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

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Dresden, December 2013
Introduction to radon and buildings
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
Figure 1  How radon enters a building

HOW RADON ENTERS A BUILDING

1. Through cracks in walls
2. Through cracks in solid floors
3. Through cracks in walls below ground
4. Through cracks in timber floors
5. Through cavities in walls
6. Through construction joints
7. Through gaps around service pipes
8. Through cracks in service ducts
9. Through construction joints
Reducing radon in existing buildings
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
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
External mini-sump system
External mini-(sump system)
External mini-ump system
Externally excavated mini – sump system with low level exhaust
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/m³
- 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/m³
  - 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

- 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/m³
  - Medium risk areas – areas where between 10% and 30% of existing unprotected houses expected to have radon levels exceeding 200 Bq/m³.
- 416 dwellings:
  - 121 in high risk areas
  - 295 in medium risk areas
• 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

<table>
<thead>
<tr>
<th></th>
<th>Unprotected</th>
<th>Protected</th>
</tr>
</thead>
<tbody>
<tr>
<td>In-situ concrete</td>
<td>194</td>
<td>87</td>
</tr>
<tr>
<td>Beam and Block</td>
<td>103</td>
<td>47</td>
</tr>
</tbody>
</table>

## Annual average indoor radon levels

<table>
<thead>
<tr>
<th></th>
<th>Unprotected</th>
<th>Protected</th>
</tr>
</thead>
<tbody>
<tr>
<td>In-situ concrete</td>
<td>130 Bq/m3</td>
<td>96 Bq/m3</td>
</tr>
<tr>
<td>Beam and Block</td>
<td>54 Bq/m3</td>
<td>20 Bq/m3</td>
</tr>
</tbody>
</table>
Long term protection

• The average radon level for the 134 protected homes in the 1990 study was **56.8 Bq/m³**

• We **retested** a sample of 70 homes in 2000 and found the radon results to average **58 Bq/m³** 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/m³**.

*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 minimum 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.nwap.org.uk.

The requirement for a site without a postal address is available through the British Geological Survey GeoReports service: http://geo.org.uk/GeoReports.

Level of protection required Setlements Roads National Grid
[ ] None Solihull Motorways 100-km
[ ] Basic Aylesbury Primary Roads 10-km
[ ] Full Luton Roads

Map 9 Oxfordshire, Northamptonshire and Warwickshire, 10-km grid square SP (axis numbers are the coordinates of the National Grid)

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Radon potential classification © Health Protection Agency and British Geological Survey copyright [2007]
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

- Radon barrier
- Floor topping
- Air gap
- Position for optional fan if needed later
- Suspended concrete floor
- Air vent
Possible working detail of full radon protection in a suspended concrete floor

- Floor topping
- Insulation
- Radon barrier sealed to cavity tray
- Suspended concrete floor
- Air vent
- Cavity filled to support cavity tray
- Position for optional fan if needed later
- Weep hole
- Cavity tray
Full radon protection in in-situ or ground-supported concrete floor (barrier under slab)

Alternative position for subfloor depressurisation pipe. Pipe must be sealed where it penetrates the membrane.

Subfloor depressurisation pipe
Radon barrier
Floor topping
Insulation
In-situ concrete floor slab

dpc
Cavity tray
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

Radon sump constructed from bricks with vertical joints left open.

Large air gaps

External wall
Condensate drain
Fan
Further guidance
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)
BRE E-Learning

On-line radon awareness course launched in the summer 2012

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