

Environmental **Radon** Newsletter

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Remediation Case Study Series 2. A terrace of houses

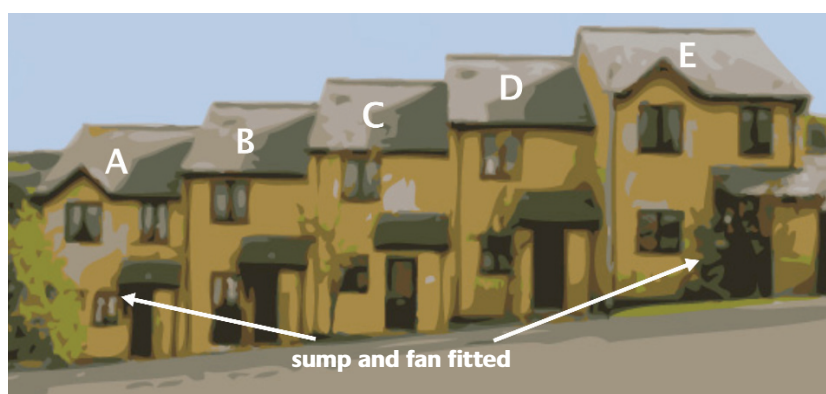
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This is the second in a series of case studies which have originated from work done by the Building Research Establishment (BRE) or others, demonstrating a range of practical and cost-effective radon reduction methods. This case study shows radon levels varying within a terrace and why properties in radon Affected Areas need to be assessed for radon risk individually.

A terrace of five houses, with rendered concrete block work cavity walls and in-situ concrete ground floor, was built on an incline in the late 1980's. The construction was typical for this period in the UK and the houses were not fitted with radon protective measures. Initially, the radon levels of houses A and E (see illustration) were measured and the seasonally corrected annual average concentrations were 2,300 Bq m⁻³ and 910 Bq m⁻³ respectively. The population-weighted indoor annual arithmetic mean radon concentration for the area is about 70 Bq m⁻³ so these levels were high, and well above the UK Action Level of 200 Bq m⁻³.

Discussions were held with the owners of each of the houses to see whether a communal approach could be applied to reduce all their radon levels simultaneously using a shared remedial system. If all five houses had similar radon levels, then an appropriate position to site a single shared sump system might have been in the middle house C. However measurements of radon levels in the houses ranged from 200 to 2,300 Bq m⁻³ and house C was the lowest (see Table 1). Consequently, sump and fan systems were sited in the two end houses A and E which recorded the highest levels. In house A, a low-level externally excavated sump and fan system was installed and in house E, the sump was constructed within the garage under the edge of the house with the fan situated in the garage and exhausted through the far wall of the garage at roof height. There were no problems encountered during installation. Further technical details of the sump systems used are described at www.bre.co.uk/radon/sumps.html (Sheets 6 and 9).

Retesting the radon levels in each house showed that the two sump and fan systems had significant effects with substantial reductions for all five houses, see Table 1. For the middle houses, radon levels were reduced by more than a factor of 10. For



Case study houses

houses A and E, radon levels were reduced by over a factor of 200 and 80 respectively. Results of a series of radon measurements over the following 10 years in house E remained low and the original fan was still running effectively at the end of that period.

Table 1 - Radon measurements and reduction factors

House	Seasonally corrected annual average radon concentration, Bq m ⁻³		Radon Reduction Factor
	Before remediation	After remediation	
A	2300	11	210
B	230	18	13
C	200	17	12
D	740	15	49
E	910	11	83

If houses share sump systems, problems may be encountered when the houses are sold. The new occupiers in the houses with the systems may or may not continue to run and maintain the systems. The solution is to set up a simple maintenance agreement to cover running and maintenance costs between the owners. This could be modelled on similar agreements such as for communal gardens and for access. Periodic checks should be carried out by home owners to check radon levels are still low. Measurements in this terrace of houses clearly show that radon levels can vary from house to neighbouring house: there are many factors which contribute to this

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POINTS OF CONTACT

www.UKradon.org provides general information on radon, and also an estimate of the probability that an individual property in the UK is above the Action Level for radon

Radon Survey
Centre for Radiation, Chemical and Environmental Hazards (CRCE)
Health Protection Agency
Chilton, Didcot, OX11 0RQ
Tel 01235 822622
email: radon@hpa.org.uk
www.hpa.org.uk/radon

Building Research Establishment (BRE)
Garston, Watford, WD2 7JR
www.bre.co.uk/radon

Health and Safety Executive
Health Directorate B6
Rose Court, 2 Southwark Bridge
London, SE1 9HF
Tel: 020 7717 6854
Fax: 020 7717 6717
www.hse.gov.uk/radiation/ionising/radon.htm

Welsh Assembly Government
Department for the Environment,
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Cathays Park, Cardiff, CF10 3NQ
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Industrial Pollution and Radiochemical
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Klondyke Building, Cromac Avenue
Gasworks Business Park
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email: IPRI@doeni.gov.uk
www.ni-environment.gov.uk/pollution-home/radiation/radon.htm

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The Radon Council Limited
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Fax: 0870 0518551
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www.radoncouncil.org

Laboratories validated by the HPA for making measurements of radon concentrations in homes are listed at: www.hpa.org.uk/radonvalidation

To obtain a report on the requirement for radon protective measures for building sites, go to <http://shop.bgs.ac.uk/Georeports> for sites in England and Wales, and www.ukradon.org for sites in the rest of the UK

UKradon.org - The UK reference site on radon, from the Health Protection Agency

Fero Ibrahimi, Health Protection Agency, fero.ibrahimi@hpa.org.uk

The UKradon.org website has been revamped and upgraded since its launch in November 2007 to provide more accessible and comprehensive information about radon in the UK.

It is operated by the Health Protection Agency (HPA) and draws on data developed jointly with the British Geological Survey (BGS). The website has seen an ongoing increase in usage since its launch, with visitors, views and referrals from search engines up from the same time last year. Over two-thirds of all new hits are still from first-time visitors to the site. Referrals from the websites of other organisations, such as the Health and Safety Executive and BGS, as well as from the main HPA website, remain steady. When the latest Indicative Atlas for England and Wales was published, an article in the Times newspaper at that time also mentioned the newly launched website. Two years on, a substantial proportion of visitors to the UKradon.org website are still being referred from Times Online.

Radon risk reports are now available using the website's 24-hour online service for any address in the United Kingdom with a valid postcode and any plot of land in Northern Ireland with a grid reference. For risk reports for plots of land in other parts of the UK, links are provided to the relevant HPA or BGS service. Radon risk reports provide the definitive answer to one of the standard legal enquiries for a house purchase in England and Wales, specifically the CON29 Standard Enquiry of Local Authority; 3.13 Radon Gas: Location of the Property in a Radon Affected Area. Most risk reports are for just one location, although

many users of the website check multiple locations throughout the year. Users can set up an online account to purchase reports without having to input payment details each time. Accounts are typically appropriate for those who require more than 10 radon risk reports each year, such as:

- Local authorities, to answer the CON 29R 3.13 radon local search question
- Solicitors, for conveyancing
- Property search providers
- Mortgage lenders
- Architects

The number of radon risk reports purchased through the website rose by over 50% compared with the same time last year, due to growing awareness of the site and partly perhaps to increasing confidence in the housing market. Feedback about the site has been very positive and has included comments that the system is simple to use and risk reports are clear.

As well as purchasing radon risk reports, users of the website can get further information about radon such as risks to health, how to measure and reduce radon levels, relevant building regulations and what to do when buying a property in a radon Affected Area or with high radon levels. The website also includes information on radon in the workplace and facilities to buy radon measurement packs online for both homes and workplaces. The HPA has developed the website further with more information about radon, particularly regarding remediation methods.

Remediation Case Study Series 2. A terrace of houses, continued

such as localised weather conditions (eg wind direction) and lifestyles of the householders (ventilation, central heating etc). Property owners in radon Affected Areas should never rely on a neighbour's measurement to assess their own radon risk.

Cost

An estimated cost for installation of two radon remedial sump and fan systems in a similar terrace of houses at current prices (2010) is given right.

Table 2 - Costs

	£
Equipment costs	800 - 1200
Labour costs approx 3 to 4 man days	420 - 700
Total cost excluding VAT	1200 - 2000

A bird's eye view of Anglesey: new information on radon susceptibility

Cathy Scheib, British Geological Survey, cemery@bgs.ac.uk

Uranium concentrations in surface rocks and soils can be a useful indicator of the potential for radon emissions from the ground. Uranium can be estimated by airborne surveys of gamma-rays from bismuth-214, one of the radon decay products. The result effectively reports short-lived radon decay product concentrations in the top 30 cm or so of the ground, and is referred to as eU (equivalent uranium).

A close correlation between airborne gamma-ray measurements and indoor radon concentrations has been demonstrated, for example, in the USA and Canada. Airborne gamma-ray measurement data has been used in Norway, Sweden, the Czech Republic and the USA to inform the production of radon potential maps*. In Northern Ireland, a statistical comparison of airborne gamma-ray measurements with in-house radon measurements concluded that a combination of gamma-ray data, soil permeability and soil geochemistry measurements could help predict radon potential**. The airborne gamma-ray measurements identified additional areas with high eU readings where radon risk may be higher compared with conventional radon maps. Further indoor radon measurements would be needed to confirm this. However, some known high radon areas did not show up on the airborne gamma-ray map, showing that these data must be interpreted with care.

An airborne geophysical survey was conducted jointly by the British Geological Survey (BGS) and the Geological Survey of Finland (GTK) over the Isle of Anglesey and part of the north-west coastal area of Gwynedd in June 2009. This multi-parameter survey was conducted at a detailed scale (200 metre line spacing) and at low altitude (about 50 m in rural areas and 250 m in urban areas). Areas where eU was high (see Figure 1) correlate well with the existing radon indicative map*** (see Figure 2). Some additional areas where eU appears relatively high which are not reflected in the radon map, for example some parts of Holy Island, may warrant further investigation.

After uranium concentration, the permeability and moisture content of rocks and soils are probably the next most significant factors influencing the concentration of radon in buildings. This is evident where the radon potential of bedrock is lowered when the rock is covered by superficial deposits with differing permeabilities. Figure 3 shows that, on Carboniferous limestone (the rocks with the highest radon potential on the Isle of Anglesey), the radon potential is lowered for a given concentration of eU where the bedrock is covered by lower permeability units such as clay, silt, sand and glacial deposits compared with areas free from superficial deposits. A more detailed investigation of the Anglesey data is currently underway; for more information contact the author.

* Smethurst, M. A., Strand, T., Sundal, A.V., Rudjord, A. L., 2008. Large-scale radon hazard evaluation of the Oslofjord region of Norway utilizing indoor radon concentrations, airborne gamma ray spectrometry and geological mapping. *Science of the Total Environment*, 407: 379-393.

** Appleton, J.D., Miles, J.C.H., Green, B.M.R., Larmour, R., 2008. Pilot study of the application of Tellus airborne radiometric and soil geochemical data for radon mapping, *Journal of Environmental Radioactivity*, 99:1687-1697.

*** *Indicative atlas of radon in England and Wales. HPA-RPD-033.* Miles et al 2007. HPA, Oxon. Available at www.hpa.org.uk (search term 'hpa-rpd-033').

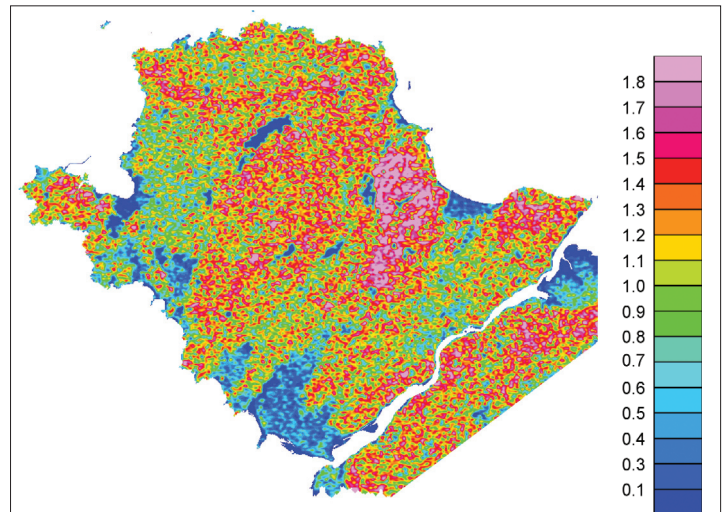


Figure 1- Map of equivalent uranium concentration (eU, ppm) across Anglesey as determined by airborne gamma-ray survey.

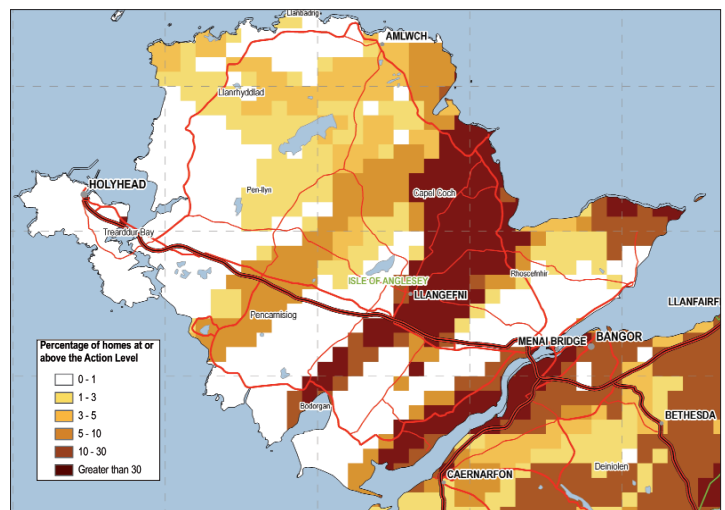


Figure 2 - Map of radon Affected Areas of Anglesey.

Colours show the maximum percentage band within each 1-km grid square of the national grid. © Crown copyright. All rights reserved [Health Protection Agency] [1000016969] [2007]. Radon potential classification © Health Protection Agency and British Geological Survey copyright [2007]

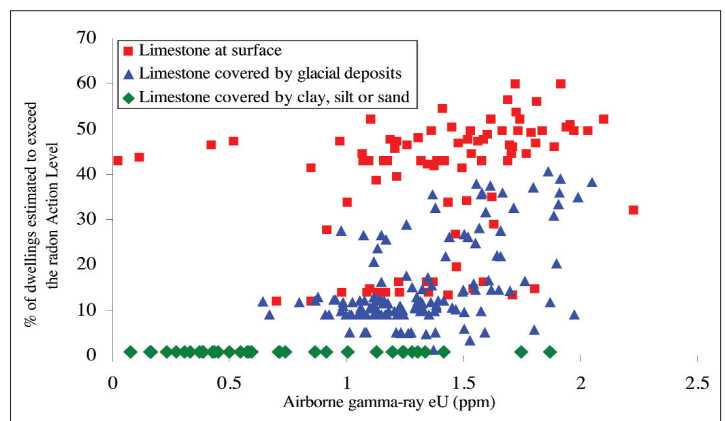


Figure 3 - Relationship between radon potential and airborne gamma-ray eU data on limestone bedrock with no superficial deposits, and on limestone where the bedrock is covered with glacial deposits and clay, silt or sand.

Exploring response rates to radon measurement surveys

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The Health Protection Agency (HPA) works closely with local authorities and Directors of Public Health to undertake targeted campaigns that offer free radon measurements to householders around the UK in high radon Affected Areas. The response rate of householders to these offers has generally increased over time as the expertise of the HPA's radon team has developed. For the most recent survey, the HPA tested three types of reminder letter to see if positive response rates could be improved.

The current procedure is to address individual invitations for a free test to the occupier of the target properties. The invitation is from the local authority and is supported by letters from the HPA and the local Director of Public Health, and includes a specially designed leaflet about the local programme. The leaflet contains information about radon, the survey and the contact details of the relevant organisations. A reminder letter from the HPA is sent to non-responders after around four weeks; the local programme leaflet is not usually included a second time. This approach has been used for radon measurement surveys undertaken by the HPA since 2006. The positive uptake of the offer, using this style of survey, is on average around 30% for the initial letter and a further 13% following the reminder letter, with a typical total uptake in the range 40 to 47%. However, where the area has had a previous free offer, the positive response can be as low as 30%.

The most recent survey started in October 2009 in areas of Cornwall with a 30% or greater chance of the property having a radon level that requires action. Free tests were offered to around 15,600 householders who had not previously had a test. The article by Lee Wagland in the Environmental Radon Newsletter, Issue 61, gives further details. The initial invitation letters were sent to householders and a positive response was received from some 3,600 (23%) of them.

In order to try and improve the response from the reminder letter, and following a suggestion from an involved householder, the opportunity was taken to test whether adding additional information would improve uptake of the offer. The 12,000

non-responders were split without geographical bias into three equal groups of around 4,000 dwellings. Householders in the first group were sent the reminder letter and a pre-paid return envelope. The second group received, in addition to these, a general information booklet on radon. The third group received, in addition to the reminder letter and return envelope, a selection of more detailed, recently published radon fact sheets on several aspects including; *What is radon*, *Measuring radon*, *The risks from radon* and *Radon and house purchase*. Householders were given a further four weeks to respond to the offer.

The total number of positive responses for the three groups is given in the table. Although there is no significant difference between the responses from the different groups, the trend indicates that additional information does not improve positive



response compared with sending a reminder letter only. The uptake from all the reminder letters was a further 1,582 positive responses from householders, some 10% of the total offered, giving an overall rate for this survey of around 33%. This response is lower than normal which may reflect the specific characteristics of the area covered by this programme. This study confirms that receiving additional information does not improve uptake from a postal reminder. Average householder decision-making process is therefore not reliant on receiving additional information. Further work continues to determine the best ways to improve response rates for future radon programmes.

Additional information accompanying reminder letter	Positive responders to reminder letter	% of overall response
None	565	3.6
Simple information booklet on radon	529	3.3
More detailed fact sheets: What is radon? Measuring radon The risks from radon Radon and house purchase	486	3.1
Total	1582	10.1

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