LEAFLET 32

RADIATION SAFETY ARRANGEMENTS FOR PROTECTION AGAINST RADON

CONTENTS

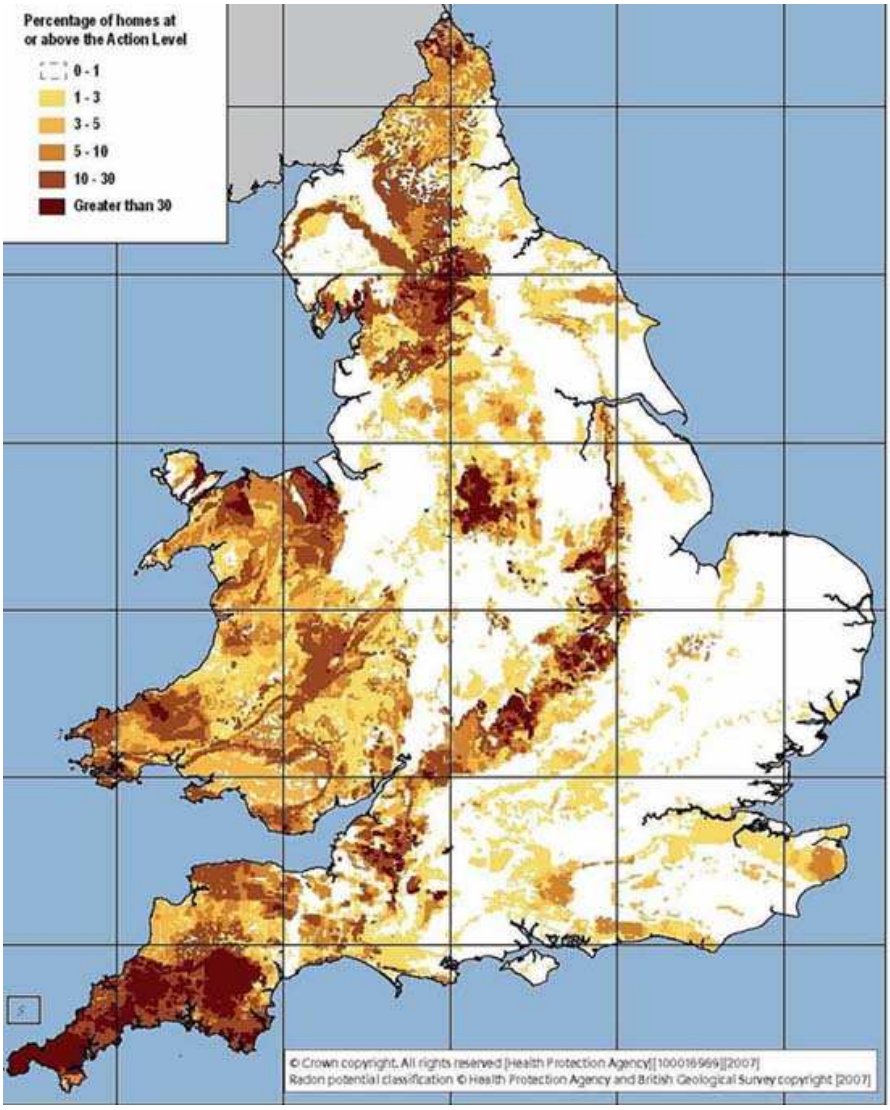
SCOPE

1 Radon is a naturally occurring radioactive gas, which if inhaled, may pose a risk to health. It is generated by either the radioactive decay of uranium in minerals and rocks such as granite, or from radium luminised articles. Radon can build up in confined spaces, particularly underground, such as mines or basements, or in poorly ventilated areas. Radon can also be found in conventional buildings as it can seep from the ground and enter through any gaps or cracks in the fabric of the building.

2 As radon is a gas it is the air activity concentration that is measured. The units used are becquerels per cubic metre (Bq m^{-3}).

3 Radon affected areas (RAA) in the UK have been identified by the Health Protection Agency (HPA) by measurements made in homes over a number of years and are shown in Figure 1. Figure 1 represents the estimated percentage of houses above the Action Level for homes. RAA are geographical areas of the UK where 1% or more of homes exceed the Action Level of 200Bq m^{-3} for homes. The HPA, in conjunction with the British Geological Survey (BGS) has produced new indicative maps (see link below) and a more detailed definitive dataset (for England & Wales) to determine if a building is likely to be in an RAA. Other maps are available from HPA for Northern Ireland and limited parts of Scotland. The Action Level for workplaces is 400Bq m^{-3}, which is higher due to the more limited time spent at work as compared to the time spent at home. A radon gas concentration of 400Bq m^{-3} equates to a dose of approximately 2.5mSv per year based on an occupancy of 1600 hours.

Figure 1 Estimated percentage of houses at or above the radon Action Level for homes (200Bq m^{-3}).



http://www.hpa.org.uk/web/HPAweb&HPAwebStandard/HPAweb_C/1204186222060.

4 For new buildings, extensions, conversions and refurbishment works, it is a requirement to comply with Building Regulations (BR) 2000. These Regulations refer to using BR 211 (Guidance on Protective Measures for New Buildings) which presents detailed guidance on where in England and Wales protection from radon is required and also provides construction details on methods of protection. For overseas locations specific advice is to be sought from the RPA.

5 This leaflet describes the radiological requirements for control of exposure to radon. The information provided in the main body of this leaflet is primarily directed to workplaces, for which the Ionising Radiation Regulations 1999 applies. Radiation safety arrangements for protection against radon exposure in residential accommodation is provided at Annex A. General information and instruction on the hazards associated with radon, personnel duties and responsibilities and statutory and MOD mandatory requirements is provided in the body of the leaflet. The RPA is to be consulted for detailed advice on specific areas affected by radon and for locations overseas.

STATUTORY REQUIREMENTS AND PARALLEL ARRANGEMENTS

6 In addition to the general requirements of the Health and Safety at Work etc Act 1974 and the Management of Health and Safety at Work Regulations 1999 (MHSWR99), the following specific legislation applies directly or is applied indirectly through parallel arrangements designed to achieve equivalent standards:

- Ionising Radiations Regulations 1999 (IRR99) (apply directly).

DUTIES

Commanding Officer / Head of Establishment (CO/HoE)

7 The CO/HoE has a duty to the Secretary of State, and a personal responsibility to protect the environment, and secure the health, safety and welfare of their staff at work. The CO/HoE is also required to protect persons not in MOD employment (e.g. members of the public) against risks to their health and safety arising from the MOD work activities. This includes radiation safety. The CO's/HoE's authority (but not responsibility) for radiation safety management arrangements may be delegated to appropriate personnel, such as a Radiation Safety Officer (RSO).

Radiation Safety Officer (RSO)

8 The Radiation Safety Officer (RSO) is to ensure that:

- They are familiar with the specific radiation hazards at their unit or establishment and that an appropriate risk assessment has been carried out.
- Local orders include the requirements for control of exposure to radon as detailed in this leaflet.
- Staff are appointed, instructed and trained in their duties relating to this leaflet.
- The requirements stemming from this leaflet are subject to audit.

Radiation Protection Supervisor (RPS)

9 Where it is likely that an individual may receive a radiation dose greater than 6mSv per year, an RPS is to be appropriately trained and appointed. They are to ensure that work is carried out in accordance with the local orders for radiation safety that include the requirements of this leaflet. Further information on the requirements for the appointment of an RPS is given in Table 3.

Workplace Supervisor (WPS) (Radon)

10 In units or establishments where radon activity concentrations are equal to or exceed 200Bqm^{-3} but where it is not necessary to appoint an RPS, a WPS (Radon) is to be appropriately trained and appointed. Duties will be to ensure that work is carried out in accordance with the local orders for radiation safety and include the requirements in this leaflet.

11 These duties should include the following:

11.1 Determine any changes in ventilation and/or occupation rates in a particular area which may affect radon activity concentrations and potential radiation doses.

11.2 Ensure, where remediation measures are installed, they are functioning efficiently and correctly and that maintenance is undertaken as directed.

11.3 Act as coordinator for the issuing of any personal radon dosimetry.

11.4 Act as coordinator for radon monitoring, including (where relevant) the placement and collection of environmental radon detectors.

Employees

12 It is the responsibility of all employees to ensure that they are familiar with the relevant parts of local orders to ensure that correct procedures are followed. Employees are to report any incidents to the appropriate supervisor or line manager.

NATURE OF RADON

13 Radon gas is primarily radon-222 (Rn-222), which has a short half-life (approximately 4 days) and decays through a number of radioactive short lived decay products, called radon progeny. When radon gas is allowed to build up in an enclosed space, such as a mine or basement, the radioactive hazard increases because of the build-up of radon progeny. The relative amounts of radon progeny to radon gas depends upon ventilation and radon ingress rates, with well ventilated areas usually containing lower concentrations of radon progeny.

14 The majority of radon gas that is breathed in is immediately exhaled and presents little radiological hazard. However, some of the radioactive radon progeny are solid and can become attached to atmospheric dust and water droplets that then can become lodged in the lungs.

15 Detailed advice on the radioactive nature and properties of radon may be sought from the RPA.

HAZARDS

Table 1 Hazards associated with radon

Radiation type	Emitted	Comments
Alpha	✓	High energy alpha radiation is emitted by radon-222 and some of the radon progeny. Alpha radiation poses a potential internal hazard e.g. inhalation of gaseous radon and alpha emitting radon progeny. In most cases alpha radiation is stopped by a thin layer of skin or a few cm of air and hence is not normally considered an external radiation hazard to most of the body.

Radiation type		Emitted	Comments
Beta	Direct	✓	Some of the radon progeny emit beta radiation of varying energies. Beta radiation from radon progeny poses a potential internal hazard from inhalation, as for alpha radiation above. Whilst beta radiation can, in some circumstances, give rise to an external hazard, the concentration of radon progeny likely to be encountered are not sufficient to give rise to any appreciable external hazard.
	Bremsstrahlung	✗	
Gamma		✓	A range of low level gamma emissions are associated with the alpha and beta decay of radon-222 and its progeny. Gamma emissions present a predominantly external radiation hazard, although the concentration of radon progeny likely to be encountered is not sufficient to give rise to an appreciable external hazard.
X-rays		✗	
Neutrons		✗	

MEASUREMENT OF RADON

16 Measuring radon concentrations in situ is the only practical way to assess the radiation exposures of persons occupying in the workplace or area. The map provided at the start of the leaflet helps to identify areas known to have higher levels, but high levels can also be found in areas not considered to be radon affected.

17 Workplace radon surveys are to be undertaken in RAA and in areas in close proximity to RAA. Priority is to be given to those areas with higher percentages of homes above the Action Level of 200Bq m^{-3}. Additionally, such surveys are to be undertaken in underground facilities and in areas where elevated quantities of radium-226 are stored (paragraph 21), regardless of whether or not these are located in radon affected areas.

18 Radon environmental detectors as shown in Figure 2 are used to assess the levels present in an area. The number of detectors required depends on the use and size of the area. These are placed for a 3 month period to take into account average conditions within the building. Measurements initiated in the winter months, November through to February, give more accurate readings. The RPA is to be contacted for further details and to arrange for the issue of radon detectors.

Figure 2 Radon Environmental Detector

19 The results issued may contain seasonally corrected values - these values are indicative and for the RPA's information only.

20 The results of radon monitoring will lead to different actions which are summarised in Table 2.

Table 2 Actions required following radon monitoring results (based on 3-month environmental monitoring)

Survey Period	Reading type	Concentration level (Bq m-3)	Action required
Initiated between Mar-Oct	Actual	> 400	Ionising Radiations Regulations 1999 apply. HSE Notification required. Consult RPA. In consultation with RPA, implement immediate action to restrict exposure. Appoint WPS (Radon)/RPS. Monitor radon levels until remediation measures are installed. Keep MHSWR99 radon risk assessment under review.
Initiated between Mar-Oct	Actual	Between 300 and 400	Consult RPA. Appoint WPS (Radon). Re-monitor during winter months (Nov-Feb). In consultation with RPA, consider immediate action to restrict exposure.
Initiated between Mar-Oct	Actual	≥ 200, but < 300	Consult RPA. Appoint WPS (Radon). Re-monitor during winter months (Nov-Feb).
Initiated between Mar-Oct	Actual	≥ 100, but < 200	Re-monitor in winter months. Keep MHSWR99 radon risk assessment under review.
Initiated between Mar-Oct	Actual	< 100	Keep MHSWR99 radon risk assessment under review.
Initiated between Nov-Feb (Winter months)	Actual	> 400	Ionising Radiations Regulations 1999 apply. HSE Notification required. Consult RPA. Appoint WPS (Radon) or possibly RPS. Restrict exposure. Re-monitor annually in winter months. Monitor radon levels until remediation measures are installed.

			Keep MHSWR99 radon risk assessment under review.
Initiated between Nov-Feb (Winter months)	Actual	Between 300 and 400	Consult RPA. Appoint WPS (Radon). Re-monitor annually in winter months (keep situation under review to ensure that if working use or conditions alter the radon concentrations are re-monitored). Consider, in consultation with RPA immediate action to reduce exposure, e.g. increase ventilation. Keep MHSWR99 radon risk assessment under review.
Initiated between Nov-Feb (Winter months)	Actual	≥ 200, but <300	Consult RPA. Re-monitor within five years (keep situation under review to ensure that if working use or conditions alter the radon concentrations are re-monitored). Appoint WPS (Radon). Keep MHSWR99 radon risk assessment under review.
Initiated between Nov-Feb (Winter months)	Actual	< 200	Keep MHSWR99 radon risk assessment under review.

RADON FROM STORAGE OF RADIUM-226

21 Where practicable, radium-226 sources are to be stored on open racking within a secure, well-ventilated store of volume exceeding 25m^3 with an activity of all radium items not exceeding 2MBq. If source cabinets, cupboards, and safes are used, these are to be subject to a supplementary radium-226 storage limit of 0.2MBq. In circumstances where it is not practicable to comply with the above requirements, the RPA is to be consulted and a request is to be made for the assessment of radon in air concentrations. The RPA will provide advice in relation to any measures required to restrict exposure to radon gas emitted by the stored radium sources.

RISK ASSESSMENTS FOR RADON

22 The risk assessment required under MHSWR99 should address potential hazards from radon in the workplace. If the radon concentrations in a workplace exceed 400Bq m^{-3}, the CO/HoE will need to arrange for a radiological risk assessment to be undertaken for the purpose of identifying the measures required to restrict exposure of employees or other persons to ionising radiation. These measures should be implemented promptly after the completion of the risk assessment and may include restriction of occupancy levels within affected buildings/offices, increasing ventilation rates, continuation of radon monitoring and remediation of buildings. In the majority of cases remediation of the building is the most effective and practicable solution. The RPA will be able to provide advice in relation to the radiological risk assessment and any requirements for restriction of exposure. Leaflet 2 describes the process to be followed in carrying out a radiological risk assessment. The general legal and MOD mandatory requirements for control of radon exposures are given in Table 3.

23 In addition, where TLBs make use of non-MOD property to conduct some areas of their business in known RAAs (e.g. cadet units operating from the volunteer estate) they have a responsibility to seek assurance from the operator/landlord of those premises (or the appropriate regional RFCA council) to ensure that the risks from radon exposure have been adequately addressed.

LEGAL AND MOD MANDATORY REQUIREMENTS

24 Table 3 below summarises the legal and MOD mandatory requirements for control of radon exposure in the workplace. In cases of doubt, the RPA is to be consulted for advice.

Table 3 Legal and MOD mandatory requirements for control of radon exposures

Requirement	Applicable	Comments	Related leaflet*
HSE Authorisation	✗		
HSE Notification	✓	Where radon concentrations are greater than 400Bq m^{-3} the HSE is to be notified in accordance with Leaflet 3.	3
EA Notification**	✗		
Risk assessment	✓	A risk assessment is required under MHSWR99 to assess the exposure to radon. A prior risk assessment under the Ionising Radiations Regulations 1999 is required where radon concentrations are greater than 400Bq m^{-3}. Contact the RPA for specific advice.	2
Restriction of exposure	✓	Where radon concentrations are 300Bq m^{-3} or greater, steps must be taken in consultation with the RPA to reduce the exposure of employees, either through limited use of the area; ventilation of the room prior to use; or remediation measures, e.g. install airbricks or sump. See Leaflet 4 for general information on restriction of exposure.	4
PPE	✗		
Maintenance of radiation engineering controls	✓	Depends on the degree of physical controls installed. Those with mechanical parts will require regular maintenance and checks.	
Contingency plans	✗	Contingency plans for radon exposure are not normally required. Leaflet 2 describes the general requirements for contingency plans.	2

Requirement	Applicable	Comments	Related leaflet*
Designated areas	see comment	If measurements of greater than 400Bq m^{-3} are recorded and it is not feasible to reduce the exposure of employees via control measures, it may be necessary to designate a controlled or supervised area. Specific advice on this is to be sought from the RPA.	4
Monitoring	✓	The measurement of radon concentrations is the only way to assess the radon exposure of persons occupying the workplace or area. If the results are 300Bq m^{-3} or greater, a monitoring programme is to be put in place to assess exposures and confirm the effectiveness of any remediation carried out. If the results are less than 300Bq m^{-3} it may be necessary to repeat measurements over an extended period of time to ensure that the radon levels do not change greatly over a year.	4
Training for users	✓	Information and instruction is required.	15
Local orders	✓	See Leaflet 16 for guidance.	16
Appointed person	✓	An RPS is required in areas to be designated as controlled or supervised. Where an RPS is not required, and the radon gas concentration is equal to or greater than 200Bq m^{-3}, a WPS (Radon) is to be appointed in accordance with Leaflet 15.	15
Storage	✗		
Accounting	✗		
Leak testing	✗		
Personal dosimetry	✓	Personal radon dosimetry may be required, as advised by the RPA, if there is a requirement for a designated area.	6
Classified persons	✓	Personnel working in designated controlled areas may need to be classified in accordance with Leaflet 6.	6
Reporting procedures	✓	Certain incidents require to be reported to MOD authorities. Reporting to external regulatory authorities may also be required. See Leaflet 14 for details.	14
Transport	✗		
Marking	✗		
Disposal of redundant items and waste arisings	✗		

*JSP 392, unless otherwise stated

**Environment Agency (EA) for England and Wales, Scottish Environment Protection Agency (SEPA) for Scotland and Environment and Heritage Service for Northern Ireland (EHSNI).

LEAFLET 32 ANNEX A

RADIATION SAFETY ARRANGEMENTS FOR PROTECTION AGAINST RADON EXPOSURE IN RESIDENTIAL ACCOMMODATION

INTRODUCTION

1. Applicability

The Housing Health and Safety Rating System (HHSRS) Regulations 2005 requires landlords to assess all potential hazards that exist in their properties which includes the risk from radon. Therefore MOD as a landlord is required to assess the risk, and instigate measures to mitigate this risk if the levels found to equal or exceed the Action Level (estimated average of 200Bq m^{-3} over a calendar year), see Table A1 below. This risk assessment process will start by using the current RAA data/maps produced by HPA and British Geological Survey (BGS), then if the site is deemed to be in a radon affected area, radon monitoring will be required to determine the actual radon concentration in the particular premises. There are two types of accommodation on the MOD estate: Single Living Accommodation (SLA) and Service Family Accommodation (SFA). The requirements of The Building Regulations (2000), as detailed in paragraph 4 of the main body of this Leaflet, also applies to residential accommodation.

2. Methodology

2.1 SFA

For SFA located within RAA (as defined by the HPA/BGS data), DE will monitor all properties included in their contract. For all other housing in RAA not covered by a DE managed contract, the CO/HoE must ensure appropriate arrangements are in place. Currently SFA monitoring is carried out by Maintenance Management Organisation (MMO) and consists of the installation of two radon detectors per property, one on the ground floor and one on the first floor (assuming conventional two storey property).

2.2 SLA (also includes SLAM, PFI etc).

For SLA, blocks of flats and Official Service Residence (OSRs) the number of badges will be determined following a risk assessment by a competent person, taking due note in each case of the building configuration, number of floors, flats/rooms per floor etc., with any initial surveys concentrating on the ground floor rooms. In most cases undertaking radon monitoring of at least 10-20% of ground floor rooms will provide adequate coverage for each building.

3. Monitoring Duration

The detectors will typically be installed for a three month period; the detectors will be located and fixed in accordance with the manufacturer's instructions and the advice provided by the RPA and/or dosimetry service.

4. Reporting

All results will be presented as a reading of the amount of radon the detector was exposed to, expressed in terms of Becquerel per cubic metre (Bq m^{-3}).

4.1 SFA
The results from the detectors will be provided in the form of two individual readings, each clearly identifying the location within the property. These results are to be provided to the householder.

4.2 SLA
The suite of results from the locations monitored will be provided to clearly identifying the building number/name and room number.

5. Actions

The required actions following the monitoring are detailed in Table A1.

5.1 SFA

For properties with estimated annual average radon levels below 150Bq m^{-3} the situation should be kept under review in consultation with specialist advice (e.g. RPA) with consideration on retesting on a five yearly basis.

For any property where either one or both of the readings are between 150Bq m^{-3} and 200Bq m^{-3} retesting will take place at least at three yearly intervals.

For any property where one or more of the readings estimated annual average radon level is equal to or exceed 200Bq m^{-3} (Action Level), then remediation works will be undertaken to reduce these levels to below 200Bq m^{-3}. The exact nature of the remediation will be determined on a case-by-case basis (considerations such as the type, construction, location of the property and cost will be made). A retest will be undertaken immediately after the remediation works are complete to ensure that the remediation is effective.

For houses in which mitigation work has been undertaken, a policy of testing on an annual basis will be implemented to ensure that the mitigation measures continue to be effective in maintaining the estimated annual average radon level below the 200Bq m^{-3} Action Level.

5.2 SLA

For any location where at least one of the readings annual average radon level is above 200Bqm^{-3}, then mitigation works will be undertaken to reduce these levels to below the 200Bq m^{-3} Action Level.

For locations with readings below 150Bq m^{-3}, no immediate further action is required however, the site should consult specialist advice e.g. (RPA) and the situation should be kept under review with consideration on retesting on a five yearly basis.

For any location where readings are between 150Bq m^{-3} and 200Bq m^{-3} retesting will take place at least at three yearly intervals.

Note 1:
Where significant structural alterations are undertaken e.g. new walls constructed, relocating or closing off of windows or doors that could interfere or change the airflow within the building, additional monitoring may be required.

Note 2:
Cross reference can be made to Defence Estates ‘Radon Information Notes 0707’.

Table A1 Actions required following radon monitoring results (based on 3-month environmental monitoring)

Any month	Estimated annual average radon level	≥ 200	Consult specialist advice (e.g. RPA) Restrict exposure (e.g. install remediation measures). Consider monitoring radon levels until remediation measures are installed.
Any month	Estimated annual average radon level	≥ 150, but <200	Consult specialist advice (e.g. RPA). Consider installing remedial measures. Retest dwellings on a three yearly basis Consider immediate action to reduce exposure, e.g. simple ventilation.
Any month	Estimated annual average radon level	< 150	Keep situation under review, consider retesting on a five yearly basis. Consult specialist advice (e.g. RPA)