Guidance for Local Authority Officers for Sampling and Testing for Radon in Private Water Supplies

Guidance: Radon in private water supplies

Introduction

This guidance is to assist local authorities implement a radon monitoring programme for private water supplies intended for human consumption, as defined within the Private Water Supplies (Wales) Regulations 2017.

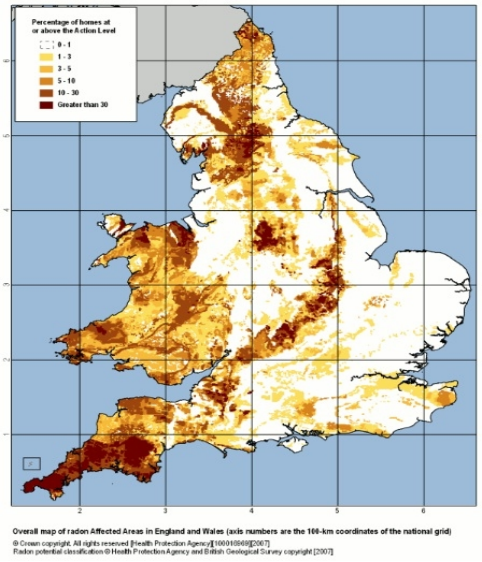
What is Radon?

Radon is a colourless, odourless radioactive gas, Radon is formed by the radioactive decay of the small amounts of uranium that occur naturally in all rocks and soils. It is a ‘noble’ gas that moves easily through the ground.

Radon has a four-day half-life and decays to particulates that can be inhaled and that emit alpha (α) radiation which damages lung tissue and is measured in units of Becquerel per cubic metre of air, Bq m-3.

Where is Radon found?

It is naturally occurring and found everywhere, however levels will vary depending on the underlying geology.



Radon Affected Areas show where >1% homes exceed 200 Bq m-3 Action Level

The darker the colour the greater the chance of a higher level.

Affected Areas are based on radon measurements in existing homes,

Indicative map of radon affected areas in England and Wales produced by Public Health England and British Geological Survey. http://www.ukradon.org/information/ukmaps

Why is radon harmful to us?

Radon increases your risk of lung cancer. The higher the radon, the longer the exposure, the greater the risk.

Radon causes over 1,100 deaths from lung cancer each year in the UK. The risk from radon is higher if the person is an ex-smoker and significantly greater for current smokers.

https://www.ukradon.org/information/risks or in greater detail

https://webarchive.nationalarchives.gov.uk/20101108170104/http://www.hpa.org.uk/Publications/Radiation/DocumentsOfTheHPA/RCE11RadonandPublicHealthRCE11

Radon in dwellings

Radon can enter a building directly from the ground or can be released from water in the building as a gas. Radon seeps through cracks and fissures into dwellings. Cellars and ground floor rooms are at higher risk.

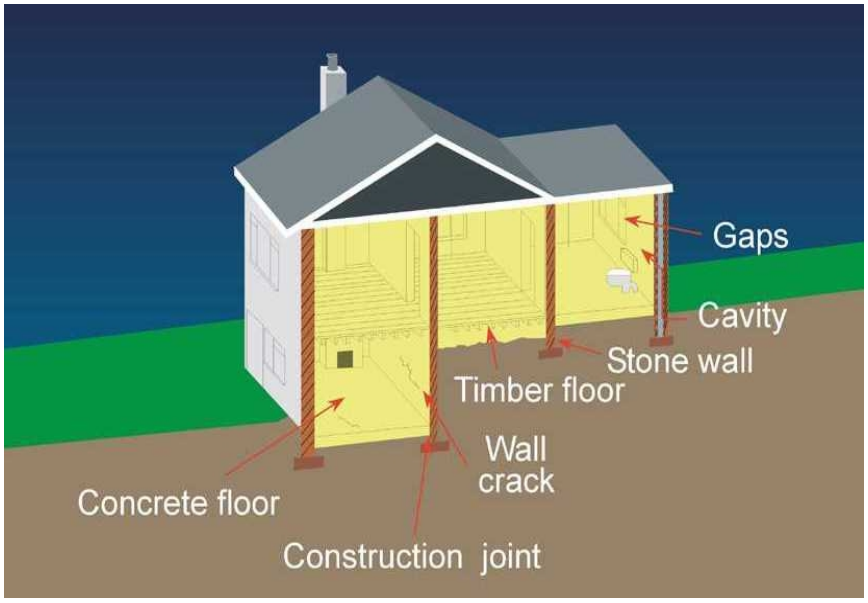


Figure1 Radon ingress into dwelling (PHE)

Measuring radon in air within dwellings

Measuring instantaneous radon levels within a dwelling is difficult. Radon levels may fluctuate due to factors such as how a property is occupied the type of ventilation, air movement, time of day and time of year.

Representative airborne radon levels are therefore best measured over a 3 month period taking into account seasonal corrections. This is done by placing two

detectors within a property (one in an occupied downstairs room and the other in an upstairs bedroom).

Normally, measurement does not take place in a bathroom or wet room. However, if investigations require measurement in a wet area then this must be specified before ordering detectors. Particular bags are required to protect the detector but still allow radon to enter. A correction factor is subsequently applied to determining the radon concentration.

Radon detectors are passive and are not radioactive *(UK Radon image)*

Radon Action Level

Public Health England (PHE) recommends radon should be reduced in homes where concentrations are >200 Bq $m^{-3.}$

Radon Target Level

A Target Level of 100 Bq m^{-3} is the ideal outcome for remediation works in existing buildings and protective measures in new buildings.

If the result of an assessment is between Target and Action Levels, action to reduce should be seriously considered, especially if smoker / ex-smoker is in the home.

Radon Protection Measures

Some dwellings may already have radon protection measures in place. It's worth checking whether radon levels have already been measured since their installation and are indeed effective and representative of occupation.

NB: Even with radon protection measures in place it is possible that the incoming water supply derived directly from the source without discharging may circumvent these measures.

Radon from water

The concentration of radon in water will depend on the concentration of radon in the source aquifer. The pathway from aquifer to consumer including the extent to which water is stored and aerated can affect radon concentration. Radon is readily released from water into the air and may accumulate within a dwelling with insufficient ventilation.

Measuring radon levels in water

Measuring radon levels in water can be done by collecting water samples from taps which are analysed by suitably accredited laboratories. These ‘snap shot’ samples suffer the same limitations mentioned above.

Legislative background

European Legislation

The European Commission Directive (2013/51/Euratom) laid down requirements for the protection of the health of the general public with regard to radioactive substances in water intended for human consumption.

Euratom Directive 2013/51 – specific requirements in relation to radon in drinking waters include the following: -

- *Establishing a parametric value for radon between 100-1000 Bq/l.*
- *Requiring that an investigation be undertaken if the value exceeds 100Bq/l.*
- *Requiring immediate action where concentrations over 1000Bq/l occur.*
- *Conducting a representative survey to determine scale and nature of likely exposure to radon in water supplies.*
- *Where the survey demonstrates a risk that a supply is likely to exceed the parametric value, monitoring must be carried out.*

National Legislation

The Private Water Supplies (Wales) Regulations 2010 transposed the requirements of Council Directive 98/83/EC on the quality of water intended for human consumption (Drinking Water Directive). This included standards for radioactive substances but didn't include monitoring requirements.

The Private Water Supplies (Wales) (Amendment) Regulations 2016 transposed the requirements for the protection of the health of the general public with regard to radioactive substances in water intended for human consumption (Euratom Directive 2013/51) Article 6 and Annex II. The main focus is monitoring radon but also covers indicative dose and tritium.

The Private Water Supplies (Wales) Regulations 2017 implement Council Directive 98/83/EC on the quality of water intended for human consumption in relation to private water supplies and Council Directive 2013/51/Euratom laying down requirements for the protection of the health of the general public with regard to radioactive substances in water intended for human consumption. These Regulations revoke and replace the Private Water Supplies (Wales) Regulations 2010.

Requirements on Local Authorities in relation to Radon

The Private Water Supplies (Wales) Regulations 2017 - Regulation 12 covers the monitoring requirements of radioactive substances in general. This document will only cover the radon parameter.

Relevant parts of this Regulation:

- Regulation 12(1) specifies that a local authority **must** monitor each private water supply in its area (other than to a single domestic dwelling) for certain radioactive substances parameters (including radon) in accordance with certain criteria.
- Schedule 3 specifies that a local authority **must** ensure a representative survey is carried out to determine the likelihood of a private water supply failing to comply with, in this case for radon, 100 Bq/l. The survey must be able to take into account different types of groundwater sources and wells in different geological areas.
- Schedule 3 also specifies that a local authority **must** carry out monitoring where there is reason to believe (survey, risk assessment etc.) that the value of 100Bq/l for radon might be exceeded.
- Regulation 12(3) specifies that if a local authority is satisfied that the radon level in a private water supply is not likely to exceed 100 Bq/l it can be excluded from the monitoring duty (specified in Regulation 12 (1)). This decision must be made on the basis of representative surveys, monitoring data or other reliable information (including risk assessments) and relevant guidance.
- Regulation 12(5) the local authority must be able to justify their decision to exclude any private water supply from radon monitoring.
- Regulation 12(7) where the local authority is no longer satisfied that the basis for an exclusion decision exists it will no longer apply.

Radon monitoring programme

In order to plan the monitoring programme all the private water supplies need to be screened to help prioritise the public health risk to the users of the private supplies.

Initially, it is advisable to look at the information available to determine which private water supplies in an area are likely to contain radon at a level which needs further investigation and/or measurement.

The joint Public Health England (PHE)-British Geological Survey (BGS) digital **Indicative Atlas of Radon in the United Kingdom** presents an overview of the results of detailed mapping of radon potential, defined as the estimated percentage of homes in an area above the Radon Action Level. The interactive map comprises of 1km squares which have been shaded different colours according to the radon level in air and classed according to the highest radon potential found within each square.

The maps can found following this link: http://www.ukradon.org/information/ukmaps

By using the downloadable PDF files marked **Indicative Atlas of Radon in the UK**, the user can identify the percentage of dwellings within the 1km square radon likely to above the action level.

There are 6 categories:

- 0-1
- 1-3
- 3-5
- 5-10
- 10-30
- 30 >

Any previous Private Water Supply Risk Assessment of the supply and any information from the Water Company or Natural Resources Wales will also be relevant.

Using the flow chart on the following pages it may be possible to exclude any supplies from monitoring if the supply is within the 0-1 or 1-3 categories as they fall within the **low** hazard groups.

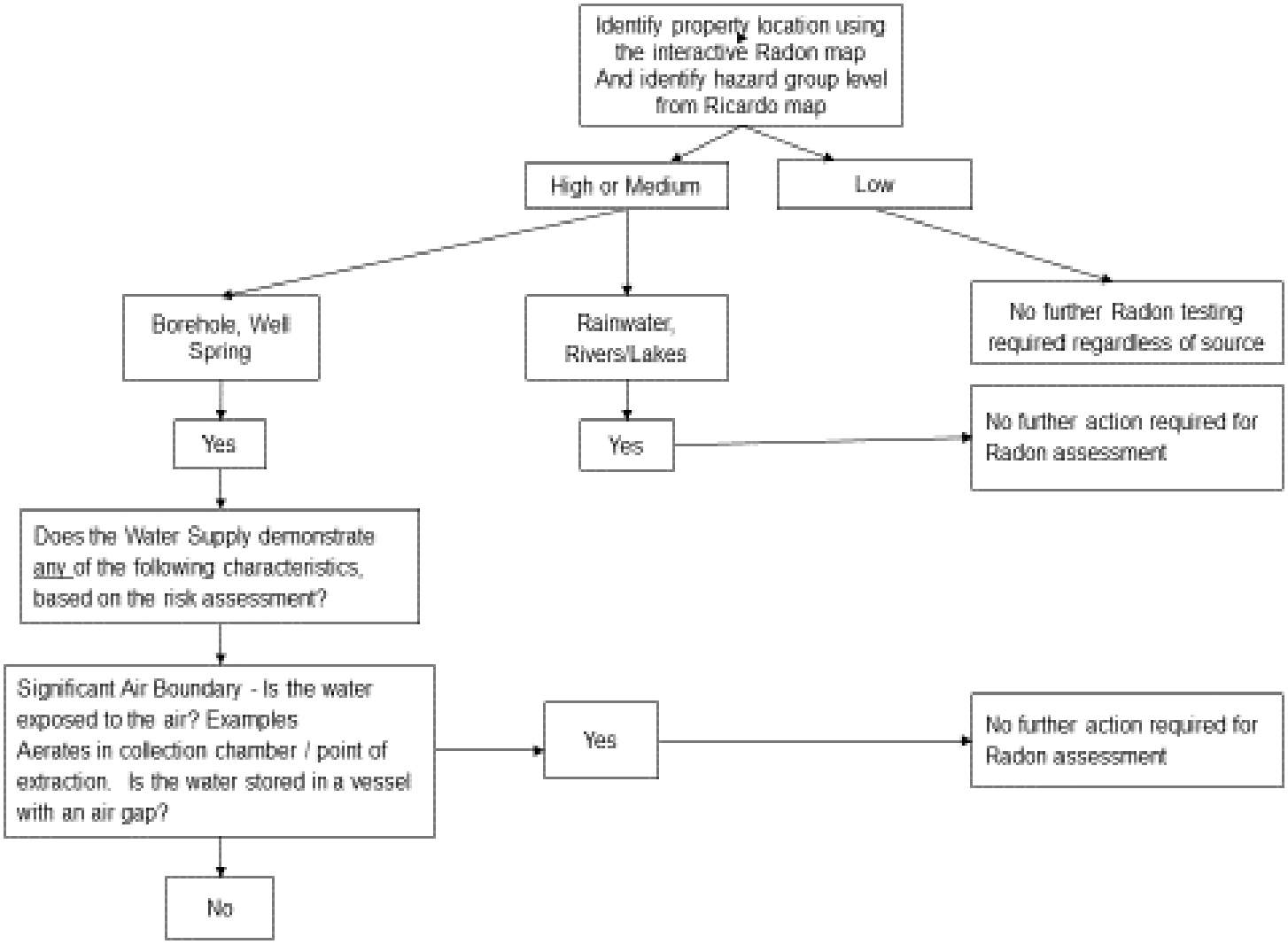
The other hazard groups - **Medium** which incorporate properties within the 3-5 and 5-10 categories and **High** incorporating the 0-30 and 30> categories will require monitoring dependant on the individual supply conditions as the prescribed value (100Bq/l) for radon might be exceeded.

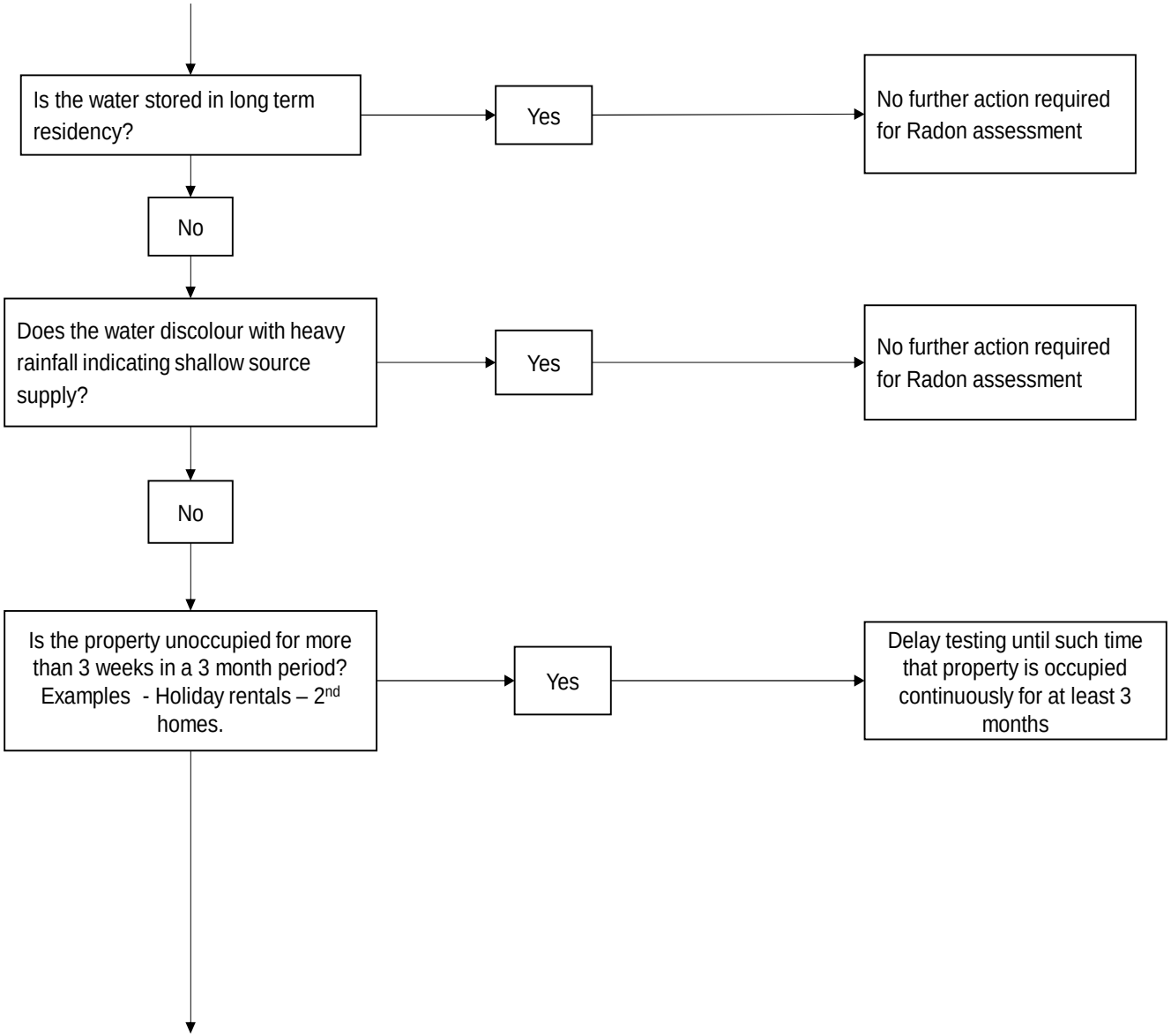
It is advised to test for radon in air (standard 3 month test) to identify homes that might have high indoor radon levels arising from a private water supply in these areas.

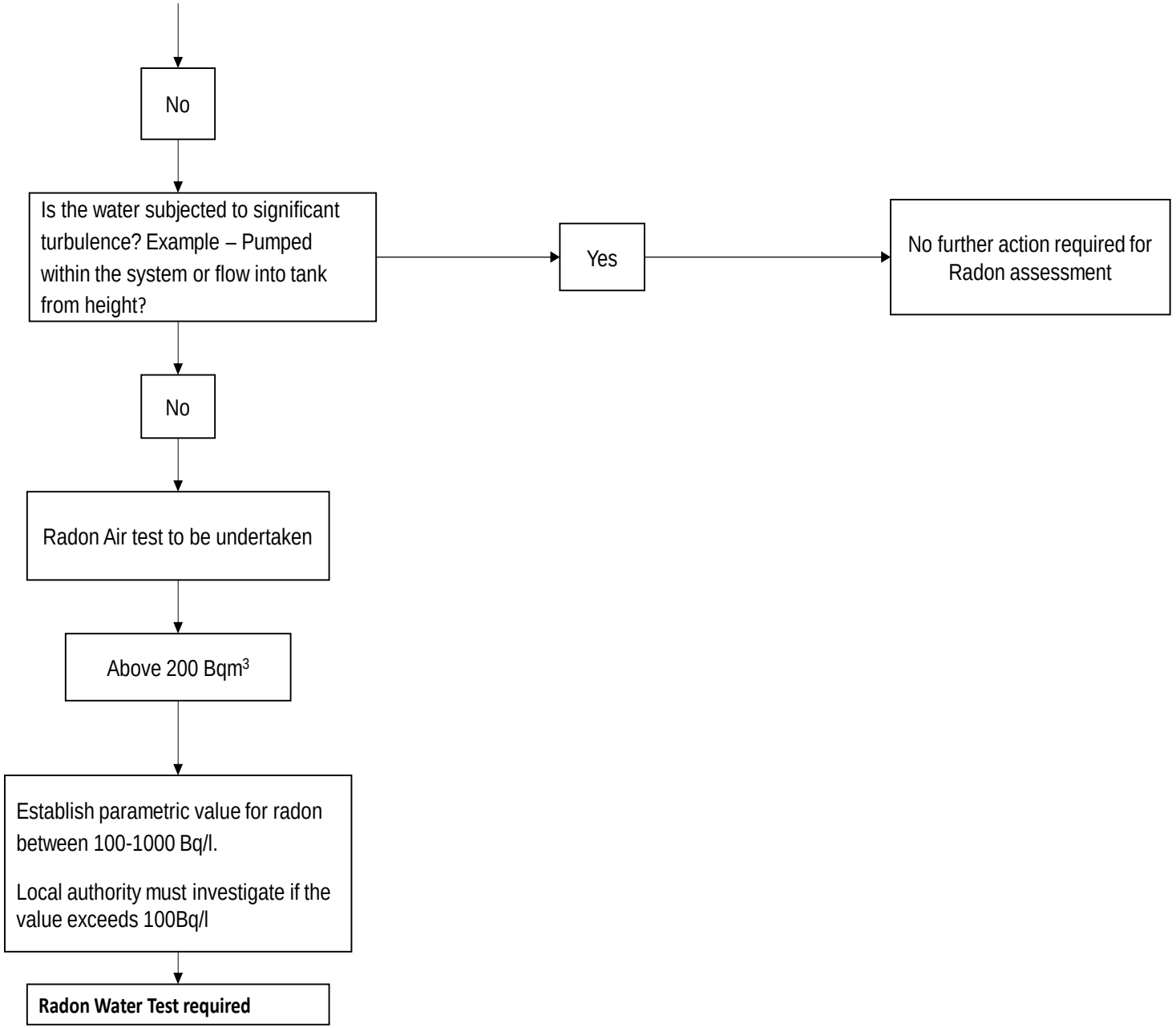
If the result of the radon in air test is above the UK action level of 200 $Bq\ m^{-3}$, it may be that the high radon level in the building is caused by radon in the water supply so the water should be tested.

If there is a high level of radon measured in a private water supply action should be taken to reduce it.

Radon monitoring programme




Is the water stored in long term residency?
Yes
No further action required for Radon assessment
No
Does the water discolour with heavy rainfall indicating shallow source supply?
Yes
No further action required for Radon assessment
No
Is the property unoccupied for more than 3 weeks in a 3 month period? Examples - Holiday rentals – 2nd homes.
Yes
Delay testing until such time that property is occupied continuously for at least 3 months


No
Is the water subjected to significant turbulence? Example – Pumped within the system or flow into tank from height?
Yes
No further action required for Radon assessment
No
Radon Air test to be undertaken
Above 200 Bqm3
Establish parametric value for radon between 100-1000 Bq/l.
Local authority must investigate if the value exceeds 100Bq/l
Radon Water Test required

Appendix

RADON FAQS

1. Could Local Authorities exclude transient populations from the risk assessment / monitoring (e.g. B+B, holidays let, holiday camps/caravan site) as the individual residence time is likely to be very low?

The higher the level of radon and the longer the period of exposure, the greater the risk will be. The life-time risk of lung cancer due to radon is greatest for smokers.

However, any commercial activity is covered by the regulations and hence will require a measurement of the water, unless measurements on the same aquifer indicate low levels or the source is in a low risk area on the Guidance maps given in the Ricardo report. If results that exceed the PCV are found, then a follow on risk assessment should take the actual exposure situations into account.

It is not advisable to test an unoccupied property for radon in air. If there is a period of three months when it will be occupied, this may provide an opportunity to complete a measurement. It is worth noting that results of any air monitoring are less reliable if the home is unoccupied for more than three weeks in the three months.

2. Does the depth of the water source influence radon concentrations? If so, can this be used in the risk assessment?

The depth of the borehole does not affect the radon concentration as far as we are aware. Radon can enter the water at any depth – it is the point that it is degassed that is important. Surface waters do not require monitoring.

3. Can spring supplies be excluded for monitoring for radon (even if in Moderate / High area) if they show at least one of following characteristics:

a. Not directly from ground.

Some springs may have surface water characteristics which lead to low radon concentrations including one or more of the following:

- *not directly derived from the ground (e.g. akin to land drains collection points)*
- *long residence time in a collection chamber or tank where no enhanced levels of the parent radionuclide (Radium-226) are present (if the gross-alpha measurement is low the Radium-226 level will be low)*
- *significant turbulence on collection or distribution*
- *significant open air boundary.*

b. More than few days in collection chamber or tank (is this dependant on whether this is open to air or covered?)

As long as there is an air gap above the surface of the water radon will degas into the air rather than stay in the water

c. **Significant turbulence on collection or distribution (what constitutes significant?)**
Degassing happens without turbulence – any pumping or pouring may lead to additional radon loss so this will reduce radon levels in the water

d. **Significant open air boundary (what constitutes significant?)**
In my view this would mean an air gap above the water in a storage tank or similar

4. **Is it worth testing radon in air first or go straight to testing radon in water as there seems to be some confusion as to the relationship between the two values?**

A standard 3-month test for radon in indoor air will identify whether significant levels of radon are being released into indoor air from a private water supply. If the test result is high, it may then be appropriate to test a sample of the water to confirm whether it is the source of radon. However, a radon in air test cannot determine compliance with the PCV. Measurements of radon in air will not answer the regulatory question required which'is the PCV for the water exceeded at the tap?' The relationship between radon in air and water is based on modelling and not measurement. The relationship must therefore be classed as a rule of thumb only.

PHE recommend the following:

Measuring radon-in-air as a surrogate for radon in water is not advised as a method of determining compliance with the PCV since the PCV roughly equates to a level of radon in air that is below normal background levels of radon in indoor air. A drinking water supply concentration at the PCV is only likely to contribute around 10 Bq/m3 in air which is less than the average radon concentration in UK homes (20 Bq/m3). Only a significantly higher than the PCV level would have an impact on a radon-in-air measurement.

The following steps are recommended for private water supplies (adapted from UK radon):

- *If your water is supplied by a water company, they will take any necessary action. You do not need to do anything.*
- *If your home has a private drinking water supply that is fed from a groundwater source, you should use the online radon map (http://www.ukradon.org/information/ukmaps) to find out if your home is in a shaded 1 km grid square.*
- *If your home is not in a shaded grid square (if you click on your local grid square, the pop-up message says "All parts of this 1 km grid square are in the lowest band of radon potential") there is a very low risk that your private water supply has high radon levels. You do not need to take any further action.*
- *If your home is in a shaded grid square, and you have a private drinking water supply fed from a groundwater source, there is an increased chance that your water supply may have high radon levels. You should test your home for radon in air, using a standard 3-month radon test.*
- *If, after following these steps, the result of your radon test is high (above the radon Action Level), it may be that the high radon levels in your home are caused by radon in your private water supply. You should test the water supply in your home for radon.*

- *High radon levels in a private water supply can be reduced. Guidance is available from the Drinking Water Inspectorate.*
- *After taking action to reduce radon levels in a private water supply, you should re-test your water supply and home for radon. Repeat the home radon test every five to ten years to make sure that levels remain low.*
- *NOTE: if the property already has mitigation is place to reduce levels of radon in air, then an air measurement may be of little value in determining radon in water and it could be wiser to go direct to a radon in water measurement.*

5. Should the building type (eg. double glazed or draughty) be taken into account when assessing whether radon from the water supply could be inhaled? Could certain property types/construction/and those with current radon protection able to be excluded?

The ventilation conditions within the building will not affect the radon levels at the tap. If the PCV is exceeded the radon in air measurement may inform the assessment of exposure and any action needed.

6. Would it be appropriate in certain situations to suggest forms of treatment instead of sampling Radon in water? If so, would PHE / PHW be able to provide us with some advice about treatment methods?

Treatment should be considered unless measurements indicate higher levels. These measurements may be from other properties on the same aquifer or supply in the same way that low levels measured in the aquifer are a reason to say the measurements are not required. It is usually more cost effective to test as remediation may be expensive.

Aeration

Aeration is the preferred treatment for radon removal. In the natural environment this process ensures that most waters coming from springs in radon emitting rocks quickly lose their radon to the atmosphere. The main reason why problems occur with radon in many private supplies is because the water is either abstracted from the rock directly or very soon after. Aeration allows radon to be easily vented to the outside air thus preventing build-up of radiation levels and means there are no disposal issues. As such, the system will typically require less maintenance. Depending on the system, there may be a need for a pressure tank or an additional pump.

Decay Storage

As radon (222Rn) has a half-life of 3.82 days (i.e. its radioactivity halves every 3.82 days), it is possible (provided that mixing and short-circuiting are avoided) to store it to achieve an adequate reduction in radioactivity. The amount of time required will depend on the level of activity. An eightfold reduction would take two weeks to achieve. For household consumption, this would typically require two 10m^3 tanks, used alternately, which is impracticably large for most locations. With a lower activity level, requirements would be less and this option may be feasible.

In any case there would be need to demonstrate that the treatment method is and remains effective.

Further Resources

UK Radon

http://www.ukradon.org/information/privatewater

DWI

DWI Q&As on radon: http://dwi.defra.gov.uk/stakeholders/guidance-and-codes-of-practice/pws-radon-QA.pdf

DWI treatment guide:

http://www.dwi.gov.uk/private-water-supply/installations/updated-manual-on-treatment-for-small-supplies.pdf)

Ricardo AEA Understanding the Implications of the EC's Proposals Relating to Radon in Drinking Water for the UK:

http://www.dwi.gov.uk/research/completed-research/reports/DWI70-2-301.pdf