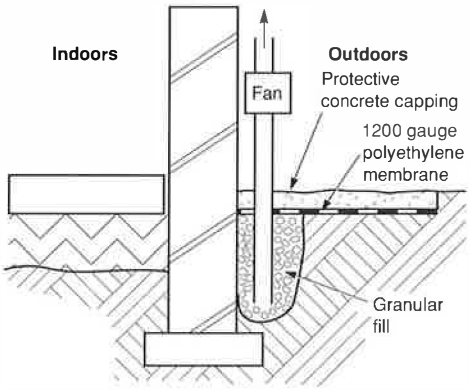

Figure 9 The external sump

A sump placed centrally under the dwelling will give the greatest effective area of depressurisation but convenience, economics and aesthetics will determine the precise positioning of the sump and its associated pipework. For a typical dwelling a single sump will probably be sufficient. Where clean, permeable fill has been used beneath the floor a single sump is likely to have an influence over an area of approximately 250 m^2, or for a distance of up to 15 m from the sump. However, obstructions below the floor slab may reduce effectiveness and more sumps or a larger fan may be required. If the under-floor area comprises several compartments then a sump may be required for each compartment (Figure 10). These may be connected to a manifold and a single fan. However in most cases there is no need to establish a manifold of pipes. A single sump located against a separating wall with a few bricks removed to allow communication between compartments will suffice (see Figure 10(c)).

For a small, single, family dwelling an externally excavated sump under the dwelling may be the best solution (see Figure 8), the whole dwelling being

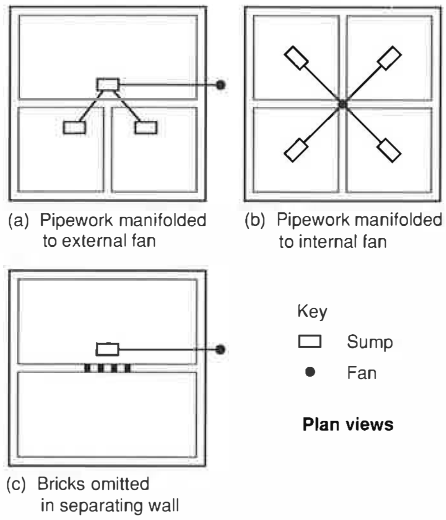

Figure 10 Location of sumps within multi-compartment subfloor areas

comfortably within the 250 m^2 area or 15 m direct run limits. As shown in Figures 8 and 9, it is essential with an externally excavated sump or an external sump to prevent air being drawn down directly from the atmosphere or elsewhere (eg the wall cavity) into the sump rather than coming from under the dwelling. With the externally excavated sump this is done by running the pipe to a sump excavated under the dwelling and sealing the pipe at the foundation, as shown in Figure 11. Where the cavity below the damp-proof course is not filled, the cavity local to the hole should be sealed (eg with polyurethane foam) before fitting the pipe (see Figure 11). With the external sump, air will be prevented from being drawn down directly into the sump by providing a concrete area of about 5–10 m^2 with a membrane underneath, as shown in Figure 9.

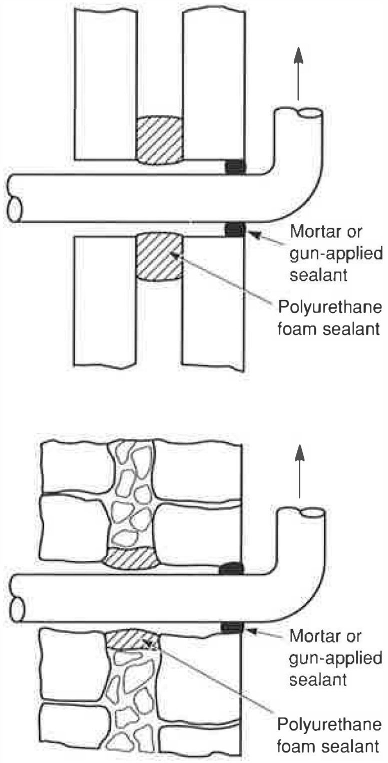

Figure 11 Sealing an externally excavated pump

Condensation within the pipework, particularly external pipework, may adversely affect the operation of the fan. The fitting of a drain, such as that shown in Figures 7 and 8, is recommended in order to make it possible to drain off condensate continuously. When draining condensate from an internal system the drain must be led to outdoors.

Sumps and solid floor construction

Before any radon sump is specified or built, the type of floor construction must be identified. The basic element found in most post-war dwellings will be a concrete slab of at least 100 mm thickness. This will commonly, but not always, be covered by a cement/sand screed. The usual thickness of the screed will be between 35 and 60 mm. Usually there will be a damp-proof membrane (dpm) either beneath the concrete, in which case it will almost certainly be polyethylene, or between the concrete and screed (sandwich construction), when it may be a hot-applied bitumen, a bitumen solution, a tar/rubber emulsion or occasionally polyethylene. Sometimes the base concrete or screed will be covered directly by other floorings like ceramic tiles, magnesite, wood blocks, mastic asphalt and, in recent construction, chipboard floating on expanded polystyrene.

In dwellings with good solid floors where the base concrete is at least 75 mm thick the 'mini-sump' may be used (Figure 5). There may be a few problems removing or cutting through floorings before breaking open the concrete base to form a hole. Ceramic tiles and wood blocks should be removed, and mastic asphalt should be warmed before breaking open, otherwise substantial cracking may occur. Care should be taken when breaking through concrete floors in case steel reinforcement is present. Where the floor is laid directly on the ground cutting through reinforcement is not likely to be detrimental. Where floors are suspended, cutting the reinforcement should be avoided, particularly in beams where it should never be cut.

If the floor is suspended there is no need to construct a sump because the sub-floor void is, in effect, a single large sump. The extract pipe system can simply be sealed into the floor slab in the usual way.

With older properties a variety of 'solid' floor constructions may be met. Where concrete bases of reasonable quality and at least 75 mm thick are encountered then mini-sumps, as previously described, can be installed. If the base is less than 75 mm thick or of poor quality, then the mini-sump should not be used, in case the floor collapses into the sump void; the standard sump should be used instead.

Floors may be found where wood blocks are stuck with hot pitch to a thin mortar layer directly overlying hardcore and, of course, there are many examples of stone slab floorings laid direct to earth. With such floors it is better to make a large hole in the floor, construct a 'standard sump' with bricks and paving slab (Figure 3) and reinstate the floor with concrete 100 mm thick.

Care should be taken when breaking the concrete floor to avoid damaging any concealed services, eg electricity cables, water mains, central heating pipes and gas and oil supply pipes. The hole in the floor should be just large enough for the extract pipe to fit (normally 110 mm diameter) or to allow the construction of a brick-built sump (normally approximately 700 mm square) as appropriate. In the latter case the reinstatement should include some kind of damp-proof protection.

When reinstating the concrete floor take care to make a good joint between the old and new concrete and between the new concrete and the extract pipe. Some form of shuttering will be required at the level of the bottom of the concrete base to prevent the new concrete filling the sump and blocking the pipe inlet. It is difficult to prevent wet concrete mixes by-passing the shuttering. The use of a semi-dry concrete mix containing screeding sand is preferred. Where a dpm has been broken through it should be reinstated. If it is not reinstated then it is effectively by-passed. In the case of the mini-sump where the dpm is below the slab it is not necessary to repair the dpm because the dpm is not by-passed by moisture. Finally, after the concrete has set, the joint between the new concrete and the pipe can be sealed with a gun-applied sealant to prevent air leakage.

The routing of pipework

Typically, the pipework can be 110 mm diameter uPVC (unplasticised polyvinylchloride) pipe as used for domestic soil and vent pipes. For a system with an externally mounted fan, it would be best to locate the pipework at the rear of the dwelling or at a re-entrant corner where subsequent installation of a boxed-in fan and pipework will be least obtrusive. Where the system is such that the fan is located inside the dwelling, the pipework will need to be routed so that it can be supported on a wall. Consideration will also need to be given to putting pipework where it will be least obtrusive, eg inside storey-height cupboards, or boxed-in in the corner of a room. Care will be needed in positioning the pipe to avoid ceiling joists and any services such as water storage tanks in the roof space.

Horizontal pipework should always slope down towards the sump to provide drainage should any condensation form within the pipework.

Positioning the fan and outlet

The fan should be positioned with the outlet well away from windows, doors and ventilation grilles, ideally discharging just above eaves level or through a gable wall, or through a ridge-mounted terminal. The system **should never** discharge into a roof space. With internal systems the fan should always be placed as close to the outlet as practical so that the pipework is always under suction. This is of particular importance when routing pipework inside the dwelling as even slight leaks could increase indoor radon levels. With external sumps, since the whole installation is outside the dwelling, it is not necessary to site the fan near the terminal. Fans should be adequately supported.

Noise may be more noticeable in ground-floor rooms if the fan is located at low level and ideally fans should not be located directly above bedrooms.

Choice of fans

The specification for a fan suitable for the operation of a radon sump is given in the Appendix. The fan is used as a pressure rather than a flow device, so it is essential that it has a 'non-stalling characteristic', ie the pressure should always rise as the air flow rate reduces. Thus generally only centrifugal fans will be suitable.

A fan of around 75 watts power input is generally used, although smaller units of around 30 watts have been used successfully, and it may well be necessary to use larger fans for larger buildings.

Some protection of the fan and pipe may be desirable to prevent mechanical damage and in some cases to provide weather protection, particularly in exposed sites.

Checking system performance

The permeability of the fill (or sometimes the soil) under the slab is obviously important in the operation of a sump. If the fill (or soil) has too low a permeability then the area of operation of the sump will be restricted. A satisfactory subfloor pressure measurement in the building near an extremity will give added confidence that the sump will work successfully. A subfloor pressure reading of more than 10 pascals measured under the floor at a point most distant from the sump will generally indicate that the sump is operating satisfactorily. In the case of large buildings, ie more than a single family dwelling, then this measurement is highly desirable.

After the installation of a sump, testing of the radon levels in the dwelling should be carried out for a further 3 months using detectors supplied by the National Radiological Protection Board or any NRPB-validated laboratory. If the indoor radon level is still above the action level, further advice should be sought.

New extensions

If a dwelling to be extended is in a radon-affected area (as defined in reference 2), it is advisable that radon-protective measures be incorporated in the new work. For a dwelling which already has radon-protective measures the extension should include full protective measures. For an unprotected dwelling the extension should be constructed in a way that will not cause an increase in radon concentrations in that dwelling. Consideration should be given to linking the radon-proof barrier in the new floor to the damp-proof course or to the radon-proof barrier in the existing building. A radon sump should be installed beneath the extension floor alongside the existing part of the dwelling[2].

Spillage risk

In some extreme cases, where houses are airtight and have open-flued appliances or open fires, there is a risk that a sump could draw flue gases back into the house. It is obviously vital that this should not happen.

Further research is being carried out in this area. Meanwhile, BRE recommends that you avoid locating a sump beneath a room with an open-flued appliance or an open fire, and you should ensure that the sump fan you install is not oversized[3]. For further advice, telephone the BRE Radon Hotline (0923 664707).

LANDFILL GAS

Although very rare, there may be cases where the building being altered is located on or adjacent to a landfill site. In such cases additional precautions may be needed to deal with methane. It is advisable therefore to contact the local authority environmental health department, before starting work, to establish whether the property is adjacent to a landfill site. If there is a problem, further advice can be obtained by ringing the BRE Radon Hotline (0923 664707).

ACKNOWLEDGEMENTS

The Building Research Establishment wishes to thank the many householders and others who have assisted in the research on which this report is based.

Special thanks also go to Mr T J Gregory of Cornwall County Council for allowing us access to, and measurement results from, many County Council properties.

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2 **Building Research Establishment.** *Radon: guidance on protective measures for new dwellings.* BRE Report. Garston, BRE, 1991.

3 **Building Research Establishment.** Radon and buildings: 1. Spillage of combustion products. *BRE Leaflet* XL8. Garston, BRE, 1994.

FURTHER READING

Building Research Establishment. Radon and buildings: 2. Minimising noise from fan-assisted radon sump systems. *BRE Leaflet* XL9. Garston, BRE, 1994.

Building Research Establishment. Radon and buildings: 3. Protecting new extensions and conservatories. *BRE Leaflet* XL10. Garston, BRE, 1994.

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APPENDIX

SPECIFICATION FOR FANS TO BE USED FOR RADON SUMP AND SUB-FLOOR EXTRACT SYSTEMS IN DWELLINGS AND OTHER SMALL BUILDINGS

Fans

Experience at BRE with fans used for radon sump and sub-floor extract systems is mostly limited to one particular style of fan but there is no reason, in principle, why other types of fan with similar performance should not be used. The specification at the time of writing (November 1991) should be as follows.

The fan should have a non-stalling pressure/flow rate characteristic, ie the pressure difference across the fan should always rise as air flow rate through the fan reduces. Thus only centrifugal-type fans are normally suitable (note that some 'in-line duct fans' have centrifugal impellers but the casing can make them look like axial fans). The point on the fan characteristic curve at which the fan will operate in service cannot be predicted at present. The fan should therefore have a non-overloading characteristic, ie the fan motor should be capable of operating the fan continuously at any point on the characteristic curve from zero flow to free delivery.

The required fan characteristic curve is not easy to specify because some radon-extract systems which are not fully effective can be made so by using a fan of greater air flow/pressure performance. Successful systems used in dwellings and small school buildings have used a fan with a similar characteristic to that given below. As interim guidance, this may be regarded as a minimum performance. Routine use of higher performance is not recommended because of consequent increases in noise and running costs, but may be required in large or difficult buildings.

Flow rate (m^3/h):	400	350	300	225	175	100	0
Pressure difference (Pa; static):	0	50	100	150	200	250	300

A fan with this performance may be expected to have a power consumption of up to about 75 watts. The power consumption of a given fan is unlikely to vary much with air flow rate but may be slightly less at lower flow rates for some designs of fan.

To prevent the escape of radon-bearing air into the building, a fan intended to be fitted anywhere inside the building (including a garage, cupboard or roof space) should have an airtight casing. This is particularly important on the discharge side of the impeller which will usually be at a higher pressure than the surroundings. Casings assembled from sheet metal pressings should have all joints sealed or taped because sliding/push fits alone are unlikely to be airtight. The duct connecting spigots/flanges should be so designed that the duct connection can be made airtight with ease.

The fan should be suitable for operation with air at temperatures between –5°C and +30°C and with relative humidity up to 95%. The fan must be designed in such a way that condensation run-off from the duct system cannot collect in the fan casing in sufficient quantity to affect the fan performance or safety (including perforation of the fan casing due to corrosion). Note that fans are not normally fitted in horizontal parts of the duct system.

The fan should be of 'maintenance free' design. This would normally mean that the fan motor and impeller bearings are of the 'sealed for life' type. Fan manufacturers are often reluctant to give an expected service life for small fans because they have no control over the operating conditions and environment. There is therefore no benefit in this specification quoting a required service life. However, the fan should clearly be of good quality design and manufacture and should be expected to run continuously without attention for many years.

Fan connections to duct system

It should be remembered that the fan inlet will require airtight connection to a duct system. The most commonly used duct materials are 110 mm and 160 mm diameter plastic soil/drain pipes, but other pipes/ducts can be used. Conversions from the duct size and shape to the fan inlet and outlet size and shape may be required. Because of the variety of duct system materials which can be used the fan inlet and outlet dimensions do not form a part of the above specification.

Suppliers of radon sump extract fans

See Yellow Pages, H and V buyers guides, etc, for details of fan manufacturers, wholesalers and local distributors. Trade associations may also be able to help — their details can often be found in main libraries. A non-comprehensive list of potential suppliers can be obtained from BRE.

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