The Evolution of practical and cost effective radon solutions for new and existing UK buildings

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Part of the BRE Trust

Introduction to radon and buildings

1

In the UK

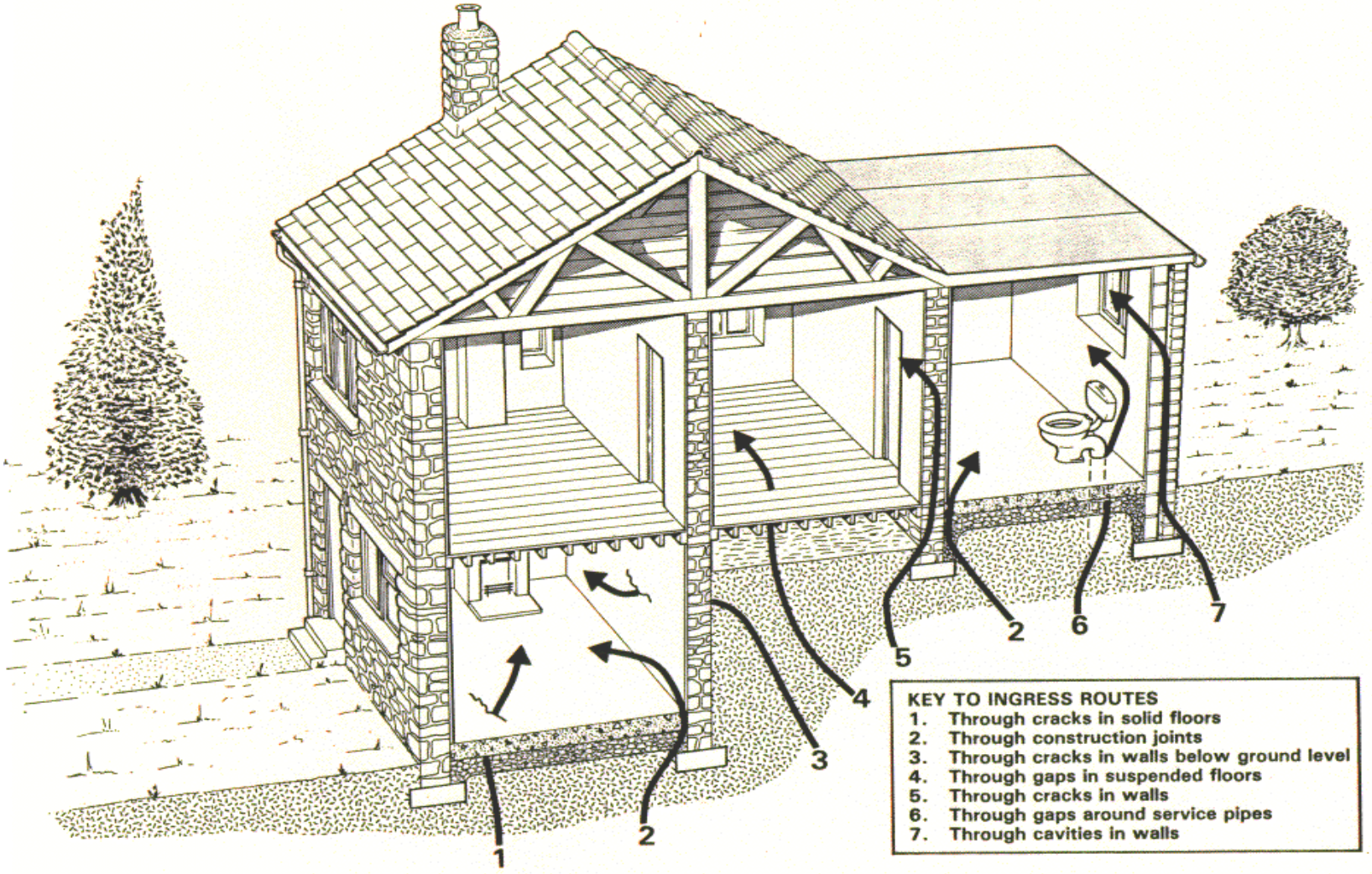
Our solutions target radon in air

Radon in water and radon emanation from building materials are rarely a problem in the UK

UK Average indoor radon level 20 Bqm^3

Estimated 100,000 homes over 200 Bqm^3

Highest average in a house 20,000 Bqm^3


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
1
2
3
4
5
2
6
7

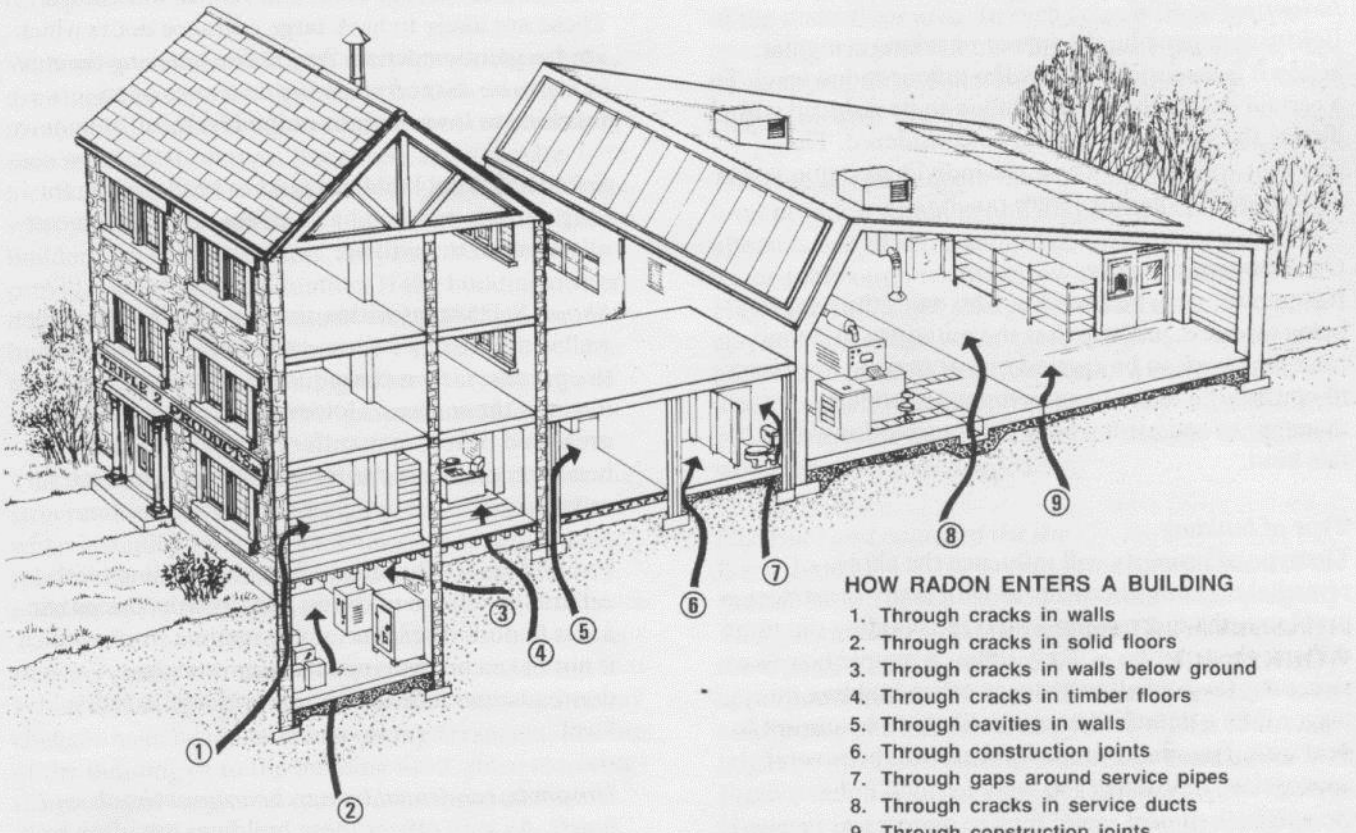
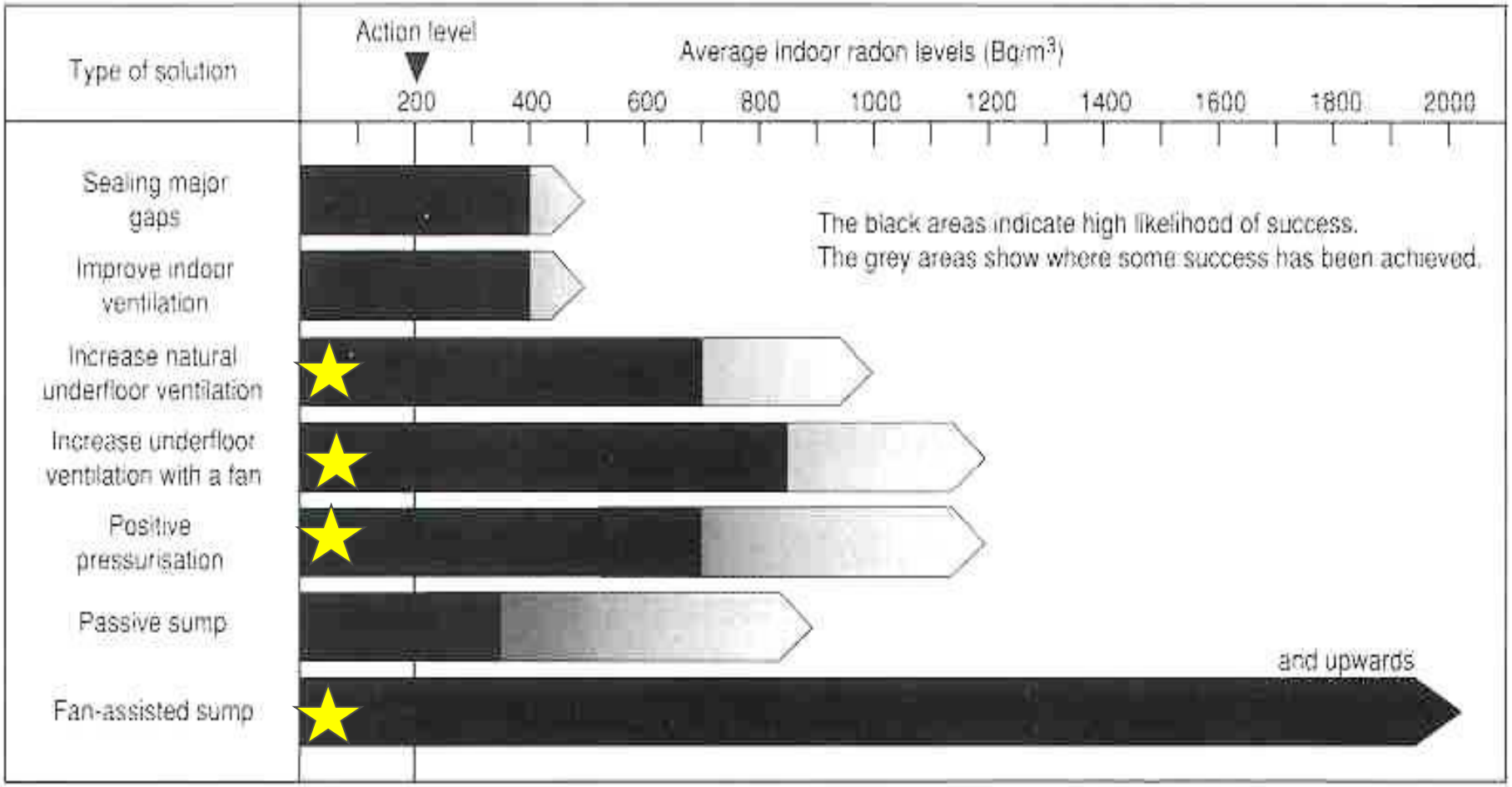


Figure 1 How radon enters a building

3

Reducing radon in existing buildings

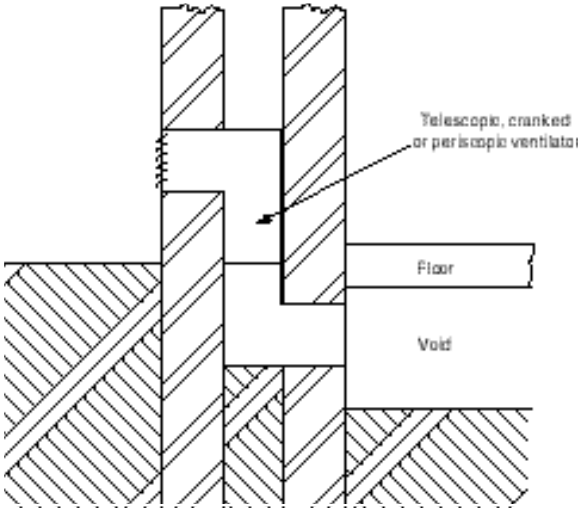
2

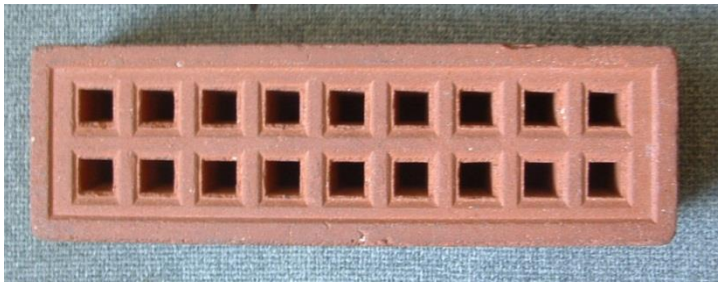


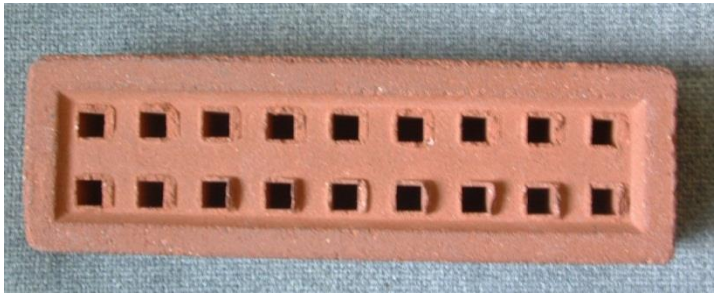
Solutions are installed :- Radon Specialists 1/3rd, Local Builders 1/3rd, Homeowners 1/3rd.

Natural underfloor ventilation

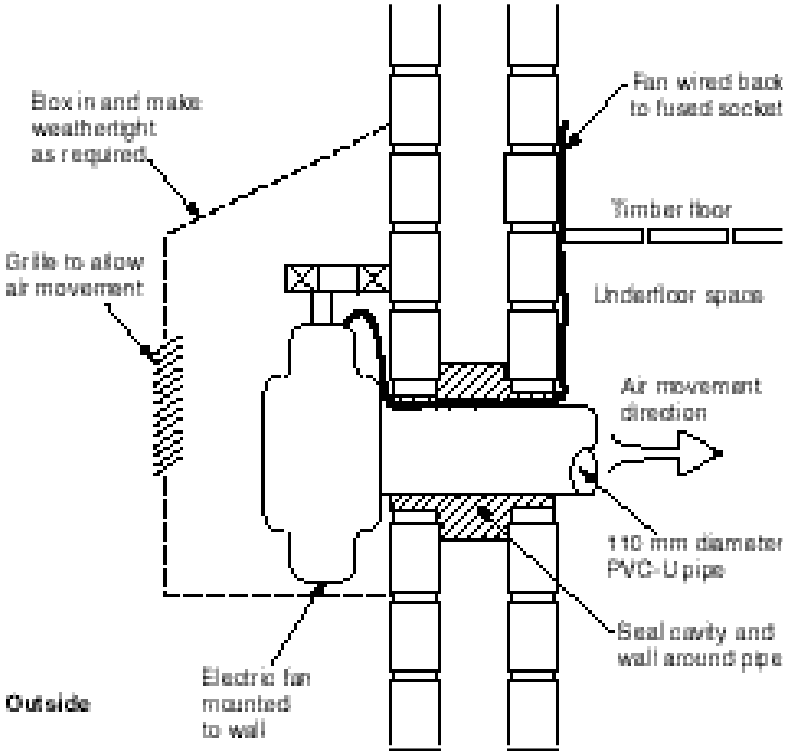
- Clear out existing vents
- Remove obstructions such as plant growth
- Pull back soil in beds, remove paving or macadam laid obstructing vents.
- Replace existing vents or provide extra vents


Telescopic, cranked
or periscopic ventilator
Floor
Void





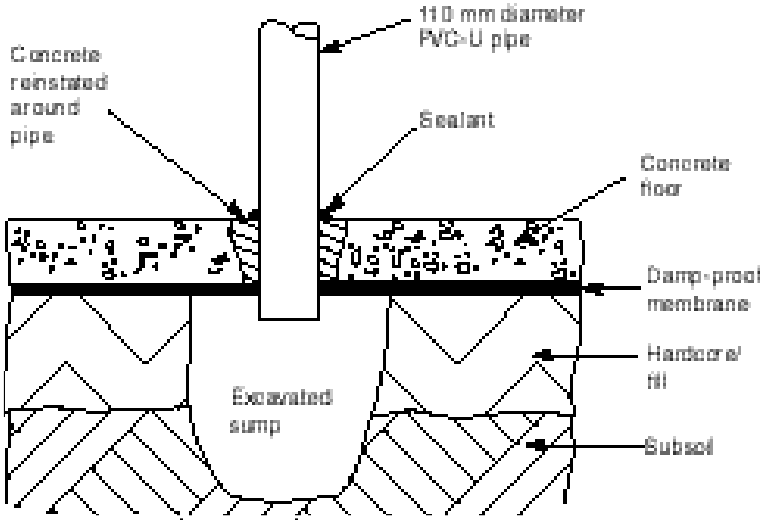
Mechanical underfloor ventilation

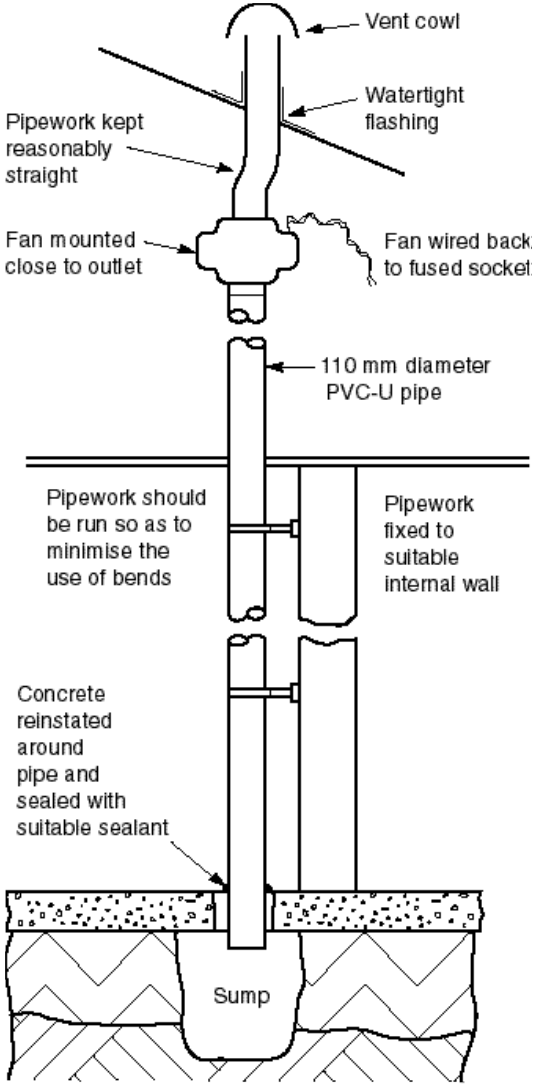


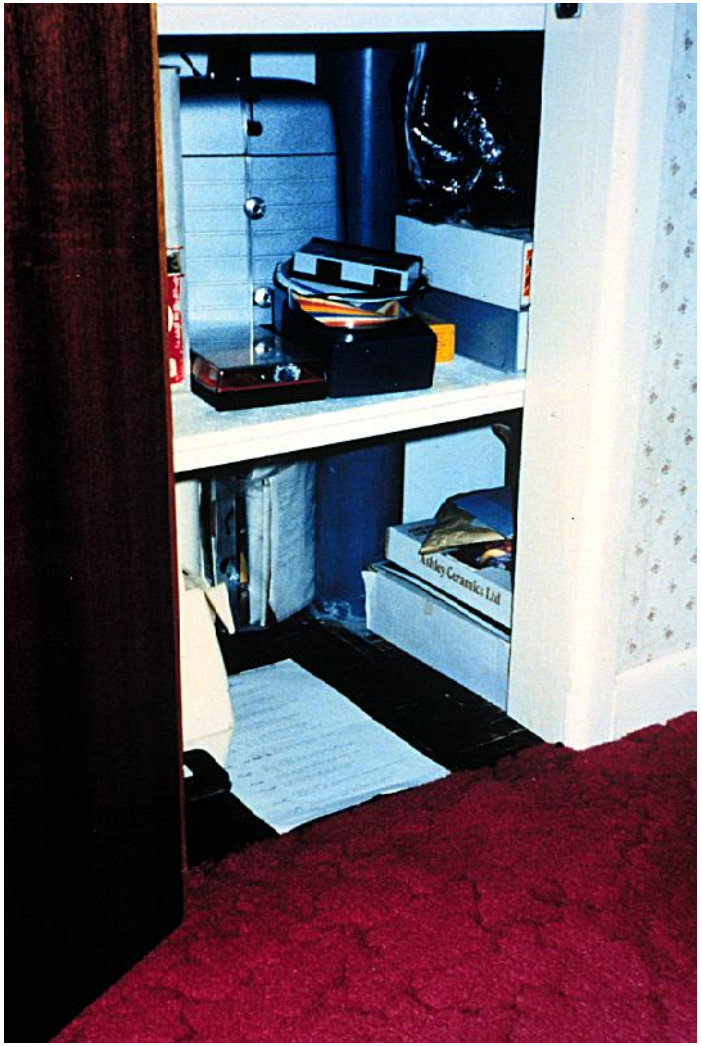
Sump/subslab depressurisation

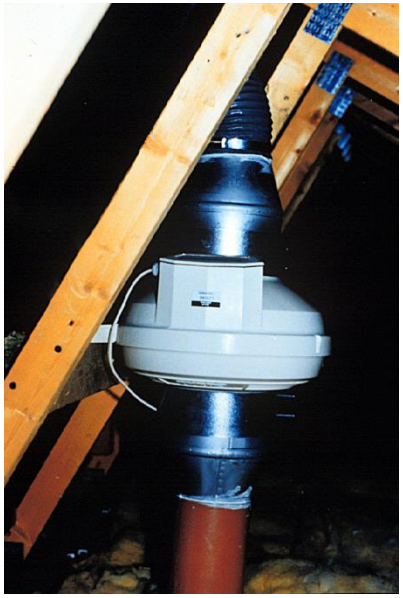
- How it works
  - reverses stack effect of the building
  - draws radon away from the building
- What can be achieved
  - gives greatest reductions
  - must run continuously

Internal mini-sump system






Ashley Ceramics Ltd

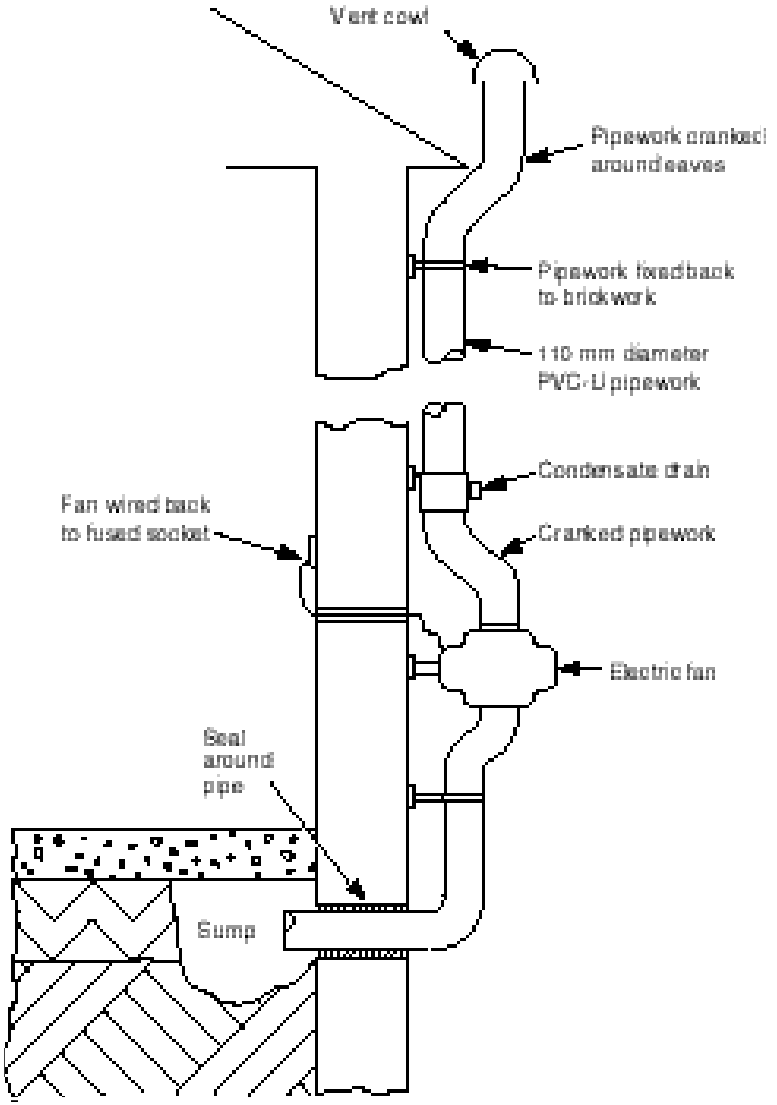


First Floor

Ground Floor

Basement

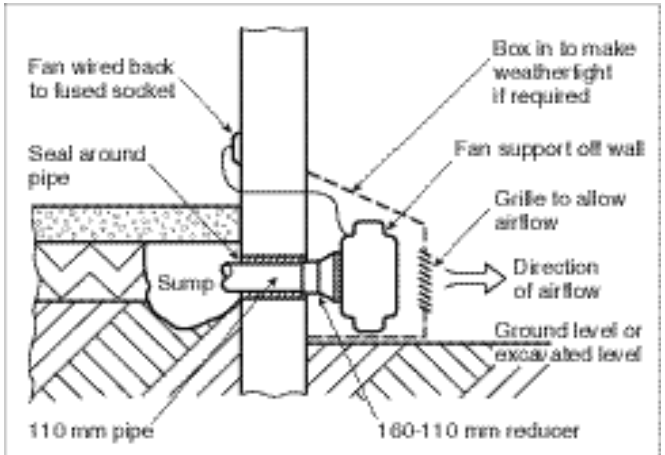
External mini-sump system



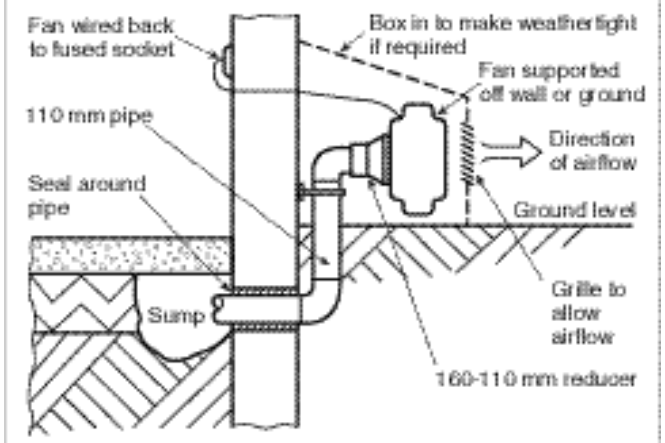
External mini-sump system

External mini-sump system

Externally excavated mini – sump system with low level exhaust



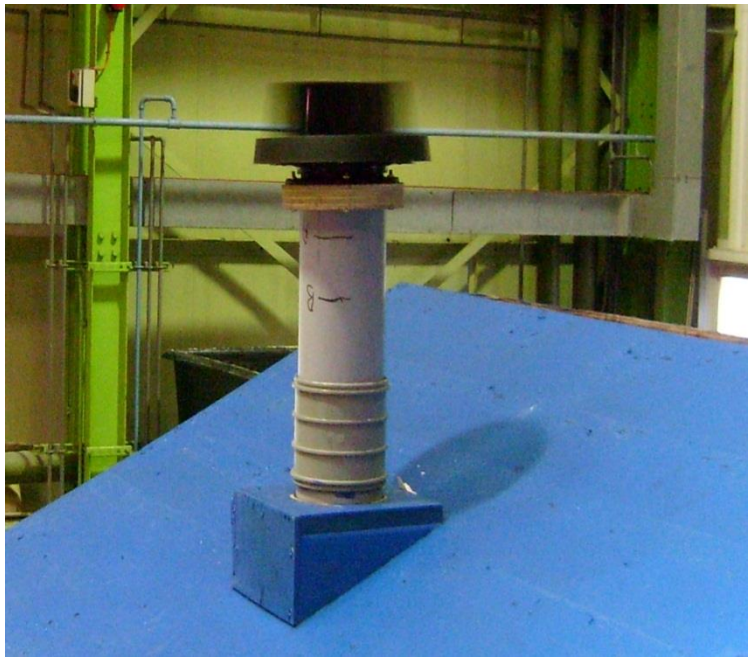
Externally excavated mini sump with low level exhaust



Alternate design of sump system

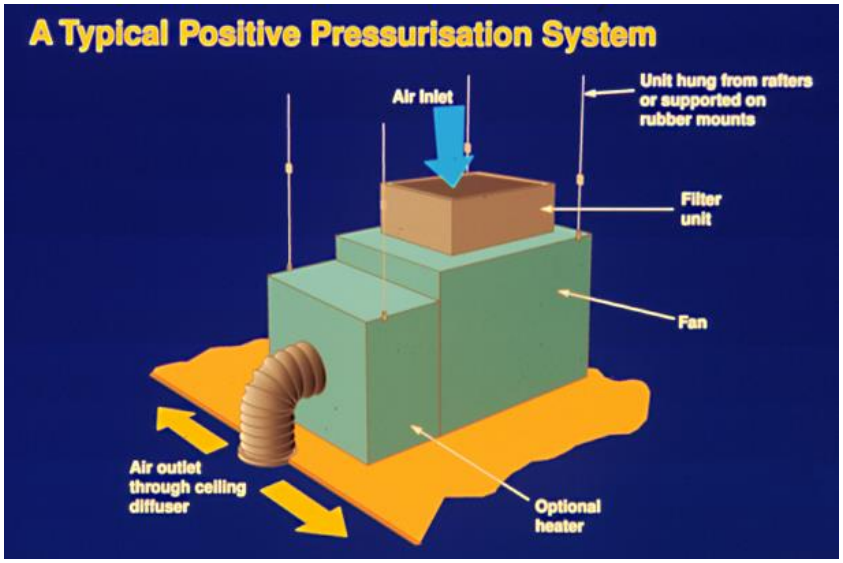
Passive stack sump system

- relies upon stack effect and action of wind over the building
- ideal as first step with lower radon levels 300-500 Bq/m^3
- depressurisation can be encouraged by design of cowl
- pipework should be kept straight
- In theory should work best where pipework is located internally
- consider need for fan later



Positive Pressurisation or Ventilation

- What is positive pressurisation?
  - loft mounted fan system
  - originally developed for condensation reduction
- How does it work?
  - Combination of positive pressure and dilution
- When to use it
  - radon levels up to about 600 Bq/m^3
  - relatively airtight houses
  - possible condensation problems



Positive ventilation systems

Diffusers

Raising awareness campaigns

- Government funded
- Target local areas
- Local Authority lead –
  - supported by Public Health England (PHE), BRE, and regional health authorities
- Awareness training for
  - Councillors
  - Local authority staff
  - Local Medical professionals
  - Surveyors, Estate Agents
  - Builders and builders merchants
- Awareness events for the public
  - Practical face to face advice on risks and solutions

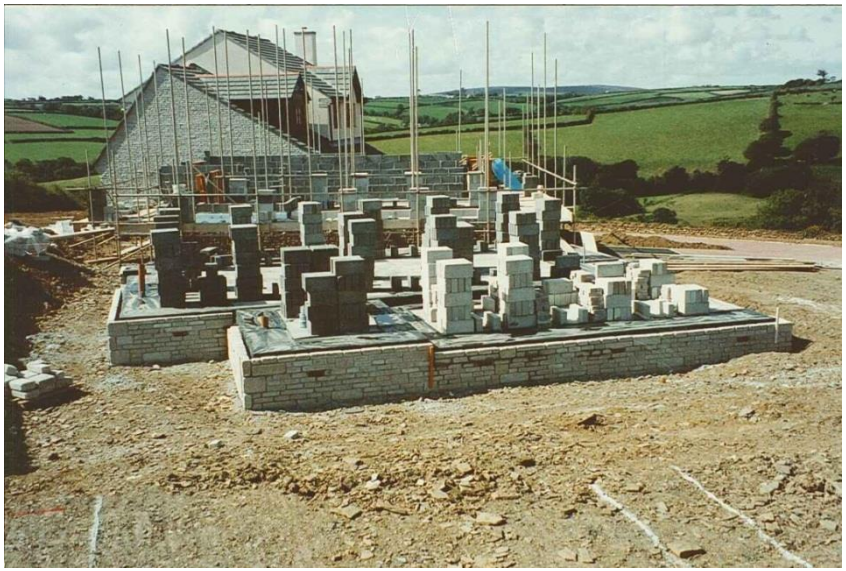
Protecting New Buildings

Newbuild Research 1988 - 1991

- a workshop for builders, designers, local building officers, and legislators to develop practical solutions for new build protection
- Interim voluntary guidance launched 1988
- Large field trial targeted :
  - High risk areas – areas where 30% or more existing unprotected houses expected to have radon levels exceeding 200 Bq/m^3
  - Medium risk areas – areas where between 10% and 30% of existing unprotected houses expected to have radon levels exceeding 200 Bq/m^3.
  - **416 dwellings:**
    - **121 in high risk areas**
    - **295 in medium risk areas**

- San

- Houses were selected on sites with both unprotected and protected houses – which gives ‘before’ and ‘after’ results
- A mix of construction types were included in the study:
  - In-situ/slab on grade concrete floors
  - Beam and block prefabricated concrete floors
- 33 building sites across Cornwall and Devon
- BRE carried out site inspection across each site



Field Trials 1989-1991

Newbuild Homes Tested		
	Unprotected	Protected
In-situ concrete	194	87
Beam and Block	103	47

Annual average indoor radon levels		
	Unprotected	Protected
In-situ concrete	130 Bq/m3	96 Bq/m3
Beam and Block	54 Bq/m3	20 Bq/m3

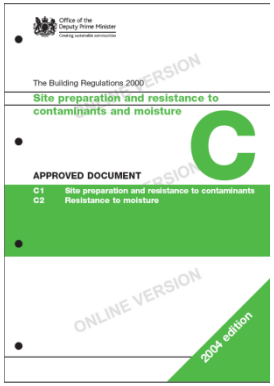
Long term protection

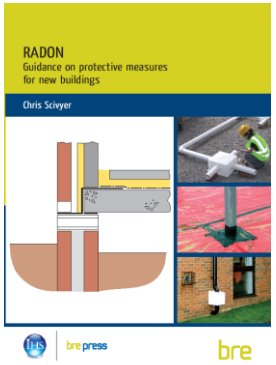
- The average radon level for the 134 protected homes in the 1990 study was **56.8 Bq/m^3**
- We retested a sample of 70 homes in 2000 and found the radon results to average **58 Bq/m^3** very similar to the earlier results
- In 2010 we retested a sample of 35 homes again and found the average to be **62.6 Bq/m^3**.

The results do not appear to have been significantly affected by adding extensions or conservatories, or from improvements such as adding double glazing, or wall/roof insulation.

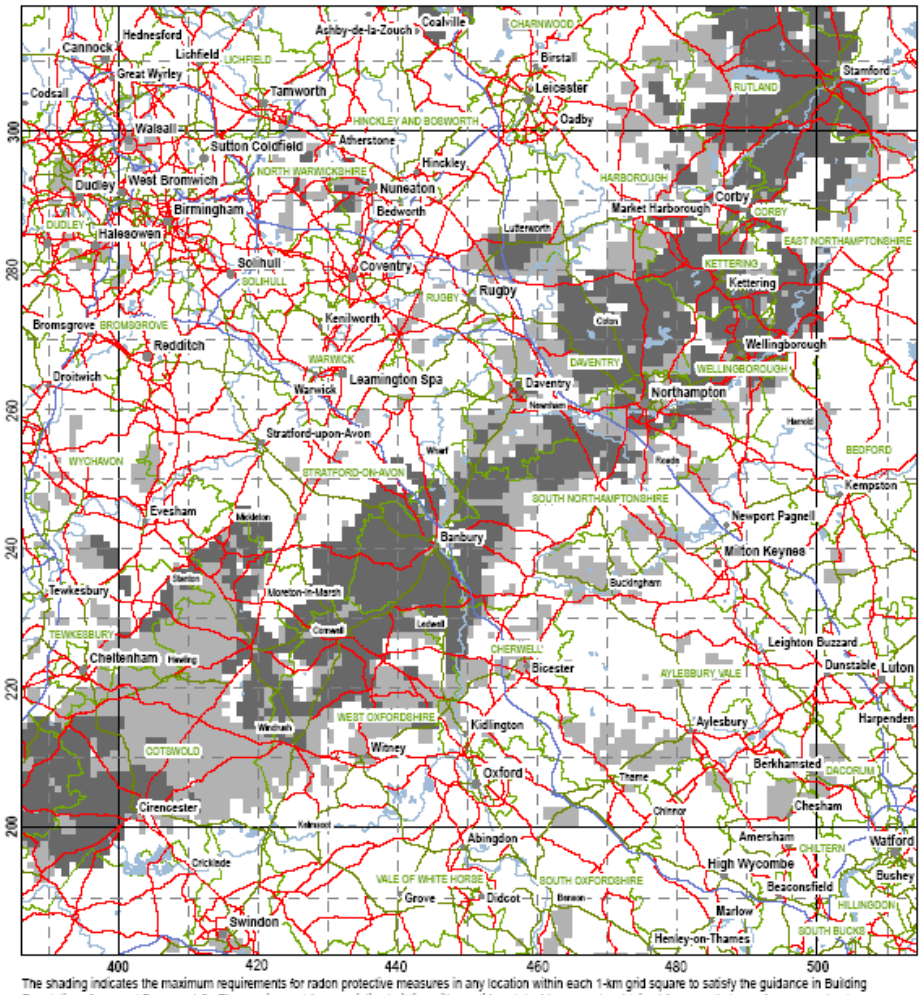
Radon Protective Measures For New Dwellings

- Requirement C2 of Schedule 1 of the Building Regulations 2013 for England and Wales states that:
  - ***'precautions shall be taken to avoid danger to health and safety caused by substances in found on or in the ground covered by the building***
  - It refers to : ***Building Research Establishment Report BR211 ' Radon : guidance on protective measures for new buildings'***





Maps



The shading indicates the maximum requirements for radon protective measures in any location within each 1-km grid square to satisfy the guidance in Building Regulations Approved Document C. The requirement for an existing building with a valid postal address can be obtained for a small charge from www.ukradon.org. The requirement for a site without a postal address is available through the British Geological Survey GeoReports service, http://shop.bgs.ac.uk/GeoReports/.

Level of protection required

- None
- Basic
- Full

Settlements

- Solihull
- Aylesbury
- Lutterworth
- Stanton

Roads

- Motorways
- Primary Roads
- A Roads
- B Roads

National Grid

- 100-km
- 10-km

Other Features

- LOCAL ADMINISTRATIVE DISTRICT
- Water features

Map 9 Oxfordshire, Northamptonshire and Warwickshire, 100-km grid square SP (axis numbers are the coordinates of the National Grid)

Protective Measures Requirements

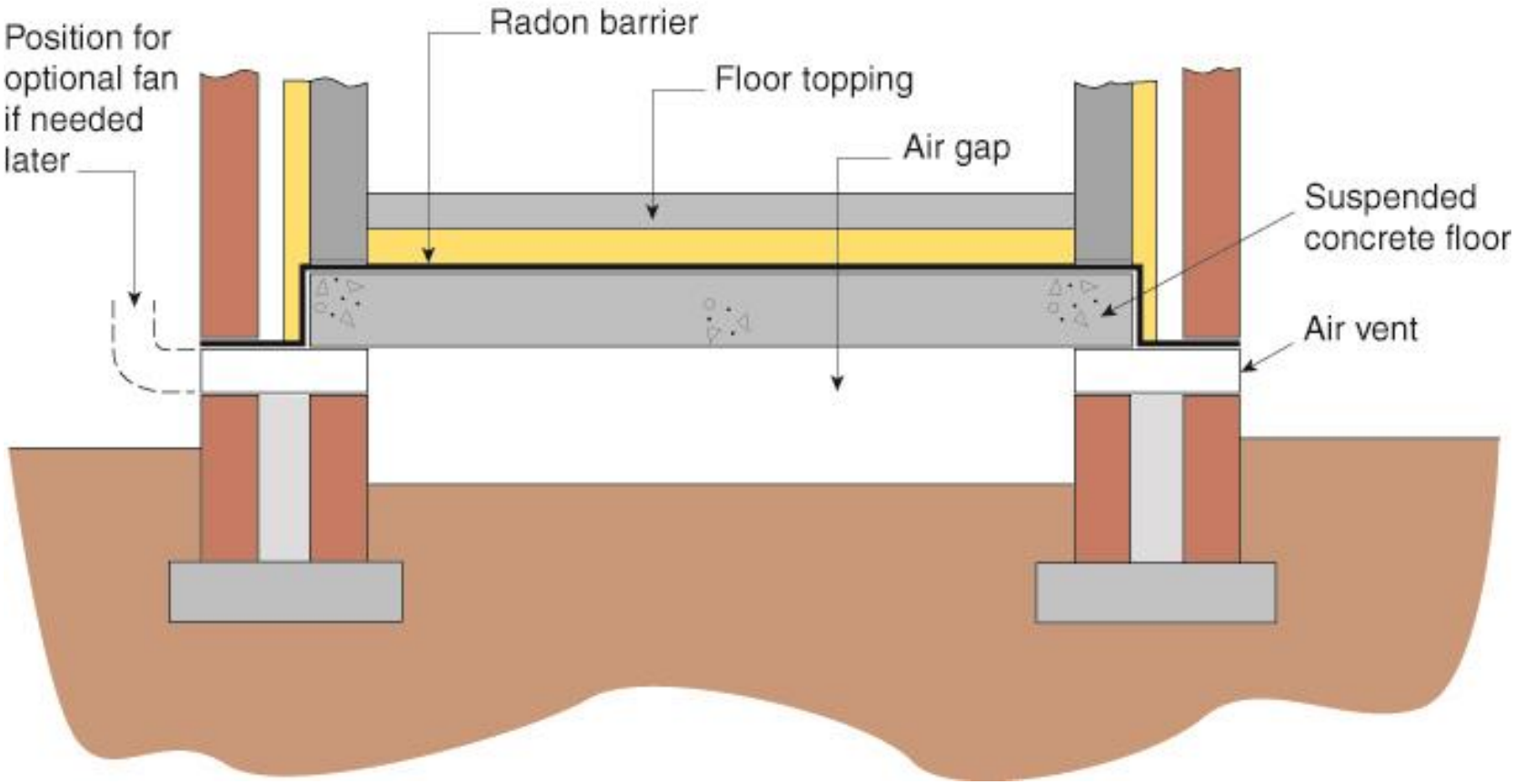
- Areas of low risk - **No protection needed**
- Areas of medium risk - **Basic protection needed**
  - radon barrier
- Areas of high risk - **Full protection needed**
  - radon barrier and provision for underfloor ventilation or sub-slab depressurisation
- Or, use Geological data to assess indoor radon risk and permit relaxation of requirements

Full Radon Protection

- Barrier required across whole floor area
  - minimum 1200 gauge/300 micrometre polyethylene sheet barrier
  - barrier joints sealed
  - cavities sealed
  - service entries sealed
- in-situ concrete ground floor slabs should be edge supported
- need to provide sump or ventilated void

Full Radon Protection : suspended concrete

Full radon protection in a suspended concrete floor



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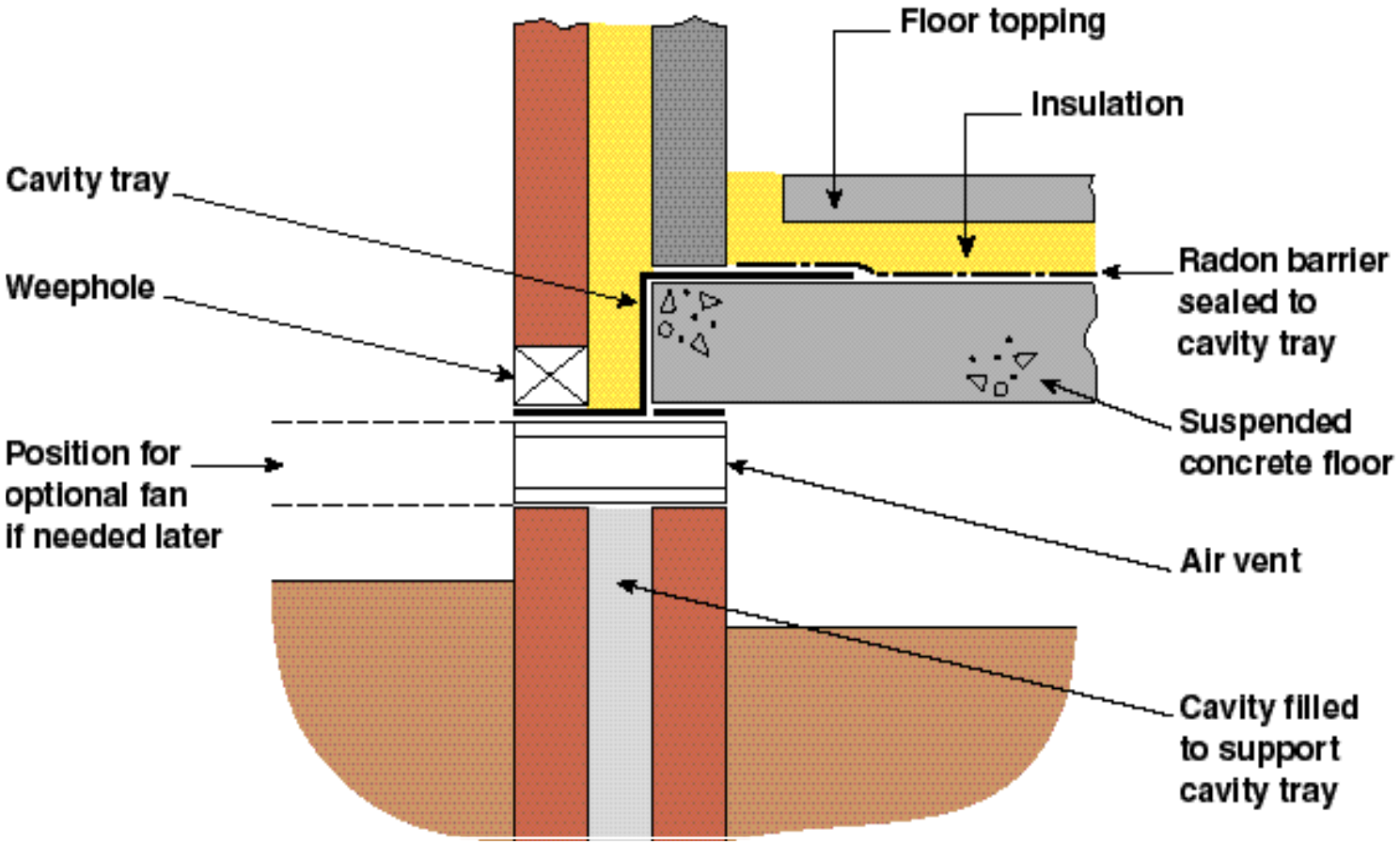
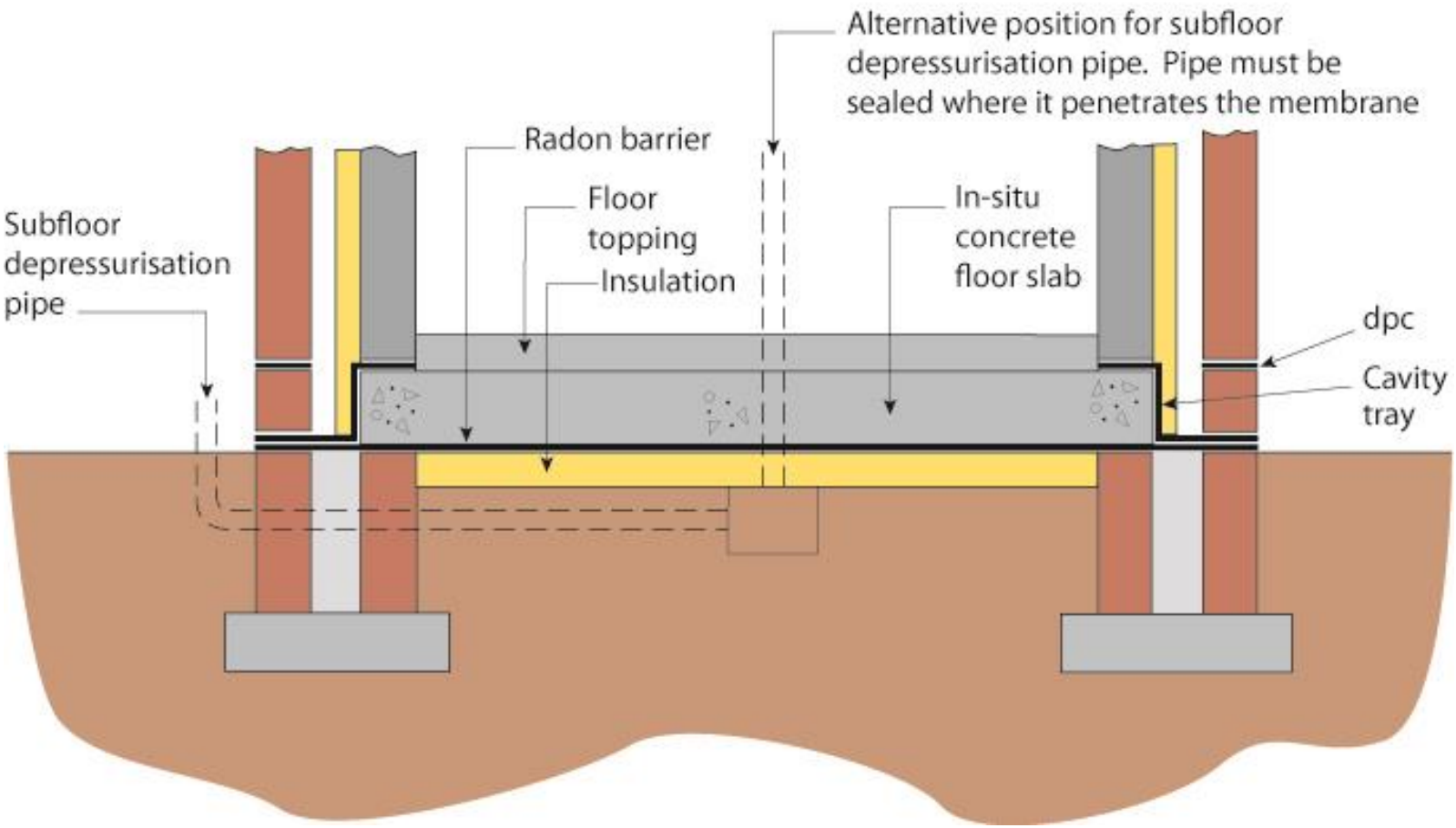
Possible working detail of full radon protection in a suspended concrete floor

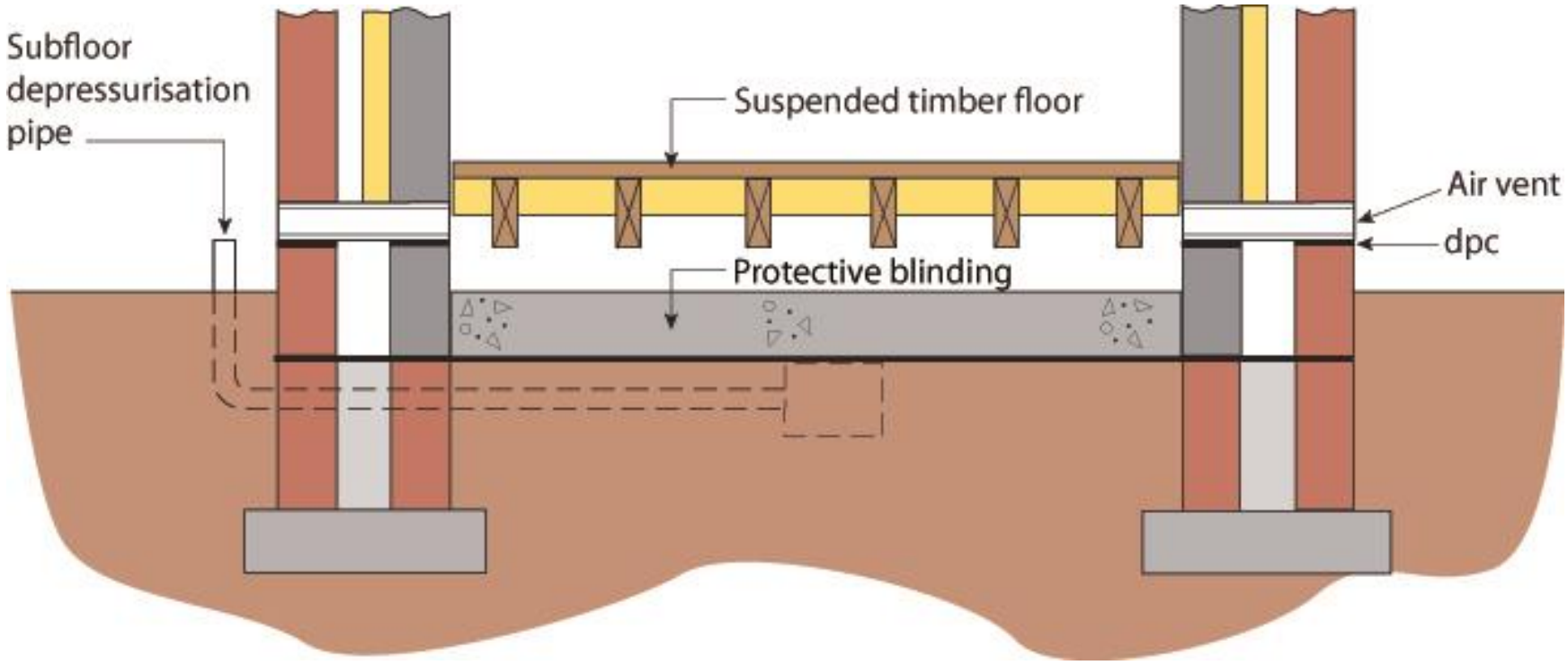


Full Radon Protection : Solid concrete

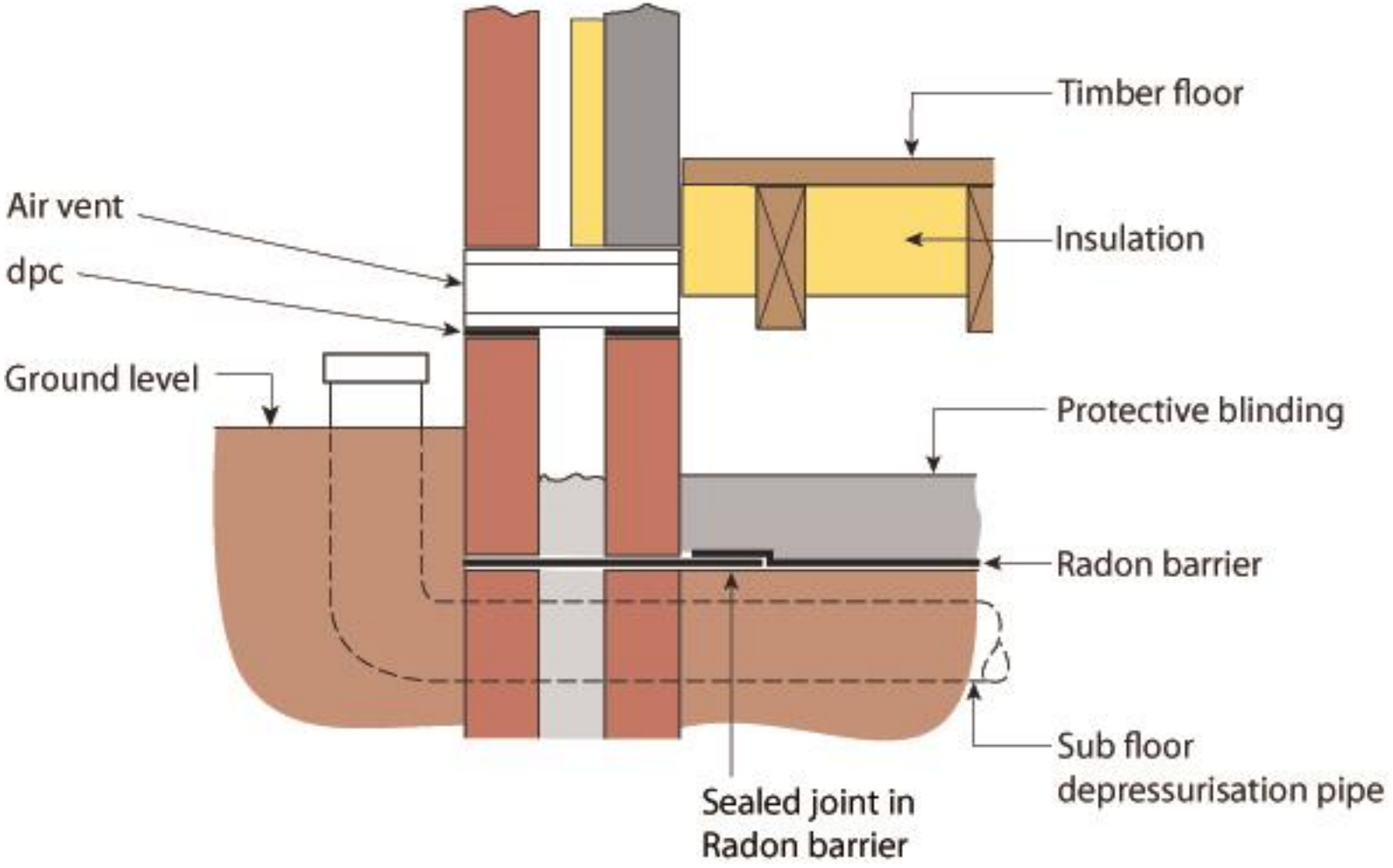
Full radon protection in in-situ or ground-supported concrete floor (barrier under slab)



Full Radon Protection : Suspended timber

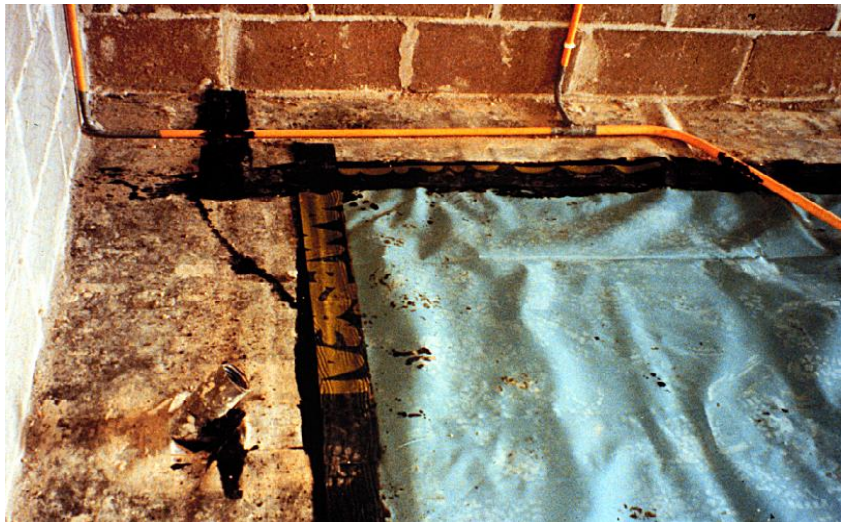


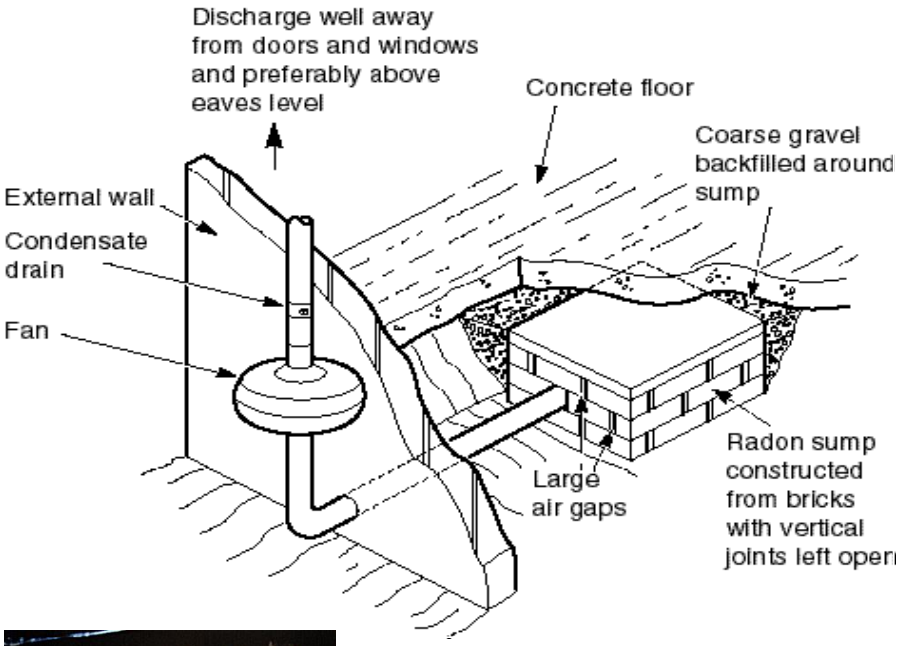
Full Radon Protection : Suspended timber

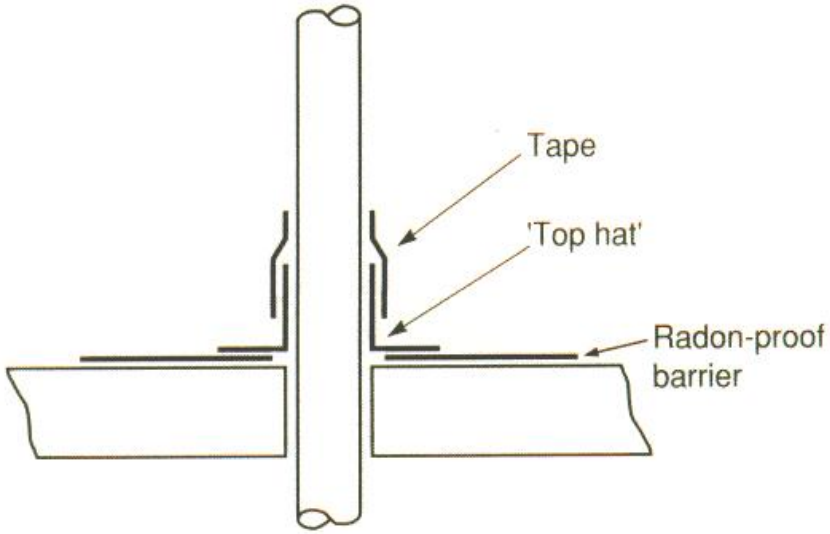


Barrier materials

- Using thicker/stronger materials
- Recycled barrier materials
- Encourage the use of prefabricated components
- Greater emphasis on sealing of joints
- Weather conditions
- Protection of the barrier
- Testing barriers




Discharge well away from doors and windows and preferably above eaves level
Concrete floor
Coarse gravel backfilled around sump
External wall
Condensate drain
Fan
Large air gaps
Radon sump constructed from bricks with vertical joints left open


Tape
'Top hat'
Radon-proof
barrier

Further guidance

4

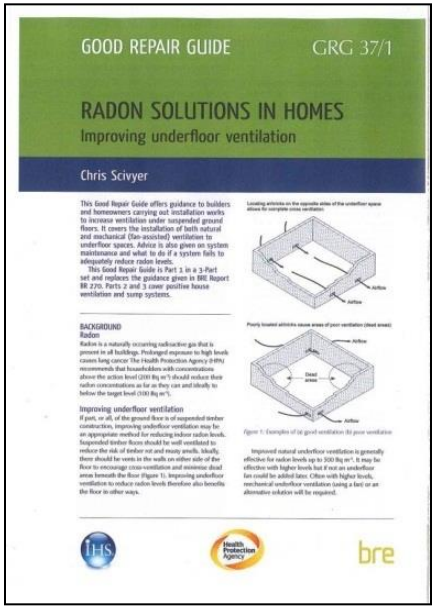
New Good Repair Guides

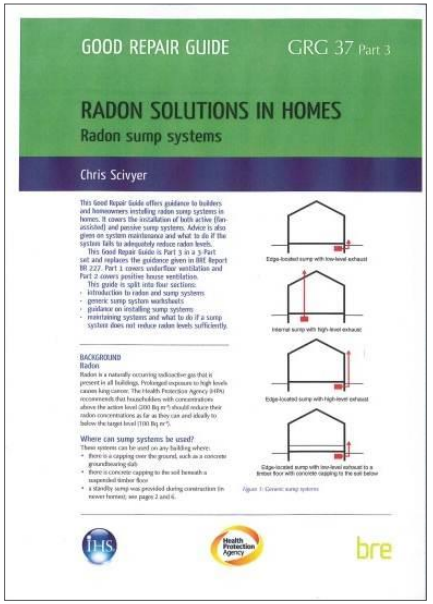
GRG 37 : Radon Solutions in Homes:

Part 1. Suspended timber floors

Part 2. Positive house ventilation

Part 3. Radon sump systems



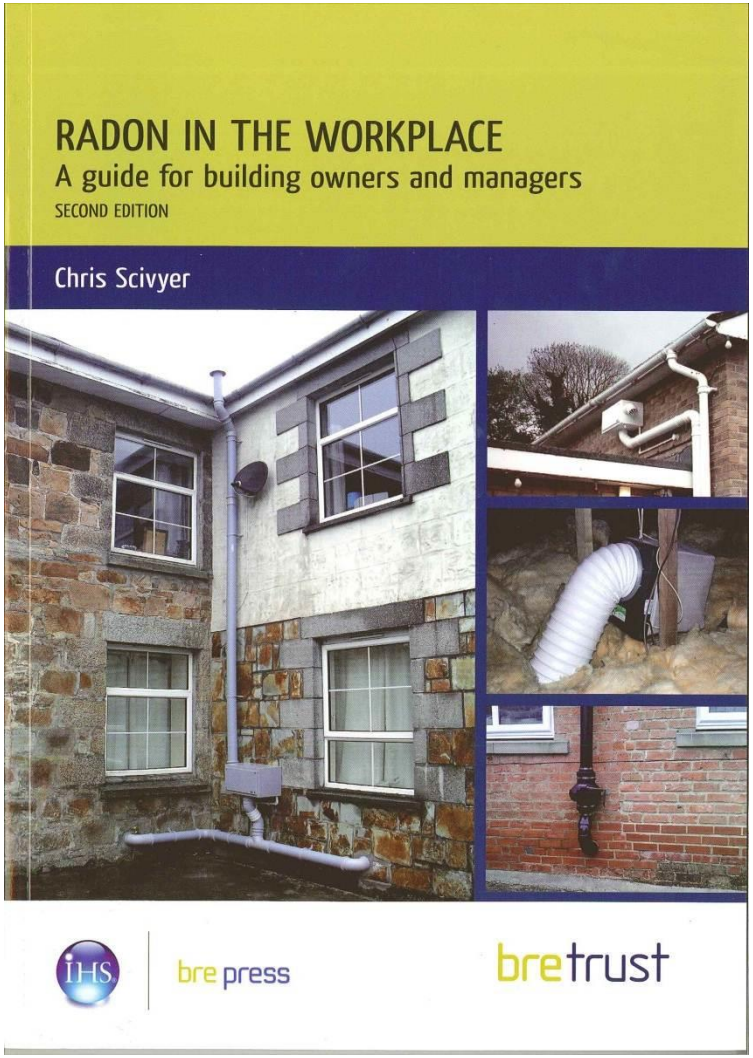


In development :

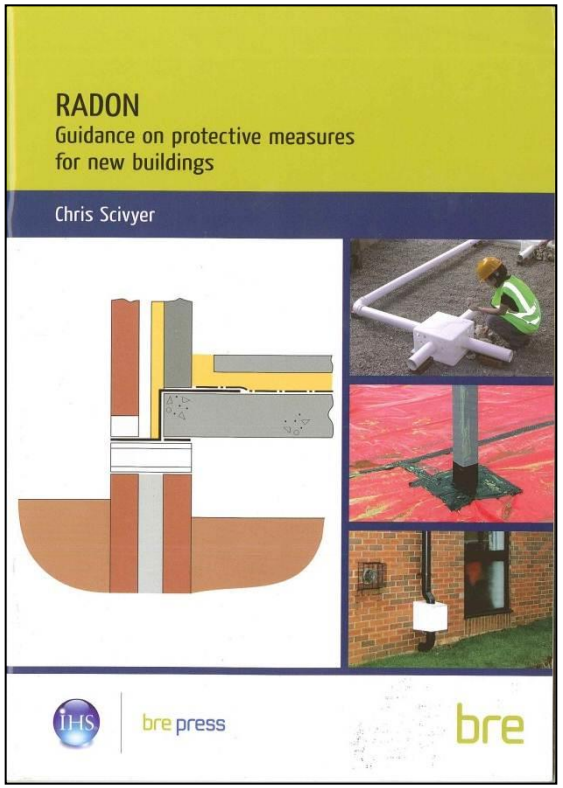
Radon Solutions in Homes: additional guidance for older buildings

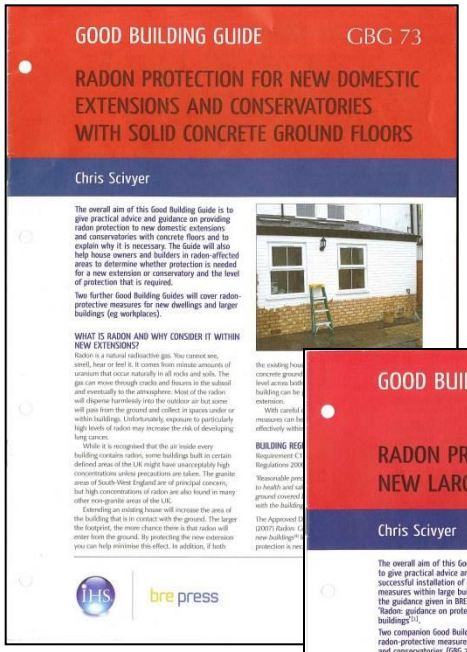
Guidance for workplace Buildings

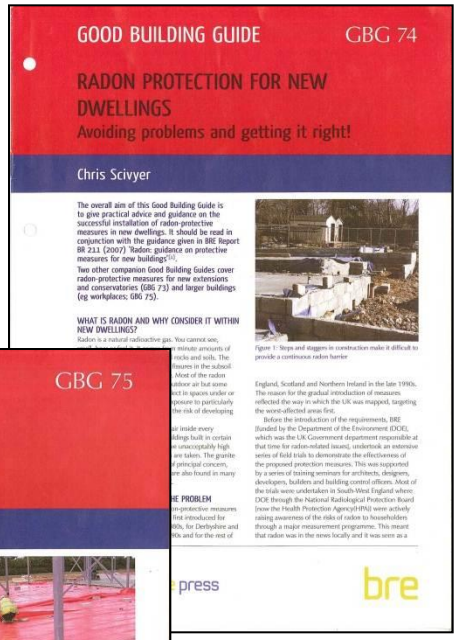
bretrust FB 41

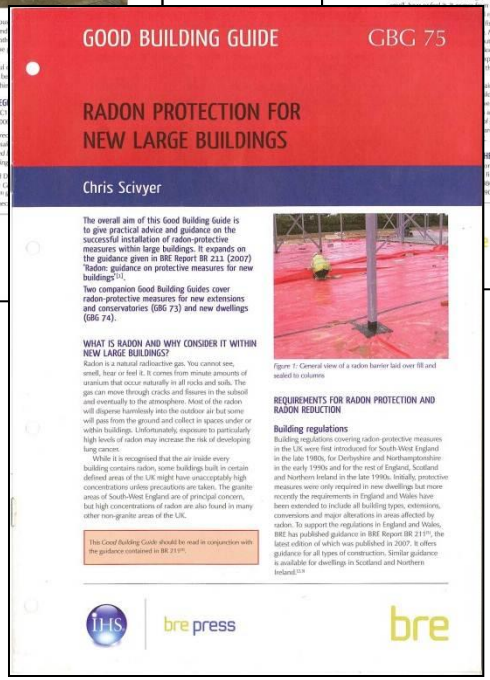


Guidance for new buildings









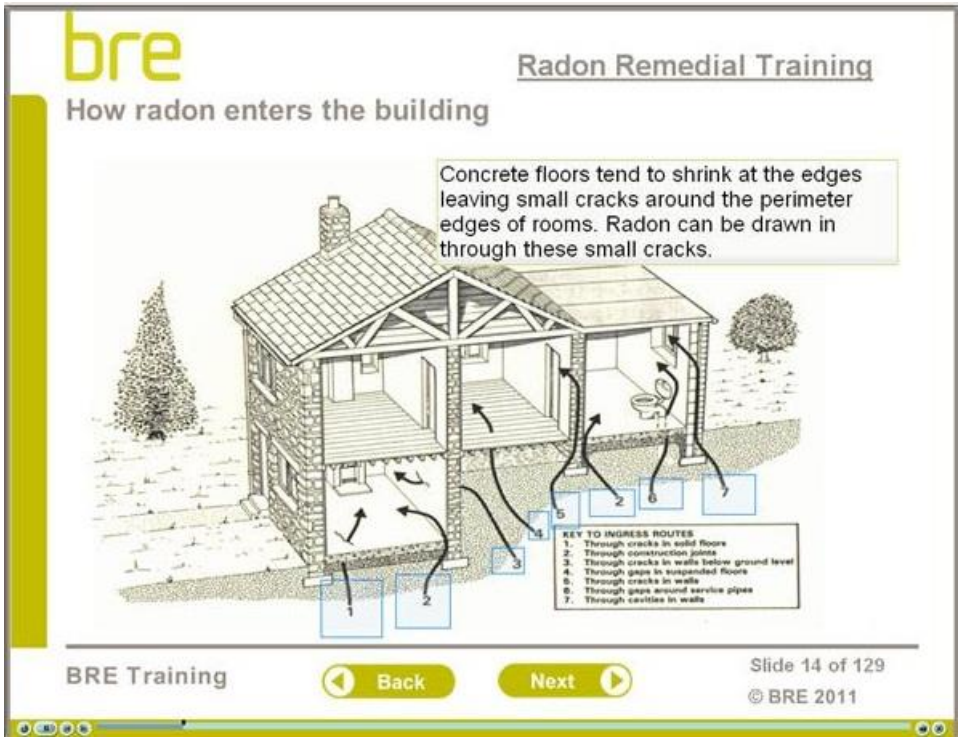
BRE Report BR211(2007)
Good Building Guides 73 and 74(2008) and 75 (2009)

www.bre.co.uk/elearning
www.bre.co.uk/training

BRE E-Learning

On-line radon awareness course

launched in the summer 2012



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And Finally…..

If all else fails ….

Remember…

– Most houses only require a single radon solution

– If there is an underfloor space ensure that it is kept clear and well ventilated.

– Fan powered systems must run continuously or they will crash!