UNDERSTANDING RADON REMEDIATION
A HOUSEHOLDERS GUIDE

October 2022

Environmental Protection Agency
McCumiskey House
Richview
Clonskeagh
Dublin 14
D14 YR62

Tel: +353 1 268 0100
Email: radon@epa.ie
Web: www.radon.ie

Introduction

This guide has been prepared by the Environmental Protection Agency (EPA) for householders who have been informed they have radon levels above the reference level of 200 Bq/m^3 in their home. The aim of the guide is to help householders to understand their radon measurement results and to decide how to deal with the problem.

Having received the result of a radon test the important point to note is that radon is not a problem one has to live with. There are a number of effective and relatively inexpensive remediation techniques available for reducing indoor radon. There is nothing complex about these techniques and the majority involve relatively simple building work. While some of the work described can be successfully undertaken by DIY enthusiasts or small builders, for more complex situations or where a significant reduction in radon levels is required, it is recommended that an EPA registered radon remediation contractor undertakes this work.

This guide provides basic information on radon remediation methods to help householders to decide what to do next. It does not provide detailed technical instructions for radon remediation but aims to give householders a general understanding of the methods available. Householders who wish to do the work themselves or who require more information should refer to "Radon in Existing Buildings – Corrective Options" published by the Department of Housing, Local Government and Heritage[1].

What is Radon?

Radon is a radioactive gas. It originates from the decay of uranium, which is present in small quantities in all rocks and soils. It is colourless, odourless and tasteless and can only be measured using special equipment. Because it is a gas, radon can move freely through the soil. Outdoors, radon surfaces in the open air and is quickly diluted to harmless levels, but when it enters an enclosed space, such as a house or a workplace, it can sometimes accumulate to unacceptably high levels.

Radon can enter a building from the ground through small cracks in floors and through gaps around pipes or cables. Radon tends to be sucked from the ground into a building because the indoor air pressure is usually slightly lower than outdoors. This pressure difference occurs because warm indoor air is less dense than outdoor air.

Radon decays to form tiny radioactive particles, some of which remain suspended in the air. When inhaled into the lungs these particles are deposited in the airways and attach themselves to lung tissue. They may damage cells in the lung and this damage may lead to lung cancer in later life. Radon is classified as a Group 1 carcinogen by the International Agency for Research on Cancer, a part of the World Health Organisation. This means that there is direct evidence from

[1] gov.ie - Radon in Existing Buildings - Corrective Options (www.gov.ie)

human studies to support the link between exposure to radon and the induction of lung cancer. It should be noted that exposure to radon has not been linked with any other health effects.

Radon in Ireland

Radon is measured in becquerels per cubic metre of air (Bq/m^3). The becquerel is a unit of radioactivity and corresponds to one radioactive disintegration per second. In 1990, the Government adopted a long-term average radon gas concentration of 200 Bq/m^3 as the national Reference Level for radon in homes.

The radon levels measured in individual Irish homes range from a few tens of Bq/m^3 to several thousand Bq/m^3. The average concentration in Irish homes is 77 Bq/m^3. It is estimated that 8 % of all Irish homes have radon levels above the reference level. High Radon Areas are areas where more than 10% of homes are predicted to have radon levels above the reference level. More information can be found on the EPA website www.radon.ie.

What Does My Radon Measurement Result Mean?

The EPA advises that, if the radon level in your home is above the national reference level of 200 Bq/m^3, you should consider taking remedial action to reduce it. The reference level does not represent a rigid boundary between safe and unsafe radon levels but rather a level at which it is prudent to consider remediation.

Lifetime exposure in the home to radon at the reference level represents a level of risk similar to several other everyday risks such as fatal accidents on the road or death due to accidental falls. Using international risk estimates the EPA has calculated that approximately 350 lung cancer cases every year in Ireland are due to radon.

Exposure over your lifetime to a radon level of 200 Bq/m^3 represents a lifetime risk of contracting lung cancer of 1 in 50 i.e. 2%. These risks are for the general population and are therefore averaged over smokers and non-smokers. Smokers are already at significant risk of contracting lung cancer and exposure to radon will further increase that risk.

The risk from radon depends on the total radon exposure received over the course of a lifetime. Radon, therefore, does not pose an immediate risk but is something that should be controlled over the longer term. In the case of children, if radon exposure starts at a young age, the total number of years of exposure is potentially greater and therefore a precautionary approach to the exposure of children to high radon levels is recommended.

Remediation should be undertaken as soon as practicable and at higher levels a greater urgency is recommended.

Radon Remediation Techniques

Radon remediation works either by preventing the entry of radon into a building from the soil or by removing it after it has entered by means of improved indoor ventilation. The most common remediation techniques include: sub-floor depressurisation (radon sump), increased under-floor ventilation, positive pressurisation, increased indoor ventilation and the sealing of cracks and gaps in the floor and around service entry points.

The most appropriate remediation solution for a particular building will depend on a number of factors including the amount of radon found in the building, and the type of building. Through the correct choice of remediation technique, the radon levels can be reduced to well below the reference level in the majority of buildings. Figure 1 shows the range of radon levels over which some common remediation techniques are likely to be effective.

At radon levels of 300 Bq/m^3 any type of remediation is likely to be effective in reducing radon levels to below the reference level. For levels up to about 800 Bq/m^3, while there are a number of different remediation options that might succeed, the installation of an active sump or an increase in under- floor ventilation are the options most likely to be successful. For radon levels greater than about 1000 Bq/m^3 installation of an active sump is always the preferred remediation option.

Some householders opt to undertake radon remediation on a phased basis. This means starting with the simplest, least expensive solution, which offers reasonable potential for reduction. Following this the house is retested and, if the radon levels have not been lowered sufficiently, then other measures are installed progressively until the required radon reduction is achieved. Alternatively, more extensive and therefore more expensive radon remedial measures may be undertaken to begin with to ensure that the radon levels will be reduced sufficiently on the first attempt. The phased approach is more likely to be adopted where the householder undertakes the work on a DIY basis, while specialist contractors will usually take the latter approach.

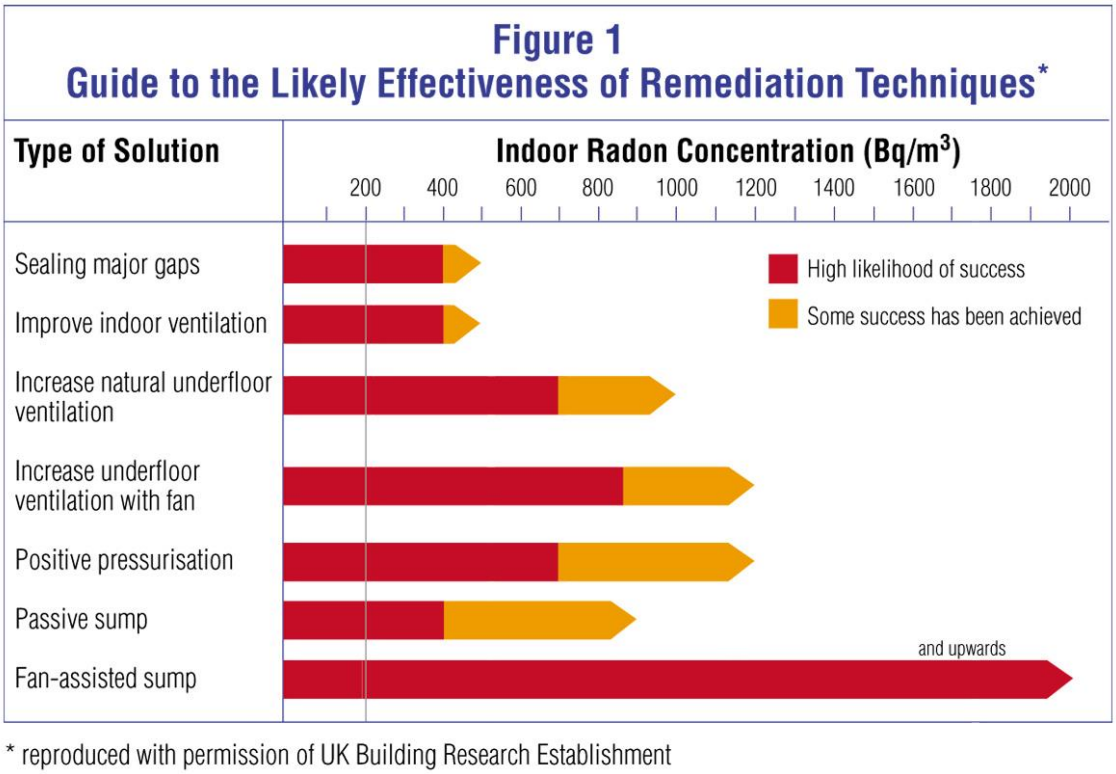

Figure 1. Common remediation techniques and their effectiveness

An overview of the most commonly used remediation systems is presented here. Technical guidance on these techniques and their installation is given in the booklet "Radon in Existing Buildings - Corrective Options" referred to earlier.

Sealing Floors and Walls

In theory, it is possible to prevent radon from entering a house from the ground by sealing all radon entry points such as cracks in solid floors, cracks or openings in ground contact walls and gaps around cables or pipes. In practice, however, effective sealing is often extremely difficult to achieve.

Sealing all possible entry routes involves removing floor covering and skirting boards and then sealing all cracks and joints with a suitable sealant. The sealant must be durable and flexible enough to accommodate future movement of building materials.

For this method to be successful, effectively all gaps must be sealed. This is difficult since some gaps may not be visible and over time new cracks and openings may develop. If only 90% of openings were sealed, for example, then radon could enter through the remaining gaps and it is likely that only a slight reduction would be achieved. In practice this method is more likely to be effective in conjunction with other methods than on its own.

Increasing Indoor Ventilation

It may be possible to increase the ventilation in a house by unblocking air vents, providing additional wall vents or by installing window trickle vents. Increasing the ventilation mixes radon-rich indoor air with outdoor air thereby bringing down the radon levels in indoor air. Increased ventilation also reduces the under-pressure in a house and so reduces the tendency for radon to be sucked into the house from the ground.

Increased background ventilation should only be installed at ground floor level as increasing the ventilation in upper floors may result in higher radon levels. This is because increased ventilation on upper floors may cause a stack effect, which draws air up through the house.

This remediation solution has the advantage of being fully passive and so does not require long-term maintenance. It may also help to improve indoor air quality generally.

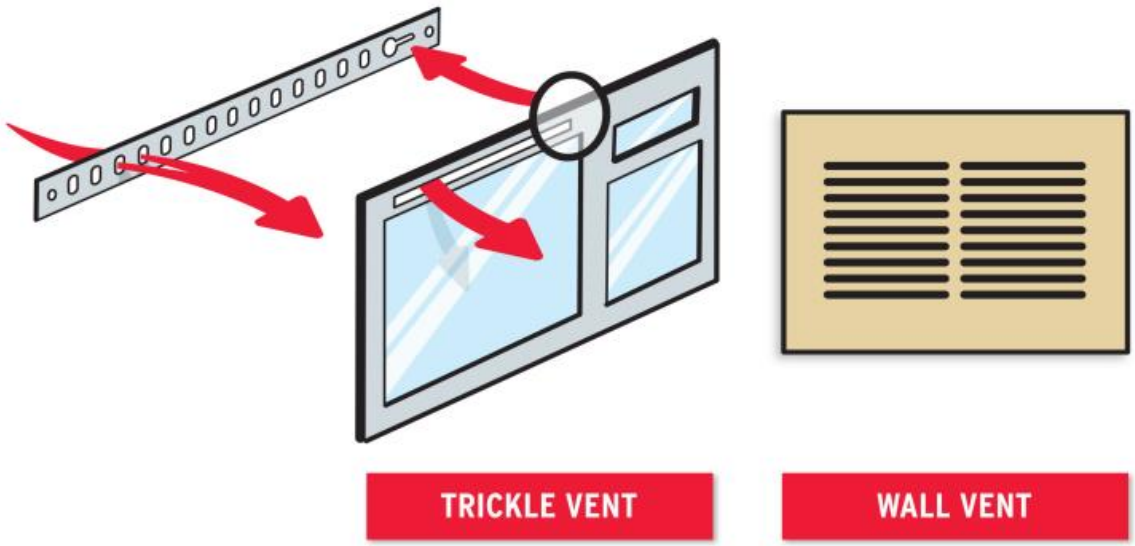

Figure 2. Increasing indoor ventilation

Increasing Under-floor Ventilation

Increasing the flow of air beneath the floor can reduce the amount of radon entering the building. This involves the installation of additional sub-floor vents or airbricks or the clearing or replacement of existing ones. Plastic airbricks are now available with a larger open surface than clay airbricks of the same size. The position of the airbricks can have a significant influence on the radon reduction achieved, as dead spaces with no flow of air will reduce their effectiveness.

If this does not reduce your radon level sufficiently, installing a fan can increase under-floor ventilation further. Fans can be installed to blow air into the underground space (supply ventilation) or suck air from underground space (extract ventilation).

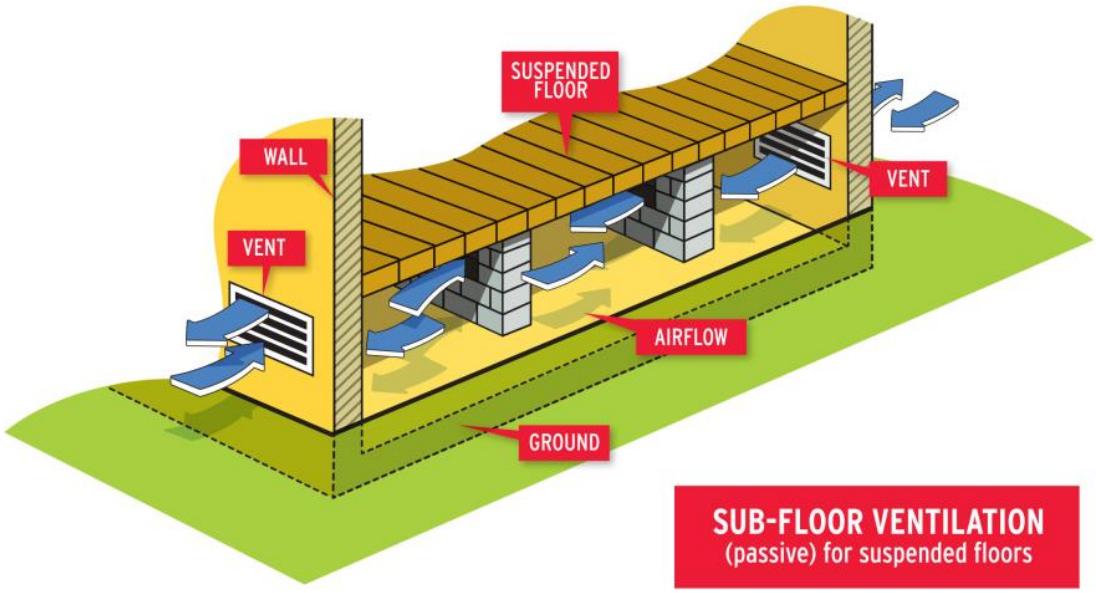

Figure 3. Increasing sub-floor ventilation

Positive Pressurisation

This method of radon remediation involves blowing air into the house from a specially installed fan unit in the attic, thus achieving a very slight positive pressure in relation to outside air. This reduces radon entry due to a pressure effect causing air to be forced out through cracks, joints, windows and openings. Positive pressurisation also has the effect of increasing ventilation and thereby reducing the radon levels by dilution.

Positive pressurisation is best achieved in relatively airtight houses. Many existing houses may be relatively draughty and measures to reduce draughts may be needed to ensure effective pressurisation. It is straightforward to install, requires no major structural intrusion and has the added advantage of reducing condensation problems. However, the running costs of such a system are likely to be greater than for an active sump.

The Radon Sump (Sub-floor Depressurisation)

A radon sump is a cavity that is created in the ground immediately under the floor slab of the house. The cavity is about the size of a bucket and it is linked to the outside by pipe work. It operates by reversing the pressure differential between the space under the floor and the room above. Radon is drawn into the sump and then extracted out the sump by an electric fan in the pipeline and so is prevented from entering the occupied building. This is known as an active sump.

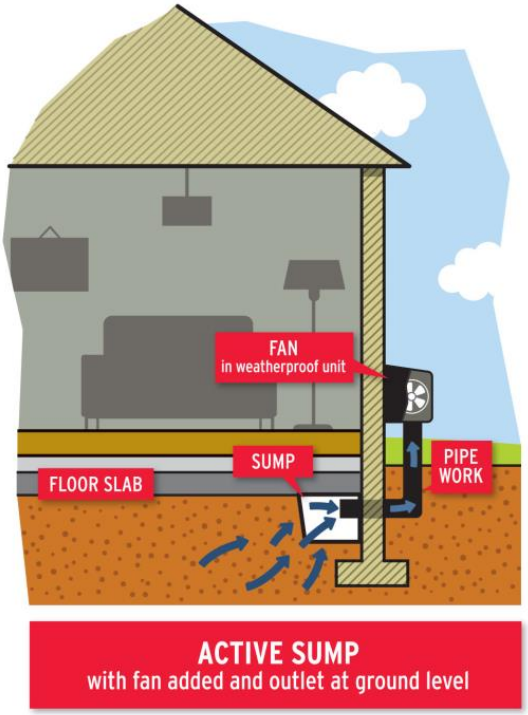

Figure 4. Installation of an active sump

Where a fan is not used the arrangement is referred to as a passive sump. A passive sump has the advantage of having no operating costs and being silent. However, it is less reliable than an active sump and probably would only be appropriate for radon levels up to a few hundred Bq/m^3. Where radon levels of several hundred Bq/m^3 or higher are present, the active sump is likely to be the most effective solution. A passive system, if not successful, can be upgraded to an active system by addition of a fan.

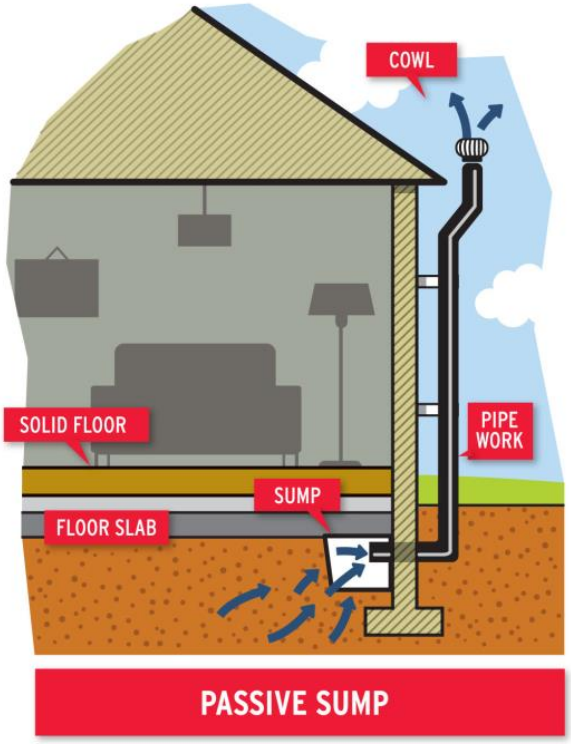

Figure 5. Installation of a passive sump

The number of sumps needed depends on the layout of the building, the floor area and the initial radon levels present. As a general rule, a single sump is effective over a surface area of 250 square metres. Several sumps can be linked together and served by the one fan.

The EPA recommends that, following remediation, all homes should be retested in order to verify that the radon levels have been reduced sufficiently. This measurement should be for a minimum of three months. The EPA provides a free post-remediation measurement service to homeowners that have carried out remedial work.

The 1997 Building Regulations

The 1997 Building Regulations specify that all new houses built since 1st July 1998 must be fitted with standby radon sump. The standby sump can be activated at a later stage to reduce radon levels if this is found to be necessary. For houses built in High Radon Areas the installation of a radon barrier as well as a sump is required.

The installation of these remedial measures is not a guarantee that radon levels will be below the reference level. You should therefore have a radon measurement made within the first year of moving into your new home. Should elevated radon levels be present, the sump can be activated by extending the pipe work and adding a fan. Activating an existing standby sump will reduce the cost and disruption associated with remediation as the need install a sump under the house is avoided.

Specific guidance on radon remediation measures for new buildings is contained in the 2004 edition of "Technical Guidance Document C - site preparation and resistance to moisture". gov.ie - Technical Guidance Documents (www.gov.ie)

Seeking Advice

For general information on radon, its health effects and radon measurements contact the EPA on:

Freefone	1 800 300 600
Email	radon@epa.ie
Web	www.radon.ie

EPA registered radon measurement and remediation companies are listed on www.radon.ie.

For further information on the technical aspects of remediation options, contact the Building Control Officer in your Local Authority or the Building Standards Section of the Department of the Housing, Local Government and Heritage (www.housing.gov.ie).