GOOD REPAIR GUIDE GRG 37 Part 2

RADON SOLUTIONS IN HOMES

Positive house ventilation

Chris Scivyer

This Good Repair Guide offers guidance to builders and homeowners installing positive ventilation systems in homes. When controlled ventilation is provided to a house, indoor radon levels can be reduced and at the same time the indoor environment can be improved by reducing condensation, mould, stuffiness and stale odours. Advice is also given on system maintenance and what to do if a system fails to adequately reduce radon levels.

This Good Repair Guide is Part 2 in a 3-Part set and replaces the guidance given in BRE Report BR 281. Part 1 covers underfloor ventilation and Part 3 covers radon sump systems.

BACKGROUND

Radon

Radon is a naturally occurring radioactive gas that is present in all buildings. Prolonged exposure to high levels causes lung cancer. The Health Protection Agency (HPA) recommends that householders with concentrations above the action level (200 Bq m^{-3}) should reduce their radon concentrations as far as they can and ideally to below the target level (100 Bq m^{-3}).

What is positive ventilation?

Positive ventilation systems blow fresh filtered air into a property. Most systems comprise a fan unit located in the roof space (Figure 1). The air usually enters through a diffuser in the ceiling of the hallway or at the top of a stairway. The fan units should run continuously to effectively reduce radon concentrations. For properties without a roof space, such as flats and apartments, wall-mounted units are available (Figure 2).

Figure 1: Roof-located positive ventilation system

Figure 2: Wall-mounted positive ventilation system

Where can positive ventilation systems be used?

Positive ventilation systems are one of the least disruptive radon remedial measures to install. The systems are likely to work best:

- in average sized 3- to 4-bedroom bungalows and houses. For the purposes of this guide an average sized property is assumed to have an approximate volume of about 250 m^3
- where radon levels are less than 500 Bq m^{-3}
- with any floor types, even mixed solid and suspended floors
- in relatively airtight properties.

Positive ventilation systems may be used at the same time as other remedial systems to increase the efficiency of radon reduction.

Airtightness in a property

Positive ventilation is likely to work well in a fairly airtight property, but it is difficult to determine the extent of airtightness. Reliable tests are available but are expensive compared with the cost of a positive pressurisation system. The following situations would indicate that a building is relatively airtight:

- there are signs of condensation and mould in the building
- the householder uses a dehumidifier
- clothes and other items stored in cupboards are musty
- odours linger rather than disperse
- the occupants are not aware of cold draughts.

Positive ventilation systems were first developed to overcome problems with condensation and mould, both of which occur where there is a lack of heat or ventilation. These systems provide multiple benefits to householders: a fresher indoor environment, reduced condensation and a reduction in radon levels.

Draughty houses

If a property suffers from draughts through doors, windows or suspended timber ground floors, positive ventilation is likely to be more effective if draught-proofing works are carried out at the same time. Unused chimneys should also be closed off. This is to stop warm air from escaping outside, which also increases the suction on the ground floor and radon entry from the ground.

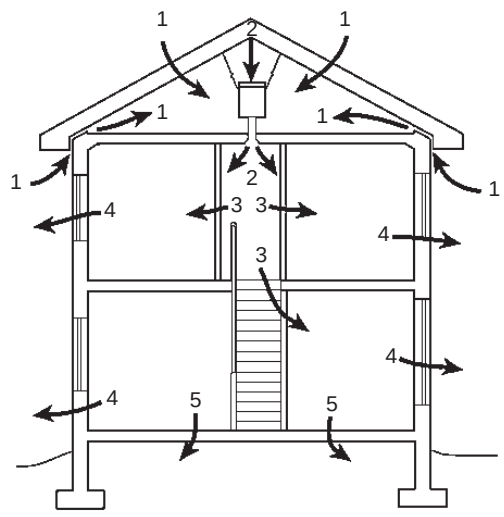


Figure 3: How positive ventilation works

Properties with no central heating

BRE does not recommend installing a positive ventilation system in a house that is not centrally heated. When local heating is used, the hallway and stairwell are often cold. Blowing air into these areas, particularly in winter, will result in them becoming colder.

How does a positive ventilation system work?

Radon reduction is achieved by a combination of whole-house positive ventilation and dilution of radon gas that enters the building (Figure 3). A fan unit, usually located within the roof space, is used to gently blow filtered fresh air into the property so that the pressure difference between the building and the underlying ground is reversed. This might be possible in an airtight building where the fan increases the indoor pressure, therefore reducing the entry of radon through the floor. In reality, the amount of positive pressure attained is uncertain and even if radon enters the building it is diluted.

Pressures generated using positive ventilation systems are small, typically between 0.2 Pa and 5.0 Pa. Occupants will not be aware of this pressure effect.

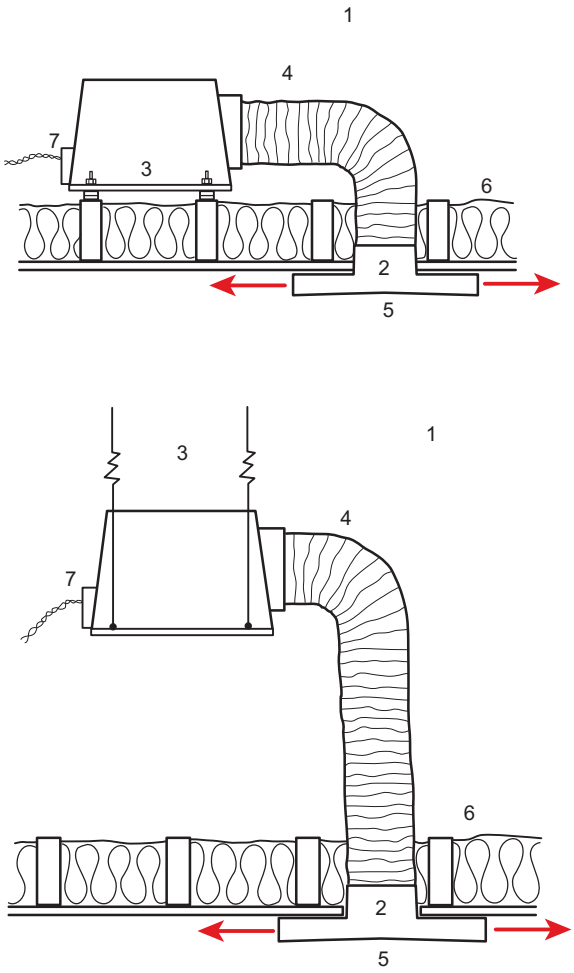
GUIDANCE ON INSTALLING POSITIVE VENTILATION SYSTEMS

Specification for installing positive ventilation systems

Figure 4 provides a technical worksheet for installing roof-located positive ventilation systems. For installation details for wall-mounted systems check the manufacturer's instructions.

A typical positive ventilation system comprises a fan connected to a ceiling diffuser by flexible ducting. Some systems are fitted with a small heater to slightly warm the air passing into the dwelling (Figure 5). Most incorporate thermostatic controls for temperature regulation. The unit must run continuously, day and night. However, some systems include thermostatic controls that shut the fan down in very cold weather conditions; the system will not reduce radon levels during these exceptional circumstances. However, this will have little adverse effect on the annual average radon level for the house.

Fresh air enters the roof space from outside (1). It passes through the fan unit (2), and disperses through the dwelling (3). Some air escapes to outside through leakage all over the structure (4). Some air is forced through the floor, stopping radon entry (5).



Select an appropriate location within the property to site the positive ventilation unit – typically above a hallway in a bungalow or above the stairwell in a house.

1 Check that the roof space has adequate ventilation from outdoors.
2 Cut a hole through the ceiling of sufficient size to accept the ducting and ceiling diffuser (typically 200 mm diameter but check the system you have purchased).
3 Mount the fan unit on vibration-reducing mounts fixed to the ceiling joists, or support the fan unit on hangers from the rafters.
4 Connect the ducting to the fan unit.
5 Connect the ceiling diffuser to the ducting and fix it to the ceiling.
6 Reinstate any insulation disturbed around the diffuser.
7 Wire the fan back to a fused spur or lighting circuit according to the manufacturer's instructions.

Figure 4: Worksheet for installing a roof-located positive ventilation system

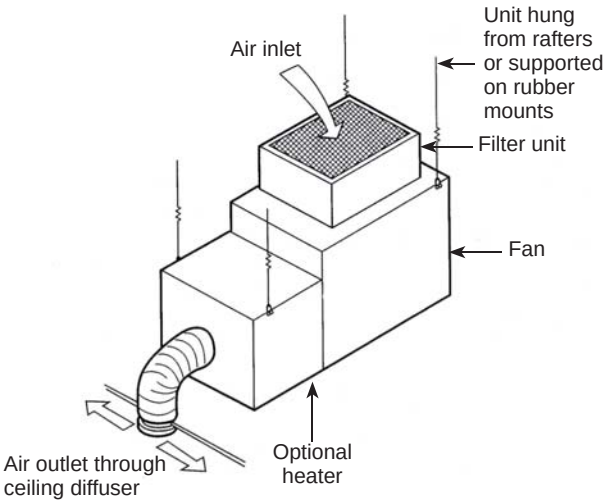


Figure 5: Typical features of a positive ventilation system

Fans

The fans are usually extremely quiet running, but potential noise problems are minimised by using vibration-reducing mounts.

Fan unit size

For an average sized property a single unit should be adequate. The unit should generally supply air at a rate of between 0.5 and 1.0 air change per hour. For example, if the total volume of the house is 250 m^3 the fan air flow rate should be between 125 m^3/h and 250 m^3/h. Greater air flows are not recommended because of greater heat loss and possible draughts.

Typically, fan units have a high-efficiency, long-life-expectancy, brushless D.C. motor. These are cheap to run, costing only a few pence per day. The actual cost will depend upon the particular product selected, the size of the property and the speed setting on which the unit runs. Manufacturers typically quote the energy consumption ranging from 1.5 W to about 18 W, depending on the setting used. A heater will further increase the running costs.

Filters

To ensure clean air is blown into the home the air intake will be fitted with a filter. Suitable filters can be used to remove allergens such as dust and pollen. Filters will need to be cleaned or replaced from time to time; refer to the manufacturer's instructions.

Installing systems

Positive ventilation systems are usually provided as a kit that is easily assembled and installed by any person familiar with basic DIY.

Roof-located systems (Figure 6) vary in physical size but typically the main unit is a box approximately 300 mm × 400 mm on plan × 400 mm in height. In some cases the box will include the fan, filters and a heater as a complete system; alternatively, the filters and heater might be attached to the box separately.

Consider the following:

- the flexible ducting that connects the fan to the diffuser should be kept as short as possible and not be crushed
- the unit will need to be wired back to a fused spur. Fans should be wired in accordance with BS 7671:2008, as amended[1]
- ensure there is enough space in the loft for the fan unit to avoid fixtures and fittings, water pipes, water tanks, flues and structural members in the roof space.

Ventilation supply

For the system to work effectively, there should be an adequate supply of fresh air to the space where the unit is housed (normally the roof space). For most homes this will not be a problem as the roof space will be sufficiently ventilated to outside.

Consider the following:

- vents into the roof space should be checked and cleared
- additional vents may be required.

If the roof space is not well ventilated, radon concentrations in the space may increase as radon can enter the roof space through cavity walls or boxed-in service pipes (eg soil pipes).

Diffusers

The location of ceiling diffusers (Figures 7 and 8) should be considered carefully to avoid potential problems with cold draughts and noise.

Consider the following:

- if possible locate the diffuser 1 m or more from a wall to avoid draughts (although this is not always possible)
- the edge of the diffuser outlet that is close to a wall can be closed (some manufacturers provide components for this purpose, alternatively use tape)
- avoid locating a diffuser next to a smoke detector so that air flow from the system will not blow smoke away from the smoke detector. Alternatively reposition the smoke detector away from the diffuser.

Figure 6: Examples of roof-located positive ventilation systems

Figure 7: Examples of ceiling diffusers

Figure 8: A ceiling diffuser located in a stairwell in a house or hallway in a bungalow

Heaters

Many manufacturers of positive ventilation systems include a small heater or can provide an optional heater to preheat air passing into the dwelling. BRE recommends that a heater be fitted for occupant comfort, particularly in winter. Heaters are either thermostatically controlled to switch on when the temperature falls below about 12°C or controlled by a switch in the dwelling, and not intended to run continuously. Although a heater will increase running costs, modern energy-efficient heaters use very little energy.

Avoiding odours

Occasionally, when the fan is operating there may be smells of tar or chimney smoke:

- the smell of tar is caused in some dwellings by the release of vapours from bituminous felts (often used under the roof tiles or slates)
- chimney smoke may enter roof spaces between gaps in roof tiles or slates because there is not any felt.

There is no easy solution to this apart from ducting supply air directly from outside to the fan unit.

When the roof timbers are treated with solvent-based wood preservatives, it is advisable to switch off the house pressurisation fan temporarily to stop solvent vapours being drawn into the dwelling. In properly ventilated roof spaces the solvents will normally disperse within a week, and the fan unit can be switched back on.

Properties without a roof space

Properties without a roof space (eg flats, apartments, homes that use the roof space for accommodation such as dormer bungalows) obviously cannot house roof-located positive ventilation units. Manufacturers have developed a range of units specifically for use in flats and apartments where often there is no roof space in which to locate the fan (Figures 9 and 10).

It is worth considering whether a communal system can be used on a block of flats or apartments as a single solution for all. Often in this situation a fan-assisted sump system would be more appropriate. For further information refer to Part 3 of this *Good Repair Guide*[2].

Figure 9: A wall-mounted positive ventilation unit

Figure 10: External air inlet vent to a wall-mounted positive ventilation system

Homes with higher radon concentrations

Although it is suggested that positive ventilation is only appropriate for use in average sized dwellings with radon levels up to around 500 Bq m^{-3}, larger dwellings and dwellings with higher radon levels have been successfully treated with positive ventilation. Sometimes this has involved using more than one fan unit. Due to the large degree of uncertainty in this approach we recommend contacting system suppliers for further advice.

Radon measurement checks

HPA recommends that householders who have installed remedial measures to reduce radon concentrations should do a long-term (three-month) validated radon measurement to measure effectiveness. Shorter measurements (7–14 days) are not normally used and may lead to false indications because of the large 'day-to-day' fluctuations in radon concentrations.

The effectiveness of the system should be assessed by repeating the radon measurement:

- at intervals of 5–10 years
- if there is a change of occupants
- after changes to buildings such as adding an extension or conservatory, installing new double-glazed windows or upgrading the insulation.

What to do if the positive ventilation system does not work

Table 1 lists reasons why positive ventilation systems may not work and suggests further works to rectify the situation. If you find that the fan is not running, the thermostatic switch may have stopped the fan to prevent cold air being blown into the property when the temperature in the loft or outdoors is very low.

LONG-TERM MAINTENANCE

Systems should be checked to ensure that they continue to work effectively. A visual inspection of the system, especially the fan, should be carried out annually.

Fans are 'sealed for life' so do not require any further lubrication. Ventilation grilles and diffusers may need to be cleaned occasionally; refer to the manufacturer's instructions.

Filters should be maintained or replaced at intervals specified by the manufacturer (typically every one to two years).

FURTHER INFORMATION

BRE. Minimising noise from domestic fan systems and fan-assisted radon mitigation systems. BRE GG 26. Bracknell, IHS BRE Press, 1996. Available at www.brebookshop.com.

Advice on radon risk and testing is available from the Health Protection Agency, Chilton, Didcot, Oxfordshire OX11 ORQ. Tel: 01235 822622. www.ukradon.org.

REFERENCES

[1] BSI. Requirements for electrical installations: IET wiring regulations. BS 7671:2008 incorporating Amendment No. 1:2011. Stevenage, Institution of Engineering and Technology (IET), 2011.

[2] Scivyer C. Radon solutions in homes: radon sump systems. BRE GR 37/3. Bracknell, IHS BRE Press, 2013.

[3] Scivyer C. Radon solutions in homes: improving underfloor ventilation. BRE GR 37/1. Bracknell, IHS BRE Press, 2012.

This *Good Repair Guide* has been prepared by BRE and HPA. It should be noted that BRE and HPA cannot guarantee that the measures described in this leaflet will reduce the radon level in a home. However, similar measures have frequently proved successful in a range of UK locations.

Table 1: **Troubleshooting for positive ventilation systems**

Observation	Solution
No change or insufficient reduction in radon level	• Check the unit is still working continuously then TEST AGAIN • Increase the fan speed then TEST AGAIN • Consider a larger unit or a second positive ventilation system • Consider alternative solutions (see Parts 1[3] and 3[2] of this *Good Repair Guide*) The unit must run continuously, day and night. A thermostatic switch may stop the fan to prevent cold air being blown into the property during very cold weather.
Insufficient radon reduction but condensation problems resolved	Consider and install additional solutions (see Parts 1[3] and 3[2] of this *Good Repair Guide*)
Radon level increases	• Improve roof space ventilation then TEST AGAIN OR • Take air directly from outside then TEST AGAIN
Building is draughty? See 'Draughty houses' section on page 2	Draught-proof doors, windows, seal floors, close unused chimneys then TEST AGAIN
Cold draughts	Contact the manufacturer to install a heater to the system

Note: After completing work to reduce radon concentrations, a three-month validated measurement of radon levels should be conducted to ensure effectiveness.

Acknowledgements

The preparation and publication of this *Good Repair Guide* was funded by BRE Trust and the Health Protection Agency.

The author would like to acknowledge the assistance of Airtech Environmental Systems, Vent-Axia and Ted Hare for supplying photographs for this guide.

Other radon publications from BRE

Radon: Guidance on protective measures for new buildings

BRE Report BR 211, 2007 edition

Get practical guidance for reducing the concentration of radon in new buildings, extensions, conversions and refurbishment projects. This guide will help architects, designers, builders and installers to specify and install successful protective measures to reduce the risk of exposure to radon. The guide contains updated maps of England and Wales for identifying areas where radon protective measures should be installed.

Radon protection for new domestic extensions and conservatories with solid concrete ground floors

Good Building Guide 73

Get practical guidance on providing radon protection to new domestic extensions and conservatories and understand why it is necessary. This *Good Building Guide* will also help house owners and builders in radon-affected areas to determine whether protection is needed and the level of protection that is required.

Radon protection for new dwellings

Avoiding problems and getting it right!

Good Building Guide 74

Find out how to install radon-protectiion measures in new dwellings successfully. This *Good Building Guide* will help designers, site managers, building control authorities and site operatives to ensure that radon-protection measures work.

Radon protection for new large buildings

Good Building Guide 75

Find out how to install radon-protection measures within large buildings successfully, eg laying a radon-proof barrier across a large floor area, how many sumps to install and how to construct the sump and pipework. In addition to the requirements of building regulations, a building used as a workplace has to meet the requirements of the Ionising Radiations Regulations 1999.

All titles are available in print and pdf format. *Good Building Guides* 73–75 are available individually or as a set of three.

Order now @ **www.brebookshop.com** or **phone the IHS Sales Team on +44 (0) 1344 328038**.

BRE, Garston, Watford WD25 9XX
Tel: 01923 664000, Email: enquiries@bre.co.uk, www.bre.co.uk

Good Repair Guides are accessible guides to the defects most commonly encountered in buildings and offer sound advice on putting them right. They are highly illustrated to make the problems and solutions easy to identify and understand.

Digests, Information Papers, Good Building Guides and Good Repair Guides are available on subscription in hard copy and online through BRE Connect. For more details call 01344 328038.

BRE publications are available from www.brebookshop.com, or IHS BRE Press, Willoughby Road, Bracknell RG12 8FB
Tel: 01344 328038, Fax: 01344 328005, Email: brepress@ihs.com

Requests to copy any part of this publication should be made to:
IHS BRE Press,
Garston,
Watford WD25 9XX
Tel: 01923 664761
Email: brepress@ihs.com
www.brebookshop.com

GR 37, Part 2

February 2013
ISBN 978-1-84806-301-3 (Part 2)
ISBN 978-1-84806-303-7 (3-Part set)