Radon

Guidance on protective measures for new buildings (including supplementary advice for extensions, conversions and refurbishment projects)

2023 edition

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Acknowledgements

The guidance in this report draws on nearly 40 years of research and experience at BRE. The original author, Chris Scivyer, first produced this publication in 1991, with amendments in 1992, 1999, 2007 and 2015. This latest version of BR211 has been produced with input from the Radon Council, specifically Peter Atchison (PAGeo Technical Ltd.) and John Sparks (GeoShield Ltd.), and Chris Scivyer (BRE Associate). Thanks go to them for their strong contribution to this updated guidance report. Thanks also go to Tracy Gooding, David Rees and the team at UKHSA for their detailed mapping and expertise of matters related to health and radon risk; British Geological Survey (BGS) for its contribution to radon risk mapping, which has contributed to more accuracy in the identification of areas at risk; Local Authority Building Control and NHBC.

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Front cover image: Prefabricated sumps and pipework being laid in a small commercial building (image courtesy of Glencoe Radon Gas Centre Ltd)

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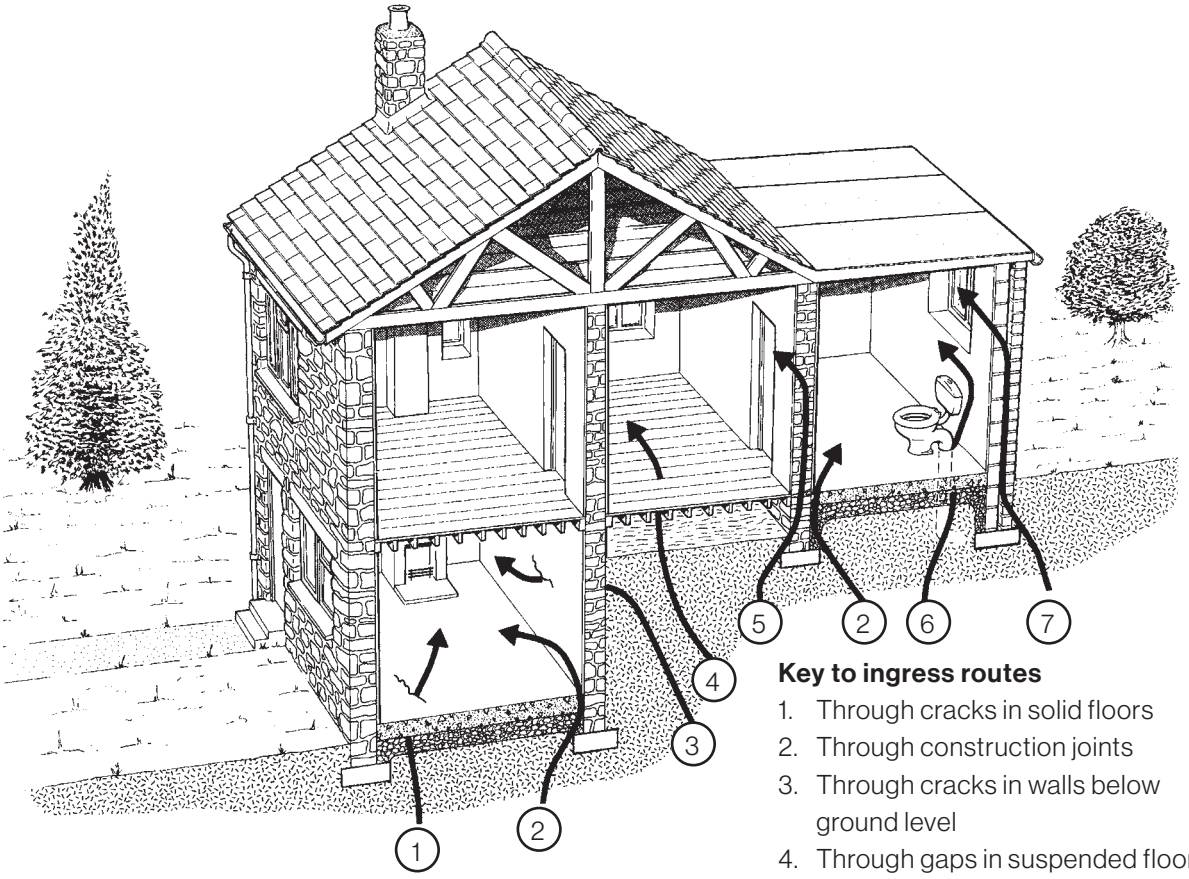
1. Introduction



Key to ingress routes

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

Figure 1: Routes by which radon enters a dwelling

This report gives guidance for reducing the concentration of radon in new buildings, extensions, conversions and refurbishment projects in order to reduce the risk to occupants of exposure to radon. It provides practical details on protective measures for both domestic and non-domestic buildings. This guide is intended for use in England, Wales, Scotland and Northern Ireland. It supports building regulations for England, Wales and Northern Ireland, and building standards for Scotland. This guide was originally introduced in 1991 and amended in 1992, 1999, 2007and 2015.

This guide replaces three earlier guidance documents:

- BRE Report BR 211, *Radon: guidance on protective measures for new buildings*, introduced in 1991 and amended in 1992, 1999, 2007and 2015, covering England and Wales.
- BRE Report BR 376, *Radon: guidance on protective measures for new dwellings in Scotland*, introduced in 1999.
- BRE Report BR 413, *Radon: guidance on protective measures for new dwellings in Northern Ireland*, introduced in 2001.

The principal changes over previous editions are:

- combined guidance for England, Wales, Scotland and Northern Ireland
- clearer explanatory guidance on specifying and installing radon-protective measures
- updated guidance to reflect recent amendments to building regulations and building standards
- additional radon management checklist
- Improved references to inspection, on-site quality management and specifications
- Appendix A replaced by links to UKradon
- Appendix B replaced by Radon Protective Measures Quality Management Record

1.1 Background

BRE has been involved with the development of practical, cost-effective radon-protective measures for use in new UK buildings since the mid-1980s. Over the years a range of research and development projects have been carried out by BRE for UK building regulation bodies. This work has included large-scale field trials to demonstrate the efficacy of installing radon- protective measures in new dwellings, as well as studies of protective measures used in non-domestic buildings. Evidence from earlier studies demonstrated that the approaches adopted for new homes in the early 1990s worked well at the time. Follow-up monitoring carried out in a small sample of these homes 10 and 20 years after completion showed that radon levels were maintained at an acceptable level.

Radon-protective measures installed in newbuild properties are expected to reduce radon levels significantly. It is difficult to quantify the effective reduction within individual households. Comparison of radon levels in properties (built in areas of close proximity), with and without protective measures, shows a trend towards lower radon levels in protected properties. However, some newly built homes still have elevated radon levels measuring above the 'action level'*. Enhanced guidance in this new edition of the report aims to improve the installation and inspection of radon-protective measures and therefore further reduce radon levels.

1.2 What is radon?

Radon is a natural, colourless, odourless, radioactive gas. It is formed by the radioactive decay of the small amounts of uranium that occur naturally in all rocks and soils. The gas can move through cracks and fissures in the subsoil and eventually to the atmosphere. Most of the radon will disperse into the air outside, but some will pass from the ground and collect in spaces under or within buildings (Figure 1). For the average UK resident, radon accounts for half of the annual radiation dose received. Exposure to high levels of radon increases the risk of developing lung cancer[1].

All buildings contain radon. Certain areas of the UK have been defined with an increased potential for high radon levels. For further information, see www.ukradon.org . The darker the shading on the radon maps, the greater the chance of a high radon level in a building. Note that not all buildings, even in the most radon-prone areas, have high levels.

With careful design and construction, radon-protective measures can be included relatively easily and cost-effectively within new buildings and extensions, or when converting or refurbishing existing buildings. Radon-protective measures do not completely stop the entry of radon into a building, however, well designed and inspected measures will effectively reduce ingress to acceptable levels. The areas where radon-protective measures are required are all contained within existing 'radon-affected areas'. Existing advice is that all homes in radon-affected areas should be tested for radon[2], with a similar recommendation for workplaces[3].

(Further information is also available at www.hse.gov.uk.) It is therefore important that new buildings with radon-protective measures are tested for radon once they are occupied. Where elevated radon levels are identified, reduction measures should be applied.

* The level above which action should be taken to reduce or manage radon levels.

2. National building regulation guidance

Throughout this guide, reference is made to national building regulation guidance. Guidance can be found in the following publications, which relate to a specific UK region:

- *England*: The Building Regulations 2010 (England). Approved Document C: Site preparation and resistance to contaminants and moisture[4].
- *Wales*: The Building Regulations 2010 (as amended in Wales). Approved Document C: Site preparation and resistance to contaminants and moisture[5].
- *Scotland*: The Building (Scotland) Regulations 2004. Technical Handbook, Domestic, Environment[6]; and The Building (Scotland) Regulations 2004. Technical Handbook, Non-domestic, Environment[7].
- *Northern Ireland*: The Building Regulations (Northern Ireland) 2012 (as amended). Technical Booklet C: Site preparation and resistance to contaminants and moisture[8].

This guidance is updated from time to time. Readers should ensure that they are using the most current edition and that the guidance is relevant to their region of the UK. The guidance in this report applies to all new buildings, extensions, conversions and refurbishment projects, whether they be for domestic or non-domestic use (unless subject to local exemptions contained within the above regulations).

3. Protective measures

To be successful, radon protective measures need to be implemented consistently through the construction process from design stage through to handover. It is recommended that the *Radon Protective Measures Quality Management Record* in Section 7 should be followed.

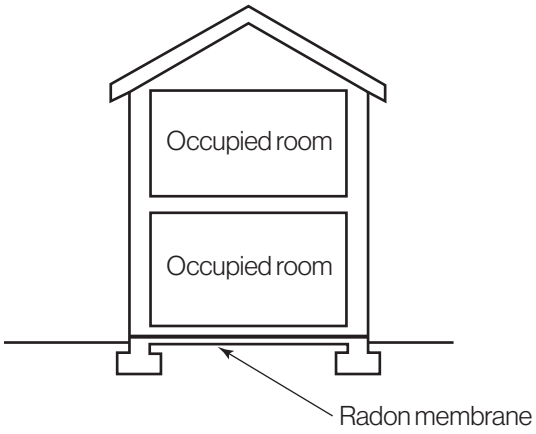


Figure 2: Passive measures to prevent radon entry

Radon and air are drawn into buildings from the underlying ground. There are two main methods of achieving radon protection in new buildings: passive and active. The passive system involves providing a membrane to resist the ingress of radon (Figure 2) and in more radon-prone areas, where the construction type allows, additional natural underfloor ventilation. This can often be achieved by increasing the general airtightness of the damp protection provided in floors and walls. The active system consists of providing natural or mechanical (fan-assisted) underfloor ventilation, or a powered radon extraction system, as an integral part of the services of the building. The last two options will incur running and maintenance costs for the life of the building. Passive systems are to be preferred in new buildings, although they may need to be supplemented later with active protection.

In areas with an increased radon potential, sufficient protection will be provided by a well-installed and inspected radon membrane. This gas-tight membrane is known as 'basic radon protection'.

New buildings in areas of higher radon potential should incorporate full radon protection comprising a radon membrane across the footprint of the building supplemented by provision for subfloor depressurisation or ventilation (either a radon sump or a ventilated subfloor void).

While terminology may vary within the different regional building regulation guidance documents covering England, Wales, Scotland and Northern Ireland, within this guide radon-protective levels are referred to as either 'basic radon protection' or 'full radon protection'.