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).

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:
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.

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).

Figure 3: How positive ventilation works
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 (e.g. 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.

[^1]: BS 7671:2008
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].

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.
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.

<table>
<thead>
<tr>
<th>Observation</th>
<th>Solution</th>
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| 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.

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


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


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.
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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.

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