



Radiological Protection Institute of Ireland

An Institiúid Éireannach um Chosaint Raideolaíoch

**GUIDANCE NOTES ON THE ACTIONS AN
EMPLOYER MAY TAKE IF HIGH RADON
CONCENTRATIONS ARE FOUND IN AN
ABOVEGROUND WORKPLACE**

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1. Purpose and scope

Radon in workplaces is a potentially significant source of exposure to natural radiation. In May 2000 legislation¹ was introduced to limit the exposure of workers to radon. This legislation is regulated by the Radiological Protection Institute of Ireland (RPII).

The legislation specifies a Reference Level for radon in workplaces of 400 becquerels per cubic metre (Bq/m³) averaged over a minimum period of three months. In situations where this concentration is exceeded, employers may carry out an evaluation to determine if remedial work is justified. These guidance notes provide advice on the issues that need to be considered as part of any such evaluation.

This document sets out a suggested means of minimising radon exposure to workers and of demonstrating good practice in this regard. However, the adoption of an approach other than that outlined in this guidance is not precluded provided that account is taken of the relevant requirements of the legislation, particularly the requirement to keep radiation exposure as low as reasonably achievable.

2. Underlying principles and assumptions

In developing this guidance it was assumed that the working year is 2000 hours and that the measured radon concentration is representative of the annual average radon concentration present during working hours. If radon concentrations above 400 Bq/m³ value are identified in a workplace the employer should notify the Regulatory Service of the RPII by completing the Radon Notification Form available at www.rpii.ie within one week of receiving results of the workplace radon survey.

At the Reference Level, the radon exposure of an employee working 2000 hours per year is 800 kilobecquerels per cubic metre hours (kBq/m³h). This figure is obtained by multiplying the Reference Level (400 Bq/m³) by the occupancy rate (2000 hours). If the radon exposure is less than 800 kBq/m³h then remedial work may not be required even if the radon concentration is greater than 400 Bq/m³. If the 800 kBq/m³h value is exceeded, then remedial work will be required to reduce exposure to radon (see Appendix 1 for worked examples).

This guidance is also designed to prevent situations where employees are exposed to average radon concentrations greater than 800 Bq/m³. This should ensure that no worker receives an annual radiation dose from radon in excess of 6 millisieverts (mSv).

Workers who are liable to receive doses greater than 6 mSv are required to be classified as Category A workers. Classification as a Category A worker requires the employer to carry out a number of administrative functions as well as to arrange for annual medical check-ups for such staff. The RPII is unaware of any circumstance where it is justified for workers employed in an above-ground workplace to be classified as Category A workers on the basis of their exposure to radon. For this reason remediation work is always required at average radon concentrations above 800 Bq/m³.

¹ The Radiological Protection Act, 1991 (Ionising Radiation Order (Statutory Instrument 125 of 2000), S.I. No. 125 of 2000.

3. Recommended action if a workplace has radon concentrations above 400 Bq/m³

In workplaces with radon concentrations in excess of 400 Bq/m³ averaged over any three month period, the preferred and simplest course of action in all cases is to carry out remedial work to reduce radon concentrations to below the Reference Level.

However, for radon concentrations between 400 and 800 Bq/m³ an employer may choose to carry out an evaluation to determine if remedial measures to reduce the radon concentration are justified. For those workplaces that have a high occupancy, e.g. up to 2000 hours per year, the outcome of such an evaluation will more than likely indicate that remediation is justified. For that reason, carrying out an evaluation is generally only warranted in workplaces with a low occupancy rate.

The evaluation should take account of the radon exposure of workers throughout the workplace and the feasibility of carrying out remediation. This evaluation must be carried out without delay and should be completed not later than one month after being notified of any radon concentration greater than 400 Bq/m³. The employer should set out the results of this evaluation in a Statement of Evaluation, which should be made available to workers. The employer should also comply with all requirements under the Safety, Health and Welfare at Work Act, 2005 and any other workplace health and safety legislation.

4. Recommended action if a workplace has radon concentrations above 800 Bq/m³

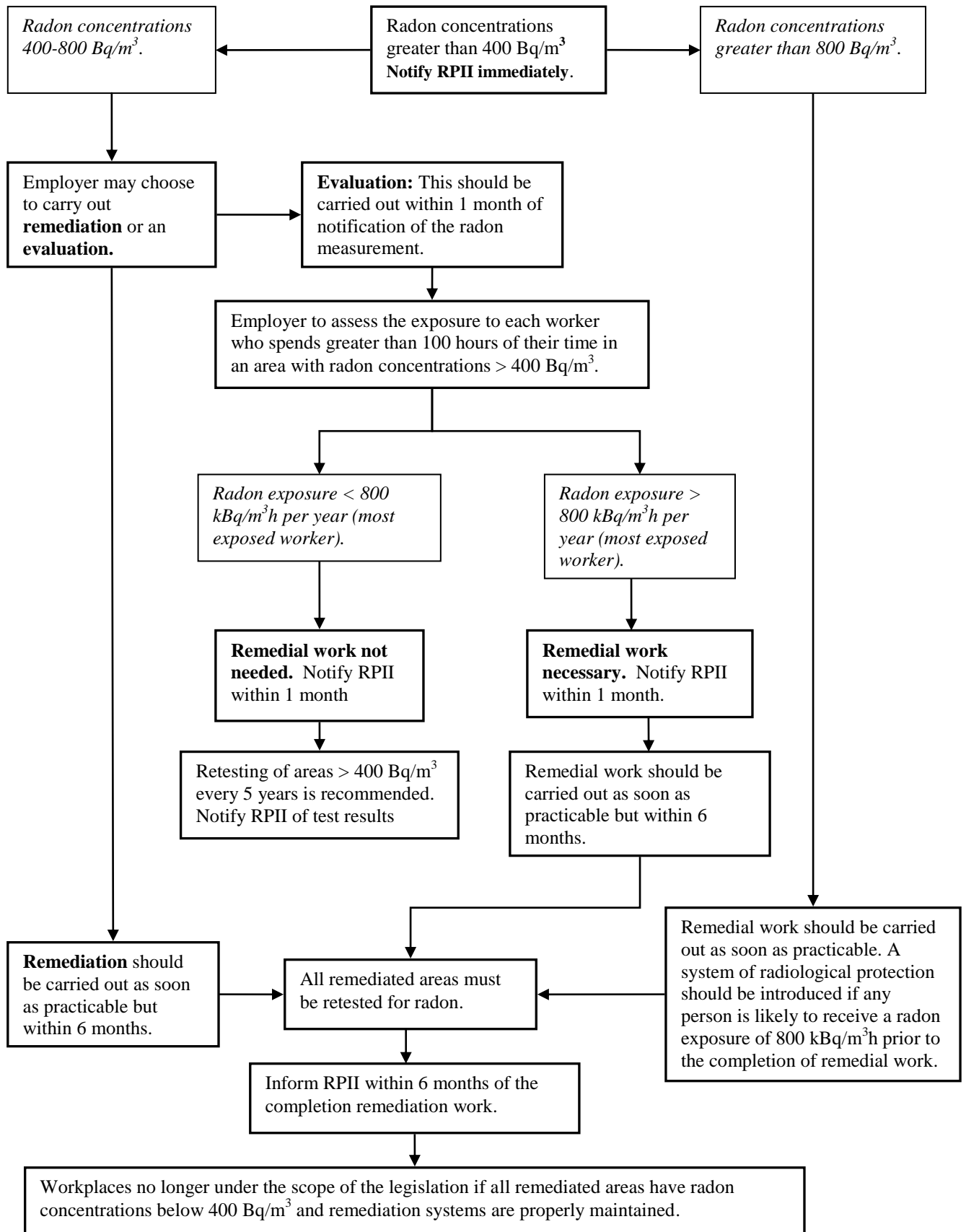
Remedial work is always justified and must be carried out as soon as practicable in workplaces with radon concentrations in excess of 800 Bq/m³.

Remedial work should be completed within a timeframe that ensures that the radon exposure to workers will not exceed 800 kBq/m³h. For radon levels up to 800 Bq/m³ this means that the remedial work should be completed within 6 months of first being notified of a radon concentration above the Reference Level. For higher radon concentrations a shorter timeframe should be set. If this is not possible a system of radiological protection should be introduced for workers to ensure that their radon exposure remains below 800 kBq/m³h for the period of time until the remedial work has been completed (see section 9).

Figure 1 summaries the options an employer may take when radon concentrations above 400 Bq/m³ are present.

Figure 1

Summary of the steps an employer may follow to determine if radon remediation is necessary



5. Assessment of radon exposure to employees

Where an evaluation of the justification for remedial measures is undertaken, the first step is an assessment of the radon exposure to workers. Based on the outcome of the assessment, the second step will be a decision on whether or not remediation needs to be carried out.

The assessment of radon exposures should be carried out for every worker that spends more than 100 hours per year in a location(s) with radon concentrations in excess of the Reference Level. This assessment shall also take into account worker exposure to radon in locations which are below the Reference Level provided the worker spends more than 100 hours of their working time in these locations.

Worked examples on how to assess the radon exposure of two workers who work in an area with maximum radon concentrations of 700 Bq/m³ are given in Appendix 1.

If the assessment indicates that a worker receives an exposure in any twelve month period of less than 800 kBq/m³h, as is the case for worker A in the example given in Appendix 1, then no remedial work is necessary. However, on-going surveillance of the workplace will be necessary (see sections 7 and 8).

If the assessment shows that the most exposed worker receives or is likely to receive an exposure in excess of 800 kBq/m³h in any twelve month period, as is the case for worker B in the example given in Appendix 1, then the employer must normally carry out remedial work at Locations C and D to reduce the radon concentrations to below the Reference Level.

In the rare situation where remedial work is not technically feasible, it will be necessary to introduce a system of radiological protection (see section 9).

In either case the RPII should be notified of the outcome of the evaluation, including the assessment of the radon exposure to employees, within one month of completing the assessment.

6. Post-remediation measurements

Once remedial work is completed an employer must carry out a post-remediation measurement in the remediated area to ensure that radon concentrations are below 400 Bq/m³. The result of this post-remediation measurement should be sent to the RPII not later than six months after the completion of remedial work. Measurements should be carried out for a continuous period of three months and need only be carried out in remediated areas which had radon concentrations above 400 Bq/m³ in the initial survey. Workplaces will cease to fall within the scope of the legislation provided all remediated areas, once retested, have radon concentrations below 400 Bq/m³.

A list of remedial contractors known to carry out radon remediation work is held by the RPII and is available on the RPII website on <http://www.rpii.ie/radon>. Advice on remedial work is outside the remit of the RPII and it is important to point out that the selection, suitability and installation of any given remedial system is strictly a matter between the employer and the company who carries out the work. However, it is recommended that the remedial option chosen provides maximum reduction in radon concentrations at a reasonable cost.

7. On-going surveillance

Where radon concentrations in parts of the workplace exceed the Reference Level but where the assessment referred to above shows no worker is likely to receive an exposure to radon greater than 800 kBq/m³h, then it is necessary to carry out further radon measurements on a regular basis. The purpose of such measurements is to ensure that the evaluation remains representative of the long-term situation in the workplace. The RPII recommends that all locations with radon concentrations greater than 400 Bq/m³ in any previous surveys be retested every five years or after any structural changes have been made to the workplace. The employer should notify the RPII of the results of these radon measurements within one month of receiving them. Should subsequent measurements indicate a significant increase in radon concentrations then remedial measures should be implemented or individual exposures reassessed, whichever is appropriate.

It is important to ensure that any remediation system installed is properly maintained so as to ensure that radon concentrations remain below the Reference Level.

8. Future changes in work practices

If at some future time changes in work practices occur that are likely to increase the radon exposure to above 800 kBq/m³h then the employer shall carry out an assessment of radon exposure to workers. The RPII shall be notified of the results of this assessment within one month of its completion. Such changes include a longer working day or a change in a workers duties, requiring them to spend a longer time in an area with an elevated radon concentration.

9. Introducing a system of radiological protection

An employer must introduce a system of radiological protection if

- (a) during the time between the identification of radon concentrations above 400 Bq/m³ and the completion of remediation work, the radon exposure to any worker could potentially exceed 800 kBq/m³h or
- (b) in the rare situation where remedial work is not technically feasible and either
 - the radon exposure assessment shows that any worker is exposed to greater than 800 kBq/m³h per year; or
 - when a worker spends greater than 100 hours per year in a location with radon concentrations greater than 800 Bq/m³.

A system of radiological protection is not limited to situations where workers receive annual radiation doses above 6 mSv. The specific circumstances that apply in the workplace may require measures such as the display of warning notices, restricting the access to those areas with high radon concentrations and on-going assessment of radiation doses received by workers.

The details of a system of radiological protection are outside the scope of this document. Where such a system is necessary, the RPII can advise employers on a case by case basis of the appropriate radiation protection measures that should be taken.

10. Maintenance of records and surveillance

All records and procedures necessary to demonstrate compliance with the legislation, including the assessment of radon exposure to workers, details of remedial work and post-remediation measurements shall be maintained indefinitely and shall be made available to an inspector of the RPII, on request.

Glossary of Terms

Above Ground Workplaces Radon is known to be a potential problem in underground workplaces such as caves and mines. The RPII has published separate guidance for such workplaces. The term 'above ground' as used in this document, refers to all workplaces other than those that are clearly underground.

Category A Worker The legislation classifies a worker who is liable to receive a dose greater than 6 mSv per year as a Category A worker. As these workers are at increased risk, additional protection is required. For example, Category A workers are subject to ongoing personnel monitoring and routine medical surveillance, the records for which must be kept until the worker reaches the age of 75. The specific requirements for Category A workers are set out in articles 25, 26 and 27 of S.I. No. 125 of 2000.

Dose Limit The dose limit for workers is 20 mSv in any 12 month period. The dose to a pregnant worker must be limited to 1 mSv for the remainder of the pregnancy from the time that she informs the undertaking of her condition.

Natural Radiation means radiation originating from sources which occur naturally in the environment. In the context of radon the source is uranium, which is naturally occurring and found in various amounts in all rocks and soils.

Radon means radon-222 gas in air. Radon is a naturally occurring radioactive gas. It is colourless, odourless and tasteless and can only be measured with special equipment. It is formed in the ground from the radioactive decay of uranium, which is present in small quantities in all rocks and soils. Because it is a gas, it can move freely through gaps or cracks in bedrock and soils. Radon which reaches the surface is rapidly diluted to harmless concentrations, but in certain circumstances radon which enters a building can build up to high concentrations.

Radon Concentration This means the activity concentration of radon gas in terms of activity per unit volume of air. The unit of radioactivity is called the becquerel (Bq), with the activity concentration given in becquerels per cubic metre (Bq/m³). A becquerel is equal to one nuclear disintegration per second. A kilo Becquerel (kBq) is 1,000 x 1 Bq.

Radon Exposure Radon exposure of a particular worker is determined by multiplying the radon concentration, measured in Bq/m³ of each area that a worker occupies by the number of hours per year spent in each area. The unit of radon exposure is kilobecquerels per cubic metre hours (kBq/m³h). The radon exposure of an employee who works for 2000 hrs per year in an area where the radon concentration is 400 Bq/m³ is 800 kBq/m³h. Please note that radon exposure is a different quantity to radon concentration.

Radiation Dose The unit of radiation dose is called the sievert. The radiation dose from radon is usually quoted in millisieverts (mSv). There are one thousand millisieverts in one sievert.

Reference Level This is a concentration of radon above which action to reduce the radon levels may be needed. In Ireland the Reference Level for radon in workplaces as specified in legislation is 400 Bq/m^3 averaged over any three month period.

Appendix 1

Examples of how to assess the radon exposure to a worker

Worker A			
	Radon Concentration (Bq/m³)	Occupancy per year (hours)	Radon Exposure (kBq/m³h)
Location A	200	1000	200
Location B	300	300	90
Location C	550	500	275
Location D	700	200	140
Cumulative Radon Exposure (kBq/m³h)			705

Worker B			
	Radon Concentration (Bq/m³)	Occupancy per year (hours)	Radon Exposure (kBq/m³h)
Location A	200	200	40
Location B	300	500	150
Location C	550	100	55
Location D	700	1200	840
Cumulative Radon Exposure (kBq/m³h)			1085

The radon exposure is obtained by multiplying the radon concentration by the occupancy rate. For Worker A, the radon exposure in location A is calculated by multiplying the radon concentration (200 Bq/m³) by the occupancy rate (1000 hours) giving 200,000 Bq/m³h or 200 kBq/m³h (1000 Bq = 1 kBq).