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# **Review of radon in the States of Jersey**

**Report for the Environment Scrutiny Panel**

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This report has been produced by Public Health England's Centre for Radiation, Chemical and Environmental Hazards under contract to States of Jersey Environment Scrutiny Panel

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# **Review of radon in the States of Jersey**

## **Report for the Environment Scrutiny Panel**

**E J Bradley**

### **ABSTRACT**

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As part of a Scrutiny review on radon in Jersey, Public Health England's Centre for Radiation, Chemical and Environmental Hazards was contracted by the States of Jersey Environment Scrutiny Panel to

- apply specialist knowledge to the review in order to assist the Scrutiny Panel in assessing the evidence presented to it; and to
- advise the Scrutiny Panel on further research it might undertake to develop a broad understanding of the issues involved.

Evidence was provided by the Scrutiny Panel and the information summarised and compared with information and control processes used elsewhere. Ten recommendations covering existing measurements, further radon testing and the need for clarification of advice on radon testing, reduction and control were made. Consideration of new EU legislation and proposed legislation was also included.



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## EXECUTIVE SUMMARY

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A review of documentation and information provided by the States of Jersey Environmental Scrutiny Panel was undertaken under contract.

Scrutiny is an evidence-based process whose principal function is to hold the Executive to account for its policies and actions. In reviewing Executive policy Scrutiny does not act as a political opposition but seeks to clarify key elements of the policy and its impact on the population through examination of evidence provided by the States of Jersey government departments, stakeholders and the general public.

As part of the Scrutiny review on radon, Public Health England's Centre for Radiation, Chemical and Environmental Hazards was contracted by the States of Jersey Environment Scrutiny Panel to

- apply specialist knowledge to the review in order to assist the Scrutiny Panel in assessing the evidence presented to it; and to
- advise the Scrutiny Panel on further research it might undertake to develop a broad understanding of the issues involved.

Evidence was provided by the panel from Jersey Government Departments and other sources, in total over 30 documents including past measurement data, geological information, submissions from officers and Jersey Laws were considered. The information was reviewed, summarised and compared with information and control processes used elsewhere. Recommendations for future work and considerations for changes to current procedures are proposed.

A total of 10 recommendations are made covering the use of existing measurements, the need for further radon testing and the need for clarification of advice on radon testing, reduction and control. Consideration of new EU legislation and proposed legislation is also included.

In conclusion, most aspects of radon exposure in Jersey have been considered and relevant control procedures put in place, although updates should be considered. The main area suggested for improvement is an overarching document that pulls together the relevant information, formal advice and regulation into a radon policy document for Jersey. The information should also be provided in simple format that is made easily available to all stakeholders.



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## 1 INTRODUCTION

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This report reviews the control of radon in the States of Jersey. It covers all aspects of potential radon exposure and the mechanisms currently in place to control radiation exposure from this natural source of ionising radiation.

This review examines the policies of the Ministers for Planning and Environment and Health and Social Services, States of Jersey in respect of measures for dealing with radon gas in Jersey, in particular the monitoring of radon levels in the Island, information provided to the public and applicable bye laws. The primary focus of the review is on evidence regarding levels of radon found in buildings in the Island, available guidance and means of prevention, rather than detailed investigation of potential health implications, which falls outside the remit of the Scrutiny Panel.

Scrutiny is an evidence-based process whose principal function is to hold the Executive to account for its policies and actions. In reviewing Executive policy Scrutiny does not act as a political opposition but seeks to clarify key elements of the policy and its impact on the population through examination of evidence provided by the States of Jersey government departments, stakeholders and the general public.

The main objectives are:

- To consider the results of the latest radon survey of properties in the Island, announced in November 2011 by the Jersey Health Department
- To compare these results with previous local surveys and relevant information available from the UK and elsewhere, to establish whether any further work is considered necessary and if so, make appropriate recommendations.
- To review the support and advice provided to the public in respect of radon, together with any assistance available to Jersey homeowners to address higher levels of radon in their properties where these are found to exceed recommended guidelines, or are considered potentially to be of concern.
- To review the scope and effectiveness of present building bye laws requiring measures to protect against the build-up of radon gas in buildings and whether they need updating

Information sources provided by the States (see Appendix A) and from other sources have been assessed and advice and recommendations for future work and considerations for changes to current procedures proposed.

## 2 RADON

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Radon is a natural radioactive gas, which has no taste, smell or colour. It is produced by the radioactive decay of uranium and thorium, present in all soils and rocks in small quantities. There are a number of isotopes of radon but the most important are radon-222 (derived from uranium-238) and radon-220 (derived from thorium-232). Radon-220, generally known as thoron because of its parent radionuclide, delivers much smaller doses to the UK public than

radon-222, and will not be discussed here. In the rest of this report, the term radon will refer to radon-222.

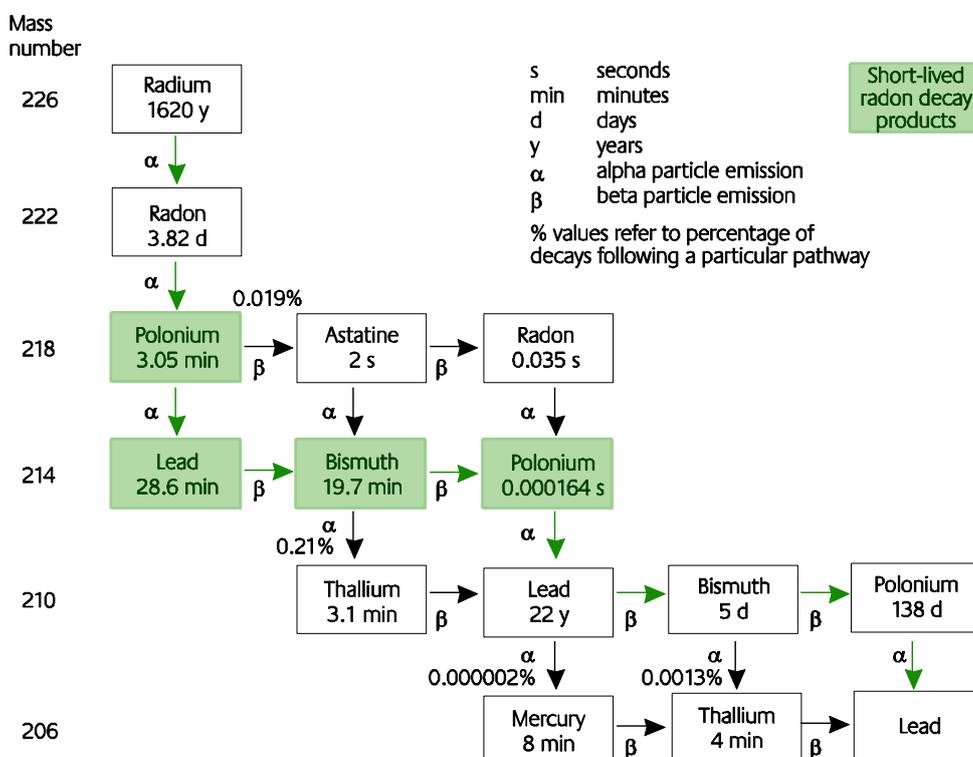
Radon has a 3.82-day half-life, it can therefore move in the ground before decay. If it escapes from the ground to the outdoor air, it is quickly diluted to low concentrations. However, radon concentrations indoors can reach high levels. Radon enters with the flow of air carrying radon from the ground into buildings. This occurs because, as a result of warm indoor air rising, the air pressure at ground level in most buildings is slightly lower than the pressure in the air beneath them. This causes a flow of soil air to be drawn into buildings, carrying radon with it.

Radon is soluble in water and under some circumstances high concentrations can be found in groundwater, for example, from wells or boreholes. If the water is used for domestic purposes this is another route of exposure to radon. In the UK this is thought to be a very small problem and one which can usually be remedied easily. Building materials can also be a source of indoor radon, although they are usually a much smaller source than the ground.

### 2.1 Risks from radon

When radon gas decays it gives rise to isotopes of the solid elements lead, bismuth and polonium, as shown in Figure 1.

FIGURE 1. The Uranium-238 decay chain from Radium-226 to stable Lead.



The short-lived decay products are also radioactive, and attach themselves to natural aerosol particles in the atmosphere. Both unattached decay products and decay products attached to particles may be inhaled, and may then stick to the walls of the lungs and other parts of the respiratory system. As these radon decay products undergo further radioactive decay, they emit alpha particles which irradiate the cells lining the walls of the respiratory system. It should be noted that the term 'exposure to radon' is used as shorthand for 'exposure to radiation released by radon and its decay products'.

It has been appreciated since the 1500s that metal miners in the Erz mountains of central Europe had a very high mortality rate. However, the disease accounting for this was not identified as lung cancer until 1879 (Harting and Hesse, 1879) and the aetiological role of radon was not established until the 20th century. In 1951 Bale pointed out that the hazard was due to the radiation dose from the decay products of radon rather than radon itself (Bale, 1951).

Since Bale's observation, many studies of the risks of exposure to radon among miners of igneous rocks have been carried out, and these studies have demonstrated an increasing risk with increasing exposure (BEIR 1999). In 1988, the International Agency for Research on Cancer (IARC) classified radon as a human carcinogen .

The range of exposures to radon in homes overlaps with the range of exposures found to cause lung cancer in miners. This suggests that radon in the home may increase the risk of lung cancer for those exposed at the highest concentrations. However, the conditions of exposure in mines are usually different from those in homes, so it is important to evaluate the risk of exposure to radon in homes directly. A number of studies designed to examine this question have been carried out. Combined ('pooled') analyses of the individual data from these studies have been published (Darby et al 2005, Darby et al 2006). These analyses now provide the most important body of evidence on the risks of exposure to radon in the home. Table 1 gives information on the lifetime lung cancer risks associated with radon at different concentrations for groups with different smoking histories.

**TABLE 1 Cumulative absolute risk of death from lung cancer to age 75 years in the UK by smoking history and long-term average residential radon concentration (AGIR 2009)**

Long-term average radon concentration (Bq m <sup>-3</sup> )	Cumulative risk of death from lung cancer to age 75 years (%)			
	Lifelong non-smoker	Ex-cigarette smoker: stopped at age 30	Ex-cigarette smoker: stopped at age 50	Continuing cigarette smoker
0	0.41	1.57	5.5	14.7
21	0.42	1.62	5.7	15.2
100	0.47	1.8	6.4	16.9
200	0.53	2.1	7.2	19.0
400	0.66	2.6	8.9	23.0
800	0.92	3.5	12.2	30.5

The information illustrates the combined effects of smoking and radon on lung cancer rates with an absolute risk of some 16% per 100 Bq m<sup>-3</sup> lifetime exposure. Radon is the second highest cause of lung cancer in the UK and gives the highest risk of lung cancer for non-smokers. It is estimated that around 1,100 deaths per year in the UK are from radon related lung cancer deaths, the majority of which are in current or ex-smokers. A summary of the information from Table 1 is given in an alternative format in Table 2. The likelihood of developing lung cancer has been calculated for the highest radon concentration measured in the most recent radon survey in Jersey (1,100 Bq m<sup>-3</sup>) and is included in the table for comparison. An important observation is that an ex-smoker exposed at this level has a similar risk of developing a lung cancer as a smoker exposed at the UK average.

**TABLE 2 Risk of death from lung cancer to age 75 years in the UK**

Long-term average radon concentration (Bq m <sup>-3</sup> )	Cumulative risk of death from lung cancer to age 75 years			
	Lifelong non-smoker	Ex-cigarette smoker: stopped at age 30	Ex-cigarette smoker: stopped at age 50	Continuing cigarette smoker
21	1 in 240	1 in 62	1 in 18	1 in 7
100	1 in 210	1 in 55	1 in 16	1 in 6
200	1 in 190	1 in 48	1 in 14	1 in 5
400	1 in 150	1 in 39	1 in 11	1 in 4
800	1 in 110	1 in 28	1 in 8	1 in 3
1100	1 in 90	1 in 23	1 in 7	1 in 2

The most recent study of radon and public health in the UK was published by the UK Health Protection Agency in 2009. The report (AGIR 2009) summarises all of the most recent research and draws together key points on all aspects of radon. The report provided 16 recommendations for consideration by the UK Health Protection Agency (HPA) - now Public Health England. These recommendations and other work published by international bodies such as the World Health Organisation (WHO 2009), the International Commission on Radiation Protection (ICRP, 1993, 2007, 2009) the European Commission (European Commission, 1990) and the UK Department of Health, Committee on the Medical Aspects of Radiation in the Environment (COMARE, 2007) prompted the HPA to publish updated advice for the UK on the Limitation of Human Exposure to Radon (HPA, 2010).

The UK report introduced the concept of the Target Level for radon (at 100 Bq m<sup>-3</sup>) to supplement the existing Action Level at 200 Bq m<sup>-3</sup> and included advice on the need for radon measurements in all homes within radon Affected Areas (areas where 1% or more homes are likely to exceed the Action Level), the application of the domestic radon Target and Action Levels to non-domestic buildings with public occupancy of 2000 hours or more and all schools, the need for basic radon protection in all new buildings, extensions, conversions and refurbished buildings and the need to carry out appropriate radon tests in new buildings fitted with full radon protection within the first year of occupation. The advice on testing in new-build

with full protection is designed to evaluate if the radon level exceeds the Action Level and hence if the radon sump needs to be activated.

The most recent review of radon and cancer in Jersey was published in July 2013 (NCIN 2013). That report was commissioned by the Jersey Medical Officer of Health to investigate the significantly higher rates of certain cancers, including lung cancer, identified in the 2011 Channel Islands Cancer Registry Report. The NCIN report concluded that the increased incidence of lung cancer was most likely influenced by the high rates of smoking rather than radon exposures. The latter will have some influence on the lung cancer rates but smoking is the primary cause. Around 59 lung cancers are observed in Jersey each year (NCIN 2013). Applying the proportions from the latest UK report (AGIR 2009) these deaths can be apportioned to different factors as given in Table 3. UK data from 2006 are included for comparison. It is important to note that in Jersey one of the two lung cancer deaths associated with radon per year are in people who do not currently smoke.

**Table 3. Causes attributable to lung cancer deaths**

Factor	Annual Lung cancer deaths		
	Jersey	UK <sup>(AGIR 2009)</sup>	% <sup>(AGIR 2009)</sup>
Radon alone	0.3	157	0.5
Radon and smoking – current smokers	0.9	532	1.6
Radon and smoking - ex-smokers	0.7	421	1.2
Smoking alone	49	28,376	83.1
Other	8	4,664	13.6
<b>Total</b>	<b>59<sup>(NCIN 2013)</sup></b>	<b>34,150</b>	<b>100</b>

## 2.2 The potential for elevated radon exposures in Jersey

Radon is present everywhere and can occur in high concentrations in buildings. Radon levels indoors are primarily influenced by the geology of the underlying rocks. The porosity and the uranium series radionuclide content of the rocks are both major factors in the potential for radon indoors. Most areas exhibit a distribution of indoor concentrations that is approximately log-normal, with a large number of low concentrations and a smaller proportion of premises with higher levels. Radon levels indoors can vary by several orders of magnitude from a few to over ten thousand becquerels per cubic metre of indoor air.

The geology in Jersey is similar to that found in areas of the South-West of England where the most recent mapping of radon potential shows a high proportion of homes with a 30% or greater chance of a radon level that exceeds the Action Level (Miles et al, 2007, Rees et al, 2011).

Reports provided to the States of Jersey in 1987 suggested that the granites in Jersey are similar but older (Pre-Cambrian to Cambrian – some 400 to 500 million years) to those found in the South West of England. The granites in Jersey are extensively fractured which gives rise to pathways for release of the gas to the surface which could give higher radon concentrations in buildings. Similarly to the South West of England, metallic minerals are found on the fringes of the granite areas in Jersey and these areas may give rise to higher concentrations of uranium series radionuclides and hence higher radon potential. Initial investigations concluded that there was a 30% chance of high levels in buildings in Jersey

close to the granite borders and mechanisms were put in place to manage exposure. Data obtained from radon measurements in homes was used to inform the Building Bye-laws, give advice on the need for testing and requirements under Health and Safety legislation.

Secondary factors that affect the indoor radon concentration are the connection of the building with the ground, environmental factors such as wind, temperature and pressure and occupancy factors such as heating and ventilation (Gumby1993). The age of the building may also have an effect as newer buildings in Jersey are required to be more air tight, insulated and since 1997 changes to the Building Bye-Laws required new homes in Jersey to include radon protection (Scivyer 2007).

The likelihood of a building having a higher level of radon can be predicted using mapping techniques (Miles 1994, 1998, Miles & Appleton 2005), however the radon level for an individual building can only be assessed by testing. The secondary factors above cause short term variations in radon levels. To assess the annual average concentration (or the worst case / winter concentration) for comparison with advisory limits or regulations, a long term test is recommended. A three month test with passive radon detectors placed in the occupied rooms (Howarth & Miles 2008) can be used for this purpose.

Radon released from water, that has been extracted recently from the ground, is a potential source of increased indoor concentrations of radon in air in some buildings in Jersey. The majority of buildings in Jersey obtain their water from surface water sources which have low radon concentrations. However, some buildings are supplied from private wells and these have a greater potential for high levels. Buildings with water supplied from underground sources may have increased indoor radon levels if the radon is released inside the occupied parts of a building, for example when the water is poured from taps or showers.

Locally sourced materials such as local granites have been used in the construction of buildings in Jersey. While the concentration of uranium series radionuclides is likely to be higher in these materials than bricks etc derived from clays it unlikely that the building material will contribute significantly to indoor radon levels. The major source of indoor radon is from the ground.

## 3 RADON IN JERSEY

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### 3.1 Radon measurements

#### 3.1.1 Radon in homes

Measurements of radon in homes in Jersey have been undertaken over many years. The majority of the testing has been funded by the States of Jersey. Information provided has identified three main phases of testing. In 1987/88 30 homes were selected, 21 spread evenly over the land area and a further 9 homes close to the edges of the granite intrusions. The results of these 3 month measurements undertaken in the winter showed that 10% of the properties had radon levels in excess of the 200 Bq m<sup>-3</sup> Action Level. The second phase of the testing concentrated in homes that were close to the homes with higher measurements found in the initial survey and also two underground workplaces. These measurements were taken over a longer period of some 9 months with the intension of eliminating seasonal variability, the results indicated 36% above the precautionary radon level of 200 Bq m<sup>-3</sup>. A

third phase of testing in St Helier town in 24 homes and five schools was completed in 1992 with all homes testing below the Action Level of 200 Bq m<sup>-3</sup>.

The most recent testing programme in homes in Jersey was carried out in 2012 and included 63 dwellings chosen to give a good spread of testing over the island (one dwelling per 1 km square). The majority, some 64% of these homes tested below the UK Target Level (100 Bq m<sup>-3</sup>), with 17% at or above the Action Level. The annual average concentrations measured were in the range 18 to 1,100 Bq m<sup>-3</sup>.

In total some 130 homes have been tested by the States of Jersey over the four measurement phases since 1987. Figure 2 shows the approximate location of the measured properties overlaid on the geological map of Jersey.

Information gathered from the occupants of the 64 properties tested in the 2012 survey showed that the majority (67%) were detached properties with 20% occupying semi-detached homes and the remaining 10% living in terraced homes or flats; 3% of householders did not provide the information. In addition most occupants (83%) owned their homes with only 10 householders (16%) renting from private landlords. The age of the properties measured was very much dominated by homes built before 1920 (some 61%) with the remainder mostly built before 1992 (30%); only one householder identified their home as being built in the period from 1993 to 2000.

Since the publication of the results of the 2012 survey a small number of homes have been tested by the States. The results from these 11 additional properties showed a very similar range of annual average radon concentrations (12 to 860 Bq m<sup>-3</sup>). The characteristics of the properties were also similar with the majority being detached homes; all owner occupied and only one home built since 1992.

The combined results of the 75 homes measured since 2012 are not sufficient to show if the average radon concentrations measured in homes in the 2012 survey have been affected by the changes to the Jersey building bye laws.

#### **3.1.1.1 Control strategy**

The current strategy for control of radon in homes is given in a recent report by the Jersey Health and Social Services Department and also in the leaflet 'Safe as Houses' available from the States of Jersey website. The advice is that all buildings in Jersey are sited on potentially radon emitting geology, so occupiers of accommodation should test for radon if the property has an occupied ground floor room or basement. This advice is not currently contained within a formal policy document for Jersey.

The property buying and selling process usually includes questions regarding hazards and potential problems with properties to best inform the purchaser. In England and Wales both the seller of the property and the local authority are asked about radon during the conveyance process. The inquiry to the local authority identifies whether the property is in a radon affected area. The inquiries of the seller also address this and ask about radon measurements for the property and any radon protection or remediation in place.

There is no equivalent process in Jersey. As a consequence, an opportunity is missed to stimulate property buyers to consider and understand the radon situation of a property they are purchasing

Including information about radon during the conveyance process would encourage more home buyers to test for radon. It would ensure that existing knowledge about the radon condition of a property, and any remedies, are passed on to the new owner.

The regulation of radon levels in homes in England and Wales is part of the Housing Act 2004 (UK Government 2004). This includes a system of rating hazards that applies to all homes. The Housing, Health and Safety Rating System (HHSRS) includes an assessment of 29 hazards that are rated according to the severity of their effects. Radon has a high rating as exposure to high levels over extended periods of time increases the risk of lung cancer. Enforcement of the HHSRS is by Local Authorities and actions are categorised according to the hazard score. High radon levels can require action to enforce reduction of the levels. While the Housing Act applies to all homes, the HHSRS, in practice is usually applied to tenanted properties where remediation of hazards to the occupants is primarily under the control of the landlord.

The new ionising radiation European Union Basic Safety Standards (EU-BSS) were published in January 2014, updating requirements for protection against the dangers arising from ionising radiation, including radon exposures in buildings. This directive is required to be incorporated into legislation by EU member states within 4 years and includes significantly greater requirements around radon than the current Directive, issued in 1996. The new directive includes:

- setting of national reference levels for radon that shall not be higher than  $300 \text{ Bq m}^{-3}$  (annual average radon concentration) in all buildings.
- establishment of a national action plan addressing long-term risks from radon exposures in dwellings, buildings with public access and workplaces for any source of radon ingress, whether from soil, building materials or water.
- ensuring that appropriate measures are in place to prevent radon ingress into new buildings. These measures may include specific requirements in national building codes.
- Identification of areas where the radon concentration (as an annual average) in a significant number of buildings is expected to exceed the relevant national reference level.

### **3.1.1.2 Recommendations**

Radon measurements in Jersey dwellings have been undertaken over a period from 1987 to 2012, with around 140 properties tested. The information is reported in different formats.

**R1 : Information about radon measurements in Jersey should be brought together in a consistent format (ideally representing the annual average radon concentration) to enable analyses and comparisons to be made.**

This will enable (with the aid of the island-wide Geographical Information System):

- Investigation of the distribution of results throughout the island and identification of any need for further testing

If sufficient measurements are available:-

- Estimates of average radon concentrations by area (such as 1km x 1km square)

- Estimates of average radon concentrations by underlying geology (rock type)
- Assessment of the impact of the radon protection required in new homes under the Jersey Building Bye Laws on reducing radon concentrations

Arrangements should be in place, consistent with Jersey laws on information governance and transparency, to maintain the privacy of individual radon measurements.

The results can then be used to determine whether further measurements are warranted to define specific radon Affected Area probability bandings, by area or by area/geological unit that may inform future radon policy.

The current radon policy includes the need for radon measurements in all locations and is therefore comprehensive. Further measurements as noted above will give additional data and hence could restrict the areas where radon measurements (and precautions for new build) are required. This might enable better targeting of protection but it is not clear at this point whether such a stratification is warranted.

NOTE: If further testing is required, careful consideration should be made of the sample selection, aiming for it to be fully representative of the housing stock on the island. The current data are heavily biased toward older detached properties that are owner occupied.

**R2 : Formal advice should be published asserting that all ground floor (or lower) dwellings on Jersey should be tested for radon and that premises with annual average indoor radon concentrations above the appropriate Action Level should be remediated.**

As the States of Jersey have already identified the need for radon testing it would be helpful if appropriate questions are asked during the buying and selling process.

**R3 : Questions about radon should be included in the conveyancing process associated with the sale and purchase of all buildings on Jersey.** The States should consider the addition of questions to conveyance documentation that asks the seller to provide the results of any radon measurements that have been made in the property and, if the measurements showed high levels, any remedies employed.

**R4 : Consideration should be given to the benefits of applying in Jersey, relevant aspects of the radon related requirements contained in the 2014 EU Basic Safety Standards.** Such an approach, embodied in a National Radon Action Plan, might support the bringing together of various strands of radon policy and support future benchmarking with EU Member States.



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### **3.1.2 Radon in non-domestic buildings**

Non-domestic buildings, essentially workplaces including schools, present a potential for exposure from radon. Some of these premises will be buildings that are used by members of the public. Some will be residential in nature, such as long stay hospitals or prisons.

One of the requirements of the EU-BSS is that the level of radon at which action should be taken, for both domestic and non-domestic exposures, is 300 Bq m<sup>-3</sup> (annual average radon concentration). The EU-BSS is required to be enacted by member states within 4 years of publication.

In the UK, advice given in 2010 (HPA 2010) included the application of the domestic Action Level (200 Bq m<sup>-3</sup> annual average radon level) and Target Level (100 Bq m<sup>-3</sup> annual average radon level) to buildings with annual public occupancy of 2,000 hours or more and to all schools. This would include residential homes that are also places of work.

Radon testing undertaken by the Jersey Government in non-domestic buildings has, so far, been limited to measurements in underground workplaces which were chosen because they were considered likely to have high radon levels and five schools in St Helier. Limited numbers of other workplace radon measurements have been undertaken by the States as part of their responsibility as an employer.

#### **3.1.2.1 Control strategy**

Non-domestic buildings are usually places of employment and are covered by the laws that protect the health and safety of employees. The current control strategy for non-domestic buildings is defined by Jersey Law. This places a duty on employers under the Health and Safety at Work (Jersey) Law, 1989 and the Approved Code of Practice for Work with Ionising Radiations, ACoP 2, 2002 revision.

The Health and Safety at Work (Jersey) Law, 1989, is the main occupational health and safety law in Jersey. It sets out the framework used by the States of Jersey, the Minister for Social Security and the Health and Safety at Work Inspectorate for dealing with health and safety issues at work.

Part 2 of the Law contains Articles 3 to 8 which place general duties on all those involved with working activities including employers, employees, the self employed, and those in control of premises.

Article 3(1) of the Law sets out a general duty on employers to ensure, so far as is reasonably practicable, the health, safety and welfare of his employees. Article 3(2) gives examples to which that duty extends, including:

(aa) The identification and assessment of risks to health and safety to which the employer's employees are exposed;

(e) The provision and maintenance of a working environment for his employees that is, so far as is reasonably practicable, safe, without risks to health, and adequate as regards facilities and arrangements for their welfare at work.

Under the law employers with five or more employees are required to prepare a written health and safety policy which includes a written statement of significant risks identified by the employer and the measures that are taken to eliminate or reduce that risk.

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Article 10 of the Law provides for the Minister for Social Security to approve codes of practice (ACoP) for the purpose of providing practical guidance on how the legal duty set out under Part 2 of the Law, or regulations made under the Law, can be met.

The current ACoP used in Jersey “Work with Ionising Radiation, ACoP 2”, was developed with assistance from the Health and Safety Executive (Great Britain) and approved on 29 August 2002. For radon, ACoP 2 applies to any work carried out in an atmosphere containing radon-222 at a concentration in air, averaged over any 24 hour period, exceeding  $400 \text{ Bq m}^{-3}$ , (except where the concentration of the short-lived daughters of radon-222 in air, averaged over any 8 hour working period, does not exceed  $6.24 \times 10^7 \text{ J m}^{-3}$ ). In practice in Jersey (and the UK) this is interpreted as any location within a workplace where a long term passive winter corrected (worst case) measurement exceeds  $400 \text{ Bq m}^{-3}$ .

Where such a concentration is identified, the employer has a responsibility to notify the Health and Safety at Work Inspectorate and to appoint a specialist Radiation Protection Advisor, who can advise the employer on the requirements of the ACoP 2.

Health and Safety at Work legislation is intended to be self regulating, requiring those with responsibilities under the Law, in this case employers, to take proactive action to identify risks to the health and safety of their employees and others, and put in place appropriate control measures. In Jersey, only a limited number of notifications have been received from employers. In these cases the Inspectorate has ensured that appropriate action was taken.

### **3.1.2.2 Recommendations**

There is currently good provision for the regulation of radon in workplaces in Jersey by application of the 1989 Jersey Law. However, UK advice (HPA 2010) published following a review of Radon and Public Health suggest that the control of some workplaces should follow the domestic control guidelines.

**R5 : The States should consider if workplaces with high public occupancy (2,000 or more hours per year) and schools should use the protection standards developed for homes.**

## **3.2 Reducing radon concentrations**

### **3.2.1 Radon in new buildings**

The results of initial measurement surveys of radon in homes were used to inform building control legislation in Jersey. Designation of areas that required protection was not deemed possible from the available results either by area or by Parish. A decision was therefore made that protection should be applied to new homes throughout Jersey.

#### **3.2.1.1 Control strategy**

The Building Bye-Laws (Jersey) 2007 give information on the requirements for new buildings in Jersey. The Laws cover the control of building work, the authorization, commencement and completion of work, the energy performance of buildings and other requirements. The Schedules that form part of the requirements include 12 Technical Guidance Documents.

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Radon is covered in Technical Guidance Document Part 4 'Preparation of Sites and Resistance to Moisture'. Section 2 deals with 'Contaminants' and the radon requirement (updated in 2013) gives information about radon risks and states: "To reduce this risk all newly created dwellings and extensions to dwellings need to incorporate precautions against radon. Guidance on suitable protective measures for new dwellings can be found in the BRE Report 211 Radon: Guidance on Protective Measures for New Dwellings". The BRE report information was not updated in 2013 and is referenced as the 1991 edition.

Several updates to the BRE report BR211 have been produced since the 1991 edition. The current report 'Radon: Guidance on protective measures for new buildings (including supplementary advice for extensions, conversions and refurbishments)' was published in 2007 (Scivyer 2007).

The most recent document "The Building Bye-laws (Jersey) List of technical guidance documents currently approved" 2013 Edition states: "The Department envisages further documents such as this will be issued in order to keep documents approved for the purposes of providing practical guidance up to date." Thus a mechanism for amending the Bye-laws exists.

The current regulation in Jersey applies to new homes and extensions only. There is no mention in the current bye-laws of the level of protection required, although information provided by the States Building Control Department indicates that the need for full radon protection (modelled on the higher risk areas in BRE report BR211) was noted in information provided to the press following the publication of the Building Bye-laws in 1997. A supporting document "Building Bye-laws Building works carried out in connection with dwellings. Template for the production of building specifications" has a section on radon and asks for a 1:10 scale detailed section through the wall / floor junction to be provided and position of sump(s) to be identified, however the link with the level of protection as defined by the report BR211 is not clear.

### **3.2.1.2 Recommendations**

**R6 : Consideration should be given to including radon protection to all new buildings and extensions, refurbishments and conversions** (as indicated in the latest 2007 edition of BR211), extending protection to non-domestic dwellings and hence reducing the risks from radon in all new buildings.

**R7 : Consideration should be given to amending the Building Bye-Laws (Technical Document Part 4) to clarify the level of protection required.** Currently there is no information in the document regarding full radon protection. Although this is inferred from the revised document (titled "Building works carried out in connection with dwellings: Template for the production of building specifications") which asks in section 4 for the position of sump(s) to be identified.

**R8 : Consideration should be given (depending on the outcome of recommendation R6) to updating the reference in Technical Document Part 4 to the latest version of the Building Research Establishment's Report BR211 2007 Edition.** Alternatively a separate guidance / advice document containing this information should be produced and referenced.

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### 3.2.2 Existing homes

In homes where radon levels are at or exceed the Action Level, householders are advised to reduce the level of radon. This advice is generally included as part of the reporting process by radon measurement laboratories. In the UK Public Health England (PHE) also recommends radon reduction should be seriously considered if members of the household are in a higher risk group (current or past smokers) and the annual average radon level exceeds the Target Level of 100 Bq m<sup>-3</sup>. PHE advises that radon levels should be reduced to as low as is reasonably achievable and if possible to below the Target Level. In the most recent survey undertaken in Jersey by PHE's predecessor HPA, householders were offered additional advice on radon reduction in their result report. Additional help was offered by the States with an invitation to householders to contact staff at the Health and Social Services Department.

#### 3.2.2.1 Control strategy

Many aspects of radon control in the States of Jersey follow the UK system that has developed over time (NRPB 1987, NRPB 1990, HPA 2010). The UK system is based on recommendations from the International Commission for Radiological Protection (ICRP 1984, ICRP 1993, ICRP 2007, ICRP 2009), the World Health Organisation (WHO 2009) and the requirements laid down by the European Commission (European Commission 1990).

Advice on the need for reduction if the radon measurement result is at or above the Action Level is given in the leaflet "Radon Safe as houses?" which is available from the States of Jersey website. No formal policy documentation exists.

#### 3.2.2.2 Recommendations

**See Recommendation R2:** Formal advice should be provided on conditions, based primarily on annual average indoor radon concentration, in which remedial action to reduce radon levels should be taken in buildings in Jersey.

### 3.3 Radon in water

Radon is soluble in water. High radon concentrations can arise in water that has been recently extracted from the ground where the water was in contact with uranium-containing rocks and minerals. As a result, high concentrations of radon can occur in water supplies in some areas. Radon in water could present a hazard in two ways: inhalation and ingestion. Firstly, radon can de-gas from the water into the indoor air, giving rise to exposure by inhalation. This can be a problem where radon levels in the water are lower but high volumes of water are handled, for example in some waterworks (Schmitz and Nickels, 2001) and other confined spaces with high water flows for example underground workings or tunnels, or where the water has higher radon concentrations, for example in buildings fed from underground water sources. Secondly, if water with high levels of radon is consumed, it can give rise to radiation doses to the gastrointestinal tract and to other body organs, although in most instances exposures through this route are small (Khursheed 2000). Inhalation is the main exposure pathway of concern from radon in water.

Where radon is present in tap water that is used indoors, it generally gives rise to a radon concentration in air about one ten-thousandth of the concentration of radon in water

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(UNSCEAR 1993, BEIR VI 1999). This means that to give rise to radon in room air at the UK average value of  $20 \text{ Bq m}^{-3}$  the concentration of radon in water would need to be about  $200 \text{ Bq l}^{-1}$  (becquerels per litre). This is much larger than the concentrations of radon normally encountered in water in the UK (Henshaw 1993) so radon in water does not normally contribute significantly to radon in indoor air in the UK.

The European Union has published a new directive laying down requirements for the protection of health of the general public with regard to radioactive substances in water intended for human consumption. This includes a parametric value for radon in water of  $100 \text{ Bq l}^{-1}$  (European Commission 2013). The Directive makes provision for Member States to adjust the parametric value up to a level not exceeding  $1,000 \text{ Bq l}^{-1}$ .

Radon concentrations are low in surface water sources due to the de-gasing of any radon into the air and radioactive decay of unsupported radon during storage. In the UK, measurements in reservoir and river water suggest that radon concentrations are likely to be of the order of  $1 \text{ Bq l}^{-1}$  (Hesketh 1980). Groundwater can contain a few tens of becquerels per litre but higher concentrations have been found in granite areas (Kenney et al 1966).

Radon concentrations may be higher in private water supplies, particularly in the case of wells drilled into rock. A survey in South West England (West Devon) examined water from 118 private supplies. Nine of these (8%) were found to have radon concentrations which exceeded  $1000 \text{ Bq l}^{-1}$ . (BGS/DETR, 2000).

In Jersey, public water supplies are almost exclusively derived from rainfall to surface with little or no contribution from groundwater. If these follow experience in the UK, then radon levels in the majority of Jersey public water supplies would be expected to be low. However, some drinking water in Jersey is provided from private supplies. As the geology of Jersey is similar to that of the South West of England there is potential for private supplies from boreholes to have higher radon concentrations.

No information is available on whether measurements of radon in water have been undertaken in Jersey. There is also no information on radioactivity measurements (which would include long lived radon decay products) to indicate if a potential for high radon levels exists.

### **3.3.1 Control strategy**

The Water (Jersey) Law 1972, (amended 2009) gives certain powers and imposes obligations on Jersey Water (the water supply company) to make provisions in relation to the conservation and quality of drinking water in the public supply. The Minister for Planning and Environment is responsible for the implementation of the law through delegated authority to officers from Environmental Protection in the Department of the Environment.

Under the 1972 law, Jersey Water is required to provide a supply of wholesome water sufficient for 'domestic purposes' (which includes supplies to retail premises where food and drink is consumed). The law also provides for the company's monitoring programme to be submitted for approval by the Minister.

There is currently no provision for the monitoring of radon. The requirements set out in the amended law specifically exclude radon and radon decay products from the indicator parameters.

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### 3.3.2 Recommendations

There currently appears to be no information available about radon levels in water in Jersey. The local geology would suggest that there is a potential for elevated levels in a limited number of private supplies fed by boreholes. While exposure from this source is mostly via inhalation (degassing of the radon from water used in the building) and can be assessed by measuring the radon in air concentration, a baseline should be established and potential pathways for exposure assessed.

**R9 : The States should consider a pilot programme to determine if radon in water is a significant source of exposure in homes and workplaces.** The study should concentrate on premises using water from boreholes in or around the areas of granite mineralisation, especially where pressurised water systems are used.

The outcome of the assessment could inform future policy on the testing of water for radon and would be consistent with the contents of the EU Directive 2013/51/Euratom (European Commission 2013).

### 3.4 Summary

This review of radon in Jersey concludes that Jersey has established some major strands of radon policy and practice. Several issues have been identified that are worthy of specific recommendations.

A summary is given below of the recommendations in earlier sections of this report. In addition a further recommendation (R10) is for the States of Jersey to publish a summary policy document on radon that would bring together all aspects of radon and the control of exposures to the population of Jersey in one document.

**R1: Information about radon measurements in Jersey should be brought together in a consistent format (ideally representing the annual average radon concentration) to enable analyses and comparisons to be made.**

**R2: Formal advice should be published asserting that all ground floor (or lower) dwellings on Jersey should be tested for radon and that premises with annual average indoor radon concentrations above the appropriate Action Level should be remediated.**

**R3 : Questions about radon should be included in the conveyancing process associated with the sale and purchase of all buildings on Jersey.**

**R4 : Consideration should be given to the benefits of applying in Jersey, relevant aspects of the radon related requirements contained in the 2014 EU Basic Safety Standards**

**R5 : The States should consider if workplaces with high public occupancy (2,000 or more hours per year) and schools should use the protection standards developed for homes.**

**R6 : Consideration should be given to including radon protection to all new buildings and extensions, refurbishments and conversions**

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**R7 : Consideration should be given to amending the Building Bye-Laws (Technical Document Part 4) to clarify the level of protection required.**

**R8 : Consideration should be given (depending on the outcome of recommendation R5) to updating the reference in Technical Document Part 4 to the latest version of the Building Research Establishment's Report BR211 2007 Edition.**

**R9 : The States should consider a pilot programme to determine if radon in water is a significant source of exposure in homes and workplaces.**

**R10 : The States should publish a summary policy document on radon that would bring together all aspects of radon and the control of exposures to the population of Jersey in one document.** The document should be made easily available for distribution to all stakeholders.

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## APPENDIX A Documents reviewed

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Number	Description	Source
1	Historical results and information  (Questions asked about radon generation in Jersey 1987, Cover letter from NRPB dated 12 August 1988, Report of measurements in 30 dwellings (AR/31/88) 11 August 1988, Internal memo (Public Health Department) Report of results of Jersey Radon Survey 1988', Letter from NRPB dated 26/10/87, Letter re geological assessment of measurement sites (Public Health Department) dated 2/12/87, copy of NRPB Radon Survey Questionnaire	States of Jersey (SoJ) Dept files
2	Hand annotated maps of Jersey (grid lines, grid plus numbers, districts in Jersey, photos of coastline rocks x2, geological map (6 categories black & white), geological map solid rocks (9 categories, black & white)	SoJ Dept files
3	Geological map of Jersey – colour (8 categories)	SoJ Dept files
4	Average radon concentrations in Jersey by 2km grid	SoJ Dept files
5	Information on Radon in Jersey Houses Surveys (internal report 'Radon in Jersey Houses Survey-Phase II')	SoJ Dept files
6	Table of results of 10 month test to April 1990	SoJ Dept files
7	Jersey radon survey results 1990 in 23 dwellings (22 with results) and 2 underground workplaces (NRPB/RS/29/90) dated 09.08.90	SoJ Dept files
8	Radon survey questionnaires	SoJ Dept files
9	1992 survey radon measurements in Jersey by parish 16.07.93 (122 results)	SoJ Dept files
10	Internal memo 'Radon in Jersey Survey', Notes on phase 1 and 2 Island surveys (1993?)	SoJ Dept files
11	Update on discussions with Island Development Committee (IDC) concerning protective measures against radon for new dwellings (Public Health Department)	SoJ Dept files
12	Background to radon surveys (documents faxed to Economic adviser's office 01.01.95) – includes info on Phase 3 survey not available elsewhere	SoJ Dept files
13	NRPB Report of radon measurements - 1998 survey of 14 dwellings (NRPB/PERS/37/98) dated 06.08.98	SoJ Dept files
14	Correspondence re States Prison readings (detailed in HPA report dated 22.08.05) and remedial suggestions 2005	SoJ Dept files
15	Report – Radon and Public Health in Jersey, Health and Social Services Department 2012	SoJ Dept files

<b>Number</b>	<b>Description</b>	<b>Source</b>
16	Leaflet – Radon in your Home-Free test offer	SoJ Dept files
17	Media Release – Channel Islands radon survey	SoJ Dept files
18	Information from the 2012 homes survey (results spreadsheet, standard result letter (States of Jersey), standard result report (HPA))	SoJ Dept files
19	Radon in the workplace: response from Health and Safety Inspectorate dated 17.12.13	SoJ Dept enquiry
20	Radon environmental information: response from Environment Department dated 12.12.13	SoJ Dept enquiry
21	Planning and Building Control information: response from Department of the Environment dated 03.12.13	SoJ Dept enquiry
22	Questions asked on the Environment Scrutiny Panel July 2010	SoJ Dept files
23	Information leaflet: Safe as houses? Essential information for: landlords, agents, tenants and home owners	www.gov.je
24	The Building Bye-Laws (Jersey) 1997. Code of Practice. Technical Guidance Document Part 4 Preparation of sites and resistance to moisture	www.gov.je
25	Building Bye-Laws (Jersey) 2007	www.jerseylaw.je
26	Building Bye-laws (Amendment No. 2) (Jersey) 2010	www.jerseylaw.je
27	Health and Safety at Work (Jersey) Law, 1989	www.jerseylaw.je
28	Approved Code of Practice (2002) Work with Ionising Radiation	www.jsc.je
29	Water Resources (Jersey) Law 2007	www.jerseylaw.je
30	Cancer in Jersey Report by Public Health England Knowledge and Intelligence Team (South West), for the Jersey Medical Officer of Health July 2013	PHE files
31	The Building Bye-laws (Jersey) List of technical guidance documents currently approved 2013 Edition	www.gov.je
32	Building Bye-laws (Jersey) 2007 (as amended) Building works carried out in connection with dwellings. Template for the production of building specifications	www.gov.je
33	Summary of Drinking Water regulations used in Jersey –email from Environmental Protection Department dated 13 February 2014	SoJ Dept enquiry
34	Water (Jersey) Law 1972 Revised Edition at 1 January 2009	www.jerseylaw.je
35	Information on Building Codes and Technical Guidance Document 4 from Building Control Department – dated 27 January 2014	SoJ Dept enquiry

All information supplied by States of Jersey had any personal identifiable information removed.