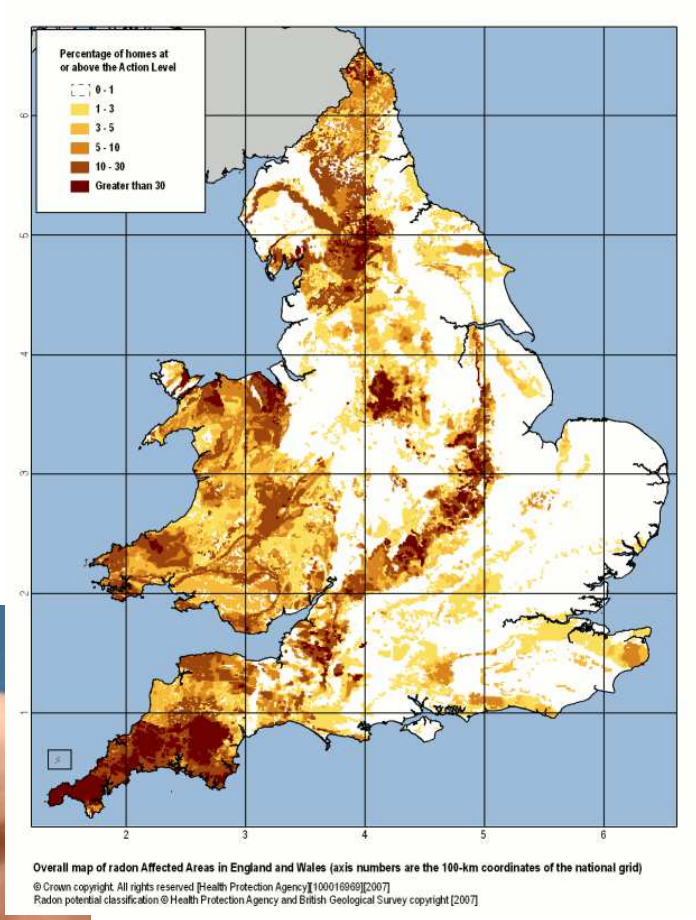

Overall map of radon Affected Areas in England and Wales (axis numbers are the 100-km coordinates of the national grid)

Strategy to measure and remediate radon levels in Powys owned housing stock

Powys County Council

Housing Services

Powys

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Executive summary

The radioactive gas radon is a hazard in many homes and workplaces. Breathing in radon is the second largest cause of lung cancer in the UK resulting in up to 1,100 fatal cancers per year. However, radon hazards are simple and cheap to measure and can be relatively easy to address if levels are high. Public Health England have published reports containing radon affected area maps for the whole of the UK, as shown in Appendix 1.

Landlords have a responsibility to their tenants under their duty of care and the Housing Act to provide a safe home. Radon is identified as a potential hazard in dwellings in the Housing Act 2004. The need for action is defined by the Housing Health and Safety Rating System (HHSRS).

In 2017 Powys County Councils Housing Services commissioned the Radon Group, Public Health England to carry out an indicative postcode search on all council owned properties. The results give an indication of likelihood of high radon levels. The results of the indicative postcode search were found to be: 484 properties (10-30% probability); 1211 properties (5-10% probability); 600 properties (3-5% probability); 1758 properties (1-3% probability); and 1321 properties (less than 1% probability). Even in the highest probability bands, not all properties will have high levels, the only way to establish actual levels in a property is to monitor.

It is proposed to implement a three phase radon monitoring programme in all Council owned properties identified in the indicative postcode search with a likelihood of 5% or greater, of approximately 1,700 properties. It is proposed to structure the programme as follows:

Phase 1 – An initial 9 month period monitoring approximately 50-75 properties on one or two estates from the highest probability category (10-30%)

Phase 2 – A further two year monitoring programme monitoring the remaining properties in the 10-30% probability category (approximately 425 properties)

Phase 3 – A five year programme monitoring all properties in the 5-10% likelihood (approximately 1211 properties)

Monitoring should be undertaken during normal occupancy conditions and after major improvement works have been completed. Remedial measures such as fans and sump pumps will be required where high levels are identified, in addition to follow up monitoring to ensure measures are having the necessary impact. Assets will need to be checked and maintained as part of an ongoing cyclical maintenance regime to ensure acceptable levels are sustained.

1. Introduction

Radon is a 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. Radioactive elements decay and emit radiation. Any exposure to radiation is thought to be a risk to health - radiation is a form of energy and can cause damage in living tissues increasing the risk of cancer. Radon is identified as a potential hazard in dwellings in the Housing Act 2004 and the Housing Health and Safety Rating System (HHSRS).

Powys County Councils Housing Services manage approximately 5,400 properties, spread across Powys. Radon maps show variations in radon levels across areas in Powys, however even in the areas with the greatest likelihood, not all buildings will have high radon levels.

This report proposes to carry out a radon monitoring programme in approximately 1,700 Council owned properties identified as having a probability of 5% or greater over the next 7 years 9 months. Where high levels are identified, remedial works will be required to bring levels within acceptable limits, as described in this report. Public Health England recommends that radon levels should be reduced in homes where the average is more than 200 Bqm^{-3}. The Target Level of 100 Bqm^{-3} is the ideal outcome for remediation works in existing buildings and protective measures in new buildings. If the result of a radon assessment is between the Target and Action Levels, action to reduce the level should be considered, especially if there is a smoker or ex-smoker in the home. Follow-up monitoring will be required to check that remedial measures are sufficiently mitigating radon levels, as described in this report.

We consider the general awareness of health risks associated with radon to be relatively low. We seek to raise awareness by working with a partner experienced in rolling out radon monitoring programmes in social housing and by planning engagement activities as described in this report.

2. Background

Radiation

We are all exposed to radiation from natural and man-made sources. Just 20 Bqm-^{3}, the average radon level in UK homes gives us half our exposure to radiation from all sources. Higher radon levels give higher exposures, which is why it is important to find out the levels in your home.

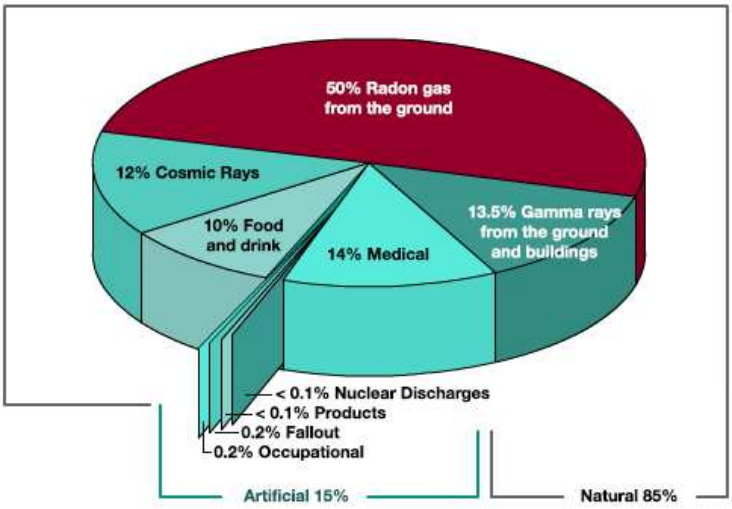


Figure 1 Breakdown of sources of radiation exposure (Public Health England © Crown copyright 2018)

Radon is a colourless, odourless radiative gas. It is formed by the radioactive decay of the small amounts or uranium that occur naturally in all rocks and soils.

Radioactive elements decay and emit radiation. Any exposure to radiation is thought to be a risk to health – radiation is a form of energy and can cause damage in living tissues increasing the risk of cancer.

Where is radon found?

Radon is everywhere; formed from the uranium in all rocks and soils. Radon levels outdoors are low everywhere but levels indoors can be higher. For most homes the risk to people's health is small. An indicative map of radon affected areas in England and Wales is found in Appendix 1. The darker the colour on the radon maps, the greater the chance of a high level in a building. However, not all buildings, even in the darkest areas have high levels.

What is a low level?

The amount of radon is measured in bequerels per cubic meter of air (Bqm^{-3}). The average level in UK homes is 20 Bqm^{-3}, where individual risk remains relatively low and is not a cause for concern. However, the risk increases as the radon level increases.

What is radioactivity and radiation?

Radioactivity is where unstable elements, such as naturally occurring uranium, thorium and radon, break down: energy is released and different elements formed. The new elements may also be unstable so the process is repeated until a stable element is formed. The energy given off is called radiation and can be alpha or beta particles or gamma rays.

Alpha particles are more harmful than beta particles or gamma rays. This is because alpha particles contain more energy and are absorbed over a smaller area. The radioactive elements formed by the decay of radon can be inhaled and enter our lungs. Inside the lungs, these elements continue to decay and emit radiation, most importantly alpha particles. These are absorbed by the nearby tissues and cause localised damage. This damage can lead to lung cancer.

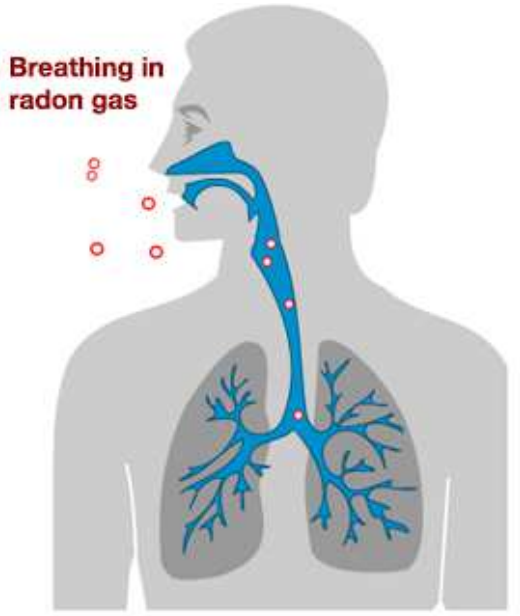


Figure 2 Breathing in radon gas

Radon affected areas

Public Health England (PHE) have published reports containing radon affected area maps for the whole of the United Kingdom, as shown in Appendix 1. The maps show areas broken down into the following probability categories:

- 0-1%
- 1-3%
- 3-5%
- 5-10%
- 10-30%

Radon risks

Any radiation exposure carries a risk: the greater the exposure, the higher the risk. Radon is now recognized to be the second largest cause of lung cancer in the UK after smoking, and is linked to over 1,100 cases of lung cancer each year in the UK. 85% of these lung cancers occur among current smokers and ex-smokers. Lung cancer is also the biggest cause of cancer related death in the UK and only 5% of all lung cancers are curable.

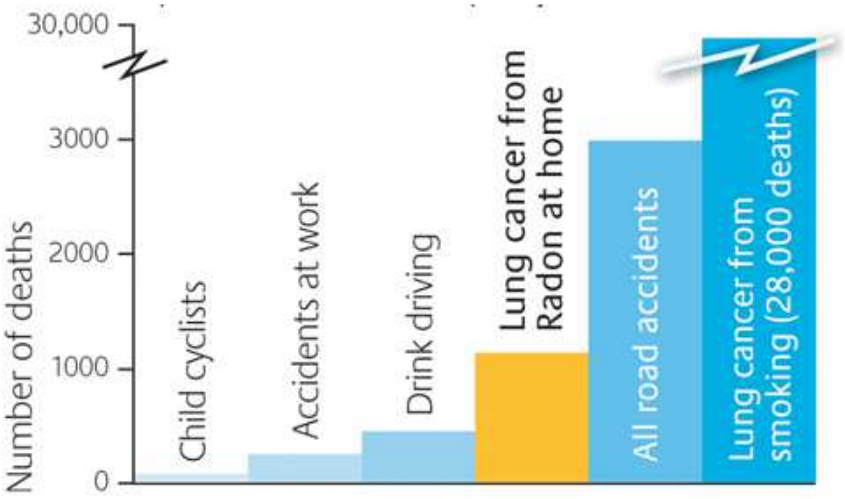


Figure 3 Radon deaths compared with other causes of premature deaths in the UK

(Public Health England © Crown copyright 2018)

Radon contributes by far the largest component of background radiation dose received by the UK population. The risk from radon is approximately twenty five times higher for cigarette smokers than for non-smokers.

Radon in homes

Every building contains radon, but the levels are usually low. The chances of a higher level depend on the type of ground. Radon levels vary between neighboring home with different living styles. To find out the level in your home, you have to measure when you are living there.

Inside buildings, the air pressure tends to be lower than outside, so radon is drawn in through the gaps in the floor.

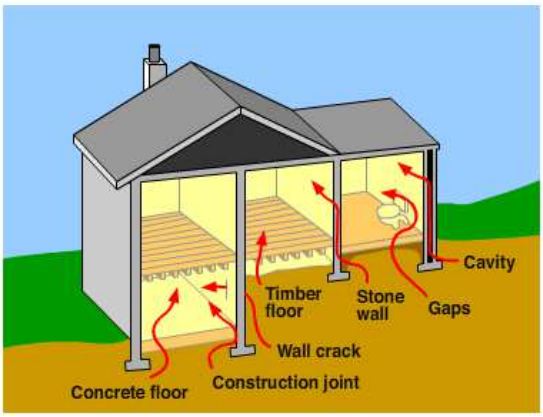


Figure 5 Radon entering a property

(Public Health England © Crown copyright 2018)

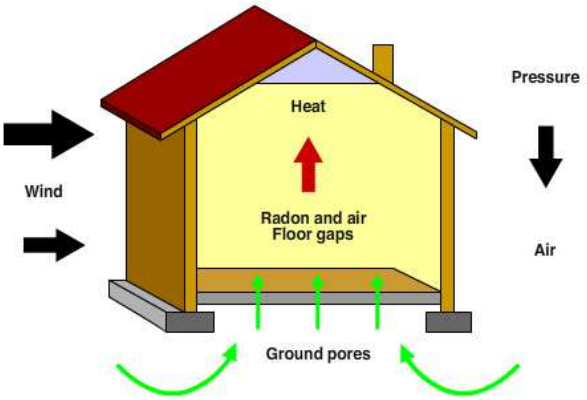


Figure 4 Radon entering a building due to wind driven ventilation

(Public Health England © Crown copyright 2018)

Radon monitors can be purchased from various organisations. A typical detector is shown in Figure 6 Typical radon detector. The detectors contain a piece of clear plastic which is sensitive to radon. At the end of a three month period the householder returns the detector for analysis. Although 7-10 day monitors are available, it is recommended to monitor for a period of three months, as radon levels vary:

- From hour to hour as windows and doors are opened and closed during the day;
- From day to day as levels naturally vary; and
- Seasonal variations.

Figure 6 Typical radon detector (Public Health England © Crown copyright 2018)

Radon causes invisible damage to the plastic inside the detector. The amount of damage is measured with an image analyser and the exposure calculated from the result. The householder / landlord is informed of the result and written to with a copy of the results.

Reducing radon levels

Public Health England recommends that radon levels should be reduced in homes where the average is more than 200 Bqm^{-3}.

The Target Level of 100 Bqm^{-3} is the ideal outcome for remediation works in existing buildings and protective measures in new buildings. If the result of a radon assessment is between the Target and Action Levels, action to reduce the level should be considered, especially if there is a smoker or ex-smoker in the home.

Employers responsibility

Under UK Regulations all employers must review the potential radon hazard in their premises. The Ionising Radiations Regulations 2017 (IRR17) come into effect where radon is present above the defined level of 300 Bqm^{-3} and employers are required to take action to restrict resulting exposures. The IRR17 replaced the Ionising Radiation Regulations 1999 (IRR99) on the 1st January 2018.

3. Radon and Powys' housing stock

Indicative postcode search

In 2017 Powys County Councils Housings service commissioned the Radon Group (Public Health England) to carry out an indicative postcode search on all of our housing stock. The breakdown of properties by probability band is shown in the table below:

Shire	Less than 1%	1 to 3%	3 to 5%	5 to 10%	10 to 30%	Total
Brecknockshire	740	690	34	378	112	1954
Montgomeryshire	212	887	500	767	218	2584
Radnorshire	369	181	66	66	154	836
Total	1321	1758	600	1211	484	5374

Table 1 Breakdown of properties by probability levels

Locations where high levels have been found

The "Radon in Homes in Wales: 2016 Data Report" identifies the following areas in Powys where previous domestic radon monitoring results have exceeded 1000 Bqm^{-3}:

- Llanrhaedr Ym Mochnant
- Rhiwcynon
- Knighton

Powys County Councils Education Service has previously carried out radon monitoring and remediation work in schools. This has identified the following areas which were found to have properties with radon levels exceeding 1000 Bqm^{-3}, prior to remedial works being undertaken:

- Llanfaes
- Llanidloes
- Presteigne
- Machynlleth
- Rhayader
- Kerry

Interestingly few properties in the areas listed above managed by Powys Housing Services fall in the 10-30% probability group.

Camlad and Clywedog House

The ground floor flats at Camlad and Clywedog House, Newtown were identified as potential locations for carrying out a pilot radon monitoring project. The property is to be externally insulated, so this would enable a very crude comparison to be carried out monitoring before and after the works. Interestingly, although Camlad and Clywedog

House fall in the 1-3% probability category, Treowen CP School, directly opposite falls in the 5-10% probability category.

In November 2017, after the local Housing Management and Options Officer informed the tenants of the work, the Radon Group (PHE) sent letters to the tenants, and the local Councillor was informed, monitors were put in place in four ground floor flats for a three month period. Two monitors were put in each flat, one in the main bedroom and one in the living room. Three of the four flats had their monitors returned to the Radon Group in early February 2018 for analysis.

4. The Way Ahead

Monitoring Programme

It is proposed to implement a 7 year 9 month radon monitoring programme within Powys County Councils housing stock in all properties with a likelihood of 5% or greater (1,695 properties). It is proposed to base the programme on a probability basis, rather than where the highest levels have been identified to seek to target the greatest number of properties with actionable levels, as follows:

Phase 1 – 50-75 properties, 10-30% probability

An initial 9 month period of monitoring 50-75 properties on an estate(s) from the 10-30% probability category where no major improvement work is planned. This phase will ideally include initial monitoring, remedial works, follow up monitoring and evaluation.

Phase 2 – 409-434 properties, 10-30% probability

Subject to Phase 1 being a success a two year monitoring programme monitoring the remaining 409-434 properties in the 10-30% likelihood bracket. This phase will include initial monitoring, remedial works, ongoing monitoring and evaluation.

Phase 3 – 1211 properties, 5-10% probability

Subject to Phase 1 and 2 being a success, implement a five year programme monitoring 1211 properties in the 5-10% likelihood. To include initial monitoring, remedial works, ongoing monitoring and evaluation.

Monitoring should be carried inaccordance with the following:

- Properties should be occupied under normal patterns of occupancy;
- Monitoring should not be carried out prior or during major improvement works which will impact on ventilation levels and the results; and
- The timeliness of placing and returning the monitors is key so that the monitors do not record background data.

It should be noted that the number of properties requiring remedial works / interim monitoring will have a lag effect on the programme. For instance where monitoring is carried out under phase 2, if levels are found to be high, and remedial works are required, once the remedial works are completed the property will need to be re-monitored which may occur during phase 3 to ensure that the levels have been brought within acceptable limits. If levels have not been brought within acceptable limits, further remedial works and a third set of monitors will be required for that property, and so on, until levels have been brought under control.

It maybe appropriate to accelerate or decelerate the programme accordingly, depending on the outcome of the number of properties found to have notifiable levels to ensure that the appropriate action is taken for properties with high levels. An important consideration is ensuring that the remedial works are dealt with in a timely manner to reduce ongoing

monitoring and show that the Landlord is committed to reducing levels once a problem has been identified.

Placing Monitors

The Radon Group have suggested a number of ways a radon monitoring programme could be rolled out:

a) Placement of monitors by nominated staff or contractor;
b) Sending measurement packs directly to tenants;
c) Writing to tenants offering/requesting they complete a radon measurement and send packs only to those who reply positively; or
d) Arrange tests for new tenants only and make it a condition of the tenancy agreement.

We have discussed the options with the Radon Group about their experiences rolling out radon monitoring programmes in social housing. The Radon Group recommend option b) sending measurement packs directly to tenants. The Radon Group have experienced issues with where the housing provider has managed the programme and put the monitors in place due to monitors being put in the wrong properties, questionnaires not being completed, timeliness collecting and retrieving monitors and gaining access to properties.

Engagement

We have met with or sought advice from the Radon Group, other social housing providers in Wales, representatives from Powys Teaching Health Board and Powys' Health and Safety Adviser for Education to share experiences and inform our proposals for rolling out a radon monitoring programme.

We understand that there is little knowledge of radon generally and associated health risks so propose to raise awareness in our stock by the following means:

- Article in 'Investing in your Home' newsletter
- Discussions with tenant representatives at Tenant Liaison Forum/sub-group
- Involvement in estate days and events – the Radon Group have leaflets for hand-outs
- Inform Local Councillors/all Councillor e-mail in areas where works will be taking place
- Joint letters sent from Public Health England and PCC prior to the works being undertaken (please refer to attached PDF)
- Tenants will be provided with a phone number for the Radon Group should they have any queries about the work

Good Practice Case Study – Events
(Radon in Scottish Homes targeted programme supported by funding from the Scottish Government)
"The events were staffed by the HPA Radon team, technical building experts from the Building Research Establishment, officers from the local council and, in some cases, representatives of social housing landlords and the smoking cessation team of the local health board. Commercial remediation contractors were invited to attend or to send a supply of information leaflets."

How to reduce radon levels

The ground is the main source of radon. The aim of remedial work is to reduce radon levels as low as possible. There are several methods that can be used to reduce high radon levels.

Some simple actions such as sealing around loft-hatches, sealing large openings in floors and extra ventilation do not reduce radon levels on their own. When combined with other effective measures, they can improve the reduction of radon levels. Completely sealing floors is difficult and can cause rot in wooden floors. The diagram below is intended as a guide for the types of measures which maybe suitable:

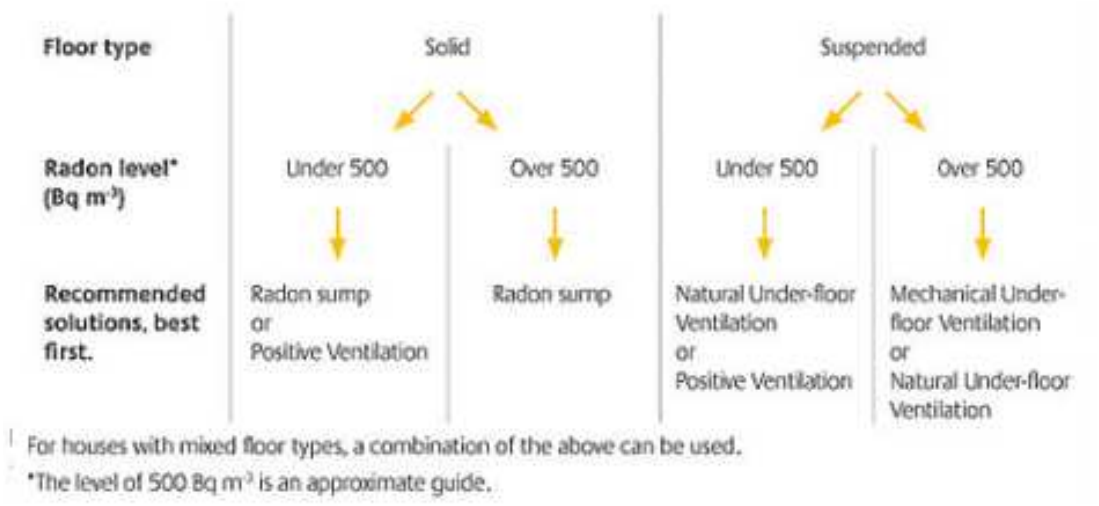


Figure 7 Remediation methods which can reduce radon levels in homes

(Public Health England © Crown copyright 2018)

Further details of typical remediation measures are shown in Appendix 2. Where significantly high levels are found, it is likely that we will need to procure the services of a Radiation Protection Adviser (RPA).

Costs

Initial Monitoring Costs

At the start of the programme, the majority of the costs are anticipated to be associated with staffing costs associated with identifying properties, ensuring contact information is

correct, attending events/engagement activities etc. Costs are likely to be based on the following:

- A monitoring pack cost of £37.50 per property (to include 2 monitors, results letter, helpline number for queries)
- Initial letter to be sent out by PCC
- Joint letters to be sent out by the Radon Group at a cost of £1 per letter
- Assuming a project/programme Officer of an initial 3 days per week to manage the project, increasing to 4 days p/w as the programme expands (flexible depending on level of engagement required).

Remedial Work Costs

Remedial work costs depend on many factors, including the complexity of the building and whether any additional work is required. A Contracts Officer / Surveyor will be required to project manage the remedial works. The table below shows approximate costs for measures installed by a contractor (apart from the DIY sump):

Remedy	Typical cost	Normal range
Active Sump (with fan)	£800	Up to £2,000
Active Sump (DIY)	£300	Up to £700
Passive Sump (without fan)	£450	Up to £1,000
Natural Under-floor Ventilation	£200	Up to £600
Active Under-floor Ventilation	£700	Up to £1,500
Positive Ventilation	£550	Up to £1,000

Table 2 Indicative radon remediation costs (Public Health England)

The indicative costs above don't include for resource or additional work required to the property (e.g. asbestos survey, redecoration). The assistance of a Radiation Protection Adviser (RPA) will be required for complex properties or properties with particularly high levels.

Follow-up Monitoring Costs

Once remedial works have been completed, providing the original test is ordered from the Radon Group there is no charge for a secondary test. If the second test results are not within acceptable limits, additional remedial works and further monitoring will be required, until the levels have been brought within acceptable limits.

Cyclical Maintenance Costs

Provision should be made for active systems (fans, sump pumps etc) to be recorded in a cyclical maintenance programme of work to ensure the assets are operational.

Asset management

After the remedial works have been completed, and the levels have been brought within acceptable limits, the Landlord has a duty to periodically check that the systems/ remediation works remain effective in reducing levels. The assets and frequency of

testing/inspection for equipment such as fans and sump pumps will need to be recorded, logged and built into a planned maintenance regime.

5. Questions for Discussion

Q1 - Large Estates

Powys County Councils Housing Service manages 210 properties on the Maesyrhandir Estate, Newtown. Of the 210 properties, 68 properties fall in the 1-3% probability category, 112 properties fall in the 5-10% probability category and 30 properties in the 10-30% probability category.

By following the proposal to monitor properties in the 5% or greater probability bracket, 142 of the 210 properties on the estate would be monitored.

Is this OK? Or do we need to consider alternatives situations, such as estate wide approaches? This will take longer to complete monitoring the medium/high probability properties, add cost and extend the project programme.

Q2 - Properties with a probability of less than 5%

If a tenant lives in a property which falls in the 5% or less likelihood bracket, but has specific concerns and a desire to have their property monitored, do we accommodate their request?

Q3 – Engagement

The Radon Group have found during previous monitoring programmes that good communication with tenants is key to completing successful tests. As a minimum they recommend sending a letter to tenants to inform them why you are testing, how the test works, what it looks like and what they need to do. However some local authorities and housing associations have also completed press releases, announcements on their websites and approached tenants directly.

Section 4 of this report contains details of a good practice case study of events held during the Radon in Scottish Homes targeted programme.

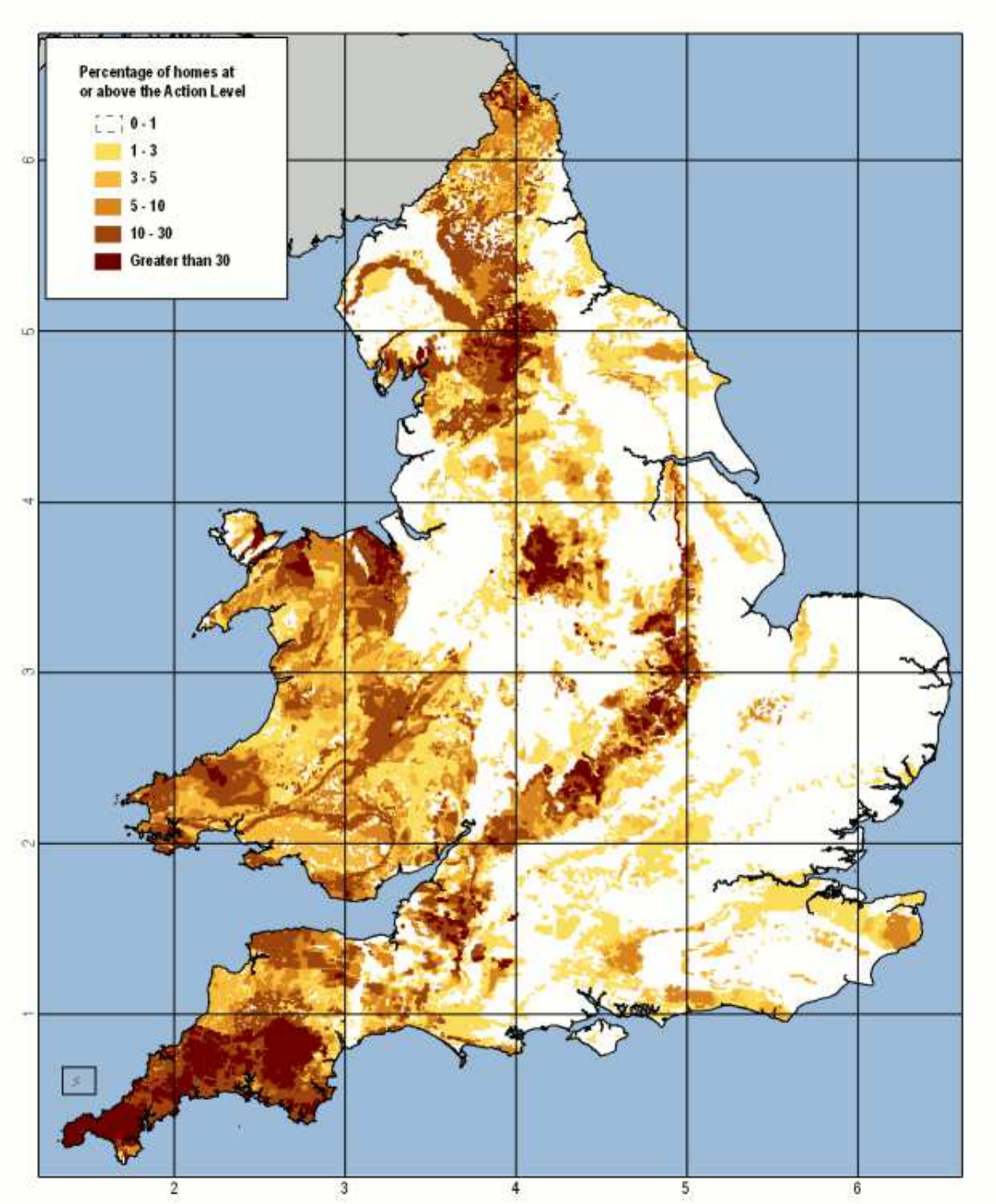
We propose to raise awareness of radon and the monitoring programme by the following means:

- Article in ‘Investing in your Home’ newsletter
- Discussions with tenant representatives at Tenant Liaison Forum/sub-group
- Involvement in estate days and events – the Radon Group have leaflets / templates we can use for hand-outs
- Inform Local Councillors/all Councillor e-mail in areas where works will be taking place
- Send tenants joint letters sent from the Radon Group and PCC prior to the works being undertaken (please refer to attached PDF)
- Tenants will be provided with a phone number for the Radon Group should they have any queries about the work.

What are your views on this approach? Are there additional approaches and activities you think we should consider? Do you think any of these aren’t necessary?

Appendix 1 Indicative map of radon affected areas in England and Wales

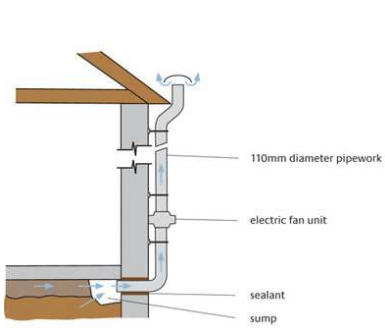
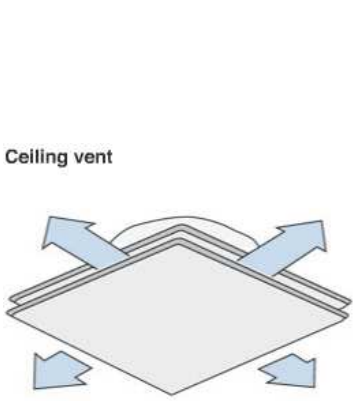
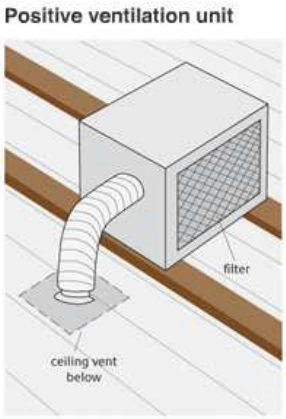
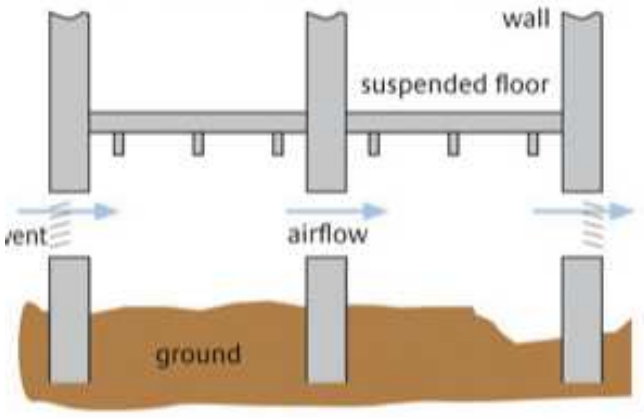
Source: Indicative Atlas of Radon in England and Wales, Health Protection Agency and British Geological survey, 2007 (this page and front cover)
http://www.ukradon.org/cms/assets/gfx/content/resource_2686cs3a0844cee4.pdf
(Public Health England © Crown copyright 2018)

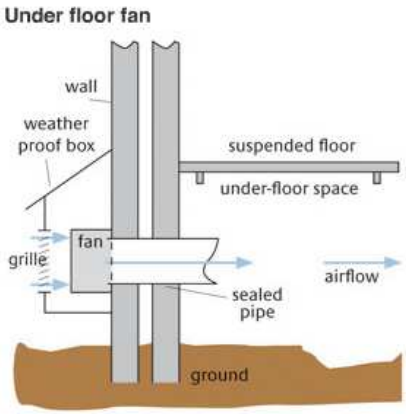
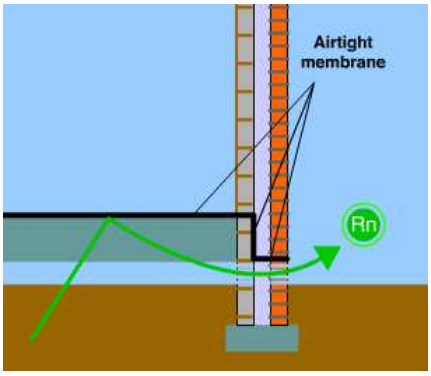


Overall map of radon Affected Areas in England and Wales (axis numbers are the 100-km coordinates of the national grid)

Appendix 2 Typical remedial measures

(Source of images: Public Health England © Crown copyright 2018)

Radon Sump	
An active radon sump, fitted with a fan, is the best way to reduce indoor radon levels. Sumps work effectively under solid floors, and under suspended floors if the ground is covered with concrete or a membrane. Occasionally, passive sumps without a fan may reduce radon levels. The typical cost of a system is £800, but might be up to £2000; installation normally takes a day or two. The continuous running cost of a fan (less than 100 Watt) will normally be less than £2 per week.	 
Positive ventilation	
Positive ventilation brings fresh air into a home, and dilutes the radon. The flow of air and radon from the ground may also be reduced. A positive ventilation system can be effective in homes with radon levels up to and around 500Bqm^{-3}. A small fan blows air, usually from the roof space, into the home.	 
Underfloor natural ventilation	
Many homes have a suspended ground floor with a space underneath. Good ventilation of this space can reduce indoor radon concentrations.	
Underfloor fan	

When natural ventilation under a suspended floor is inadequate to reduce the radon level, active under-floor ventilation can be installed. A fan is used to either continuously blow air into or extract air from the underfloor space. Both ways can be successful.	
Radon Membrane (new build properties)	
For new houses, simple measures can be taken cheaply during construction to prevent high radon levels. This diagram shows an airtight membrane across the floor and through the walls.	

Appendix 3 Further reading and sources of information

UK Radon Group, Public Health England
http://www.ukradon.org/

General information about radon
http://www.ukradon.org/information/radonataglance

UK maps of radon, Radon Group, Public Health England
http://www.ukradon.org/information/ukmaps

Health and Safety Executive, radon information
http://www.hse.gov.uk/radiation/ionising/radon.htm

Building Research Establishment, Radon
https://www.bre.co.uk/radon

British Geological Survey, radon data: indicative atlas of radon
http://www.bgs.ac.uk/radon/indicativeRadonDataset.html

Indicative atlas of radon in England and Wales
http://www.ukradon.org/cms/assets/gfx/content/resource_2686cs3a0844cee4.pdf

Radon in Homes in Wales: 2016 Data report
https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/602520/Wales_data_report_2016.pdf

Radon in Scottish Homes, report of a targeted programme
https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/340132/HPA-CRCE-042_for_website.pdf