Radon in Scottish Homes: Report of a Targeted Programme

B M R Green, D M Rees, E J Bradley, J Smithard and N P McColl

SUMMARY

This report details a programme, supported by funding from the Scottish Government, to identify homes with significantly elevated radon concentrations in the areas of Scotland with the greatest risk of high radon levels and, where high levels are found, to encourage the responsible person, normally the owner-occupier or landlord, to carry out remedial works. The three-year programme commenced in April 2009 and was initially based on the radon maps published at that time. An updated and more detailed radon map was published in July 2011 and the programme was modified to accommodate this.

The programme operated in the following Scottish Regions, listed in descending order of the number of households involved: Aberdeenshire, including a very small number of homes in Moray; the Orkney Islands; Highland; the Scottish Borders; the Shetland Islands; Dumfries and Galloway. In each region, following an initial meeting with representatives of the local council to secure local partnerships, householders in the highest risk areas were contacted by letter and offered a free radon test. Householders accepting the offer were sent measurement kits, again by post and, in due course, received a report detailing the results and advising whether action to reduce radon levels was recommended. Householders found to have high radon levels were invited to local events to discuss the health risks and the effective ways in which to reduce the radon levels in their homes. Local seminars were held for professionals involved in housing provision. Typically, this included officers of the local council and housing associations, solicitors, estate agents, surveyors and builders.

In most areas, the programme was run as a partnership between the local Council, Health Board, the Building Research Establishment and the Health Protection Agency. In round terms, over 12,000 householders were invited to participate; over 6,000 took up the offer and over 1,000 homes were identified above the UK radon Action Level of 200 Bq m^{-3}. Over 20 days of local events were held which included some 10 seminars and over 600 householders attended a radon advice session. In the course of the programme, press releases and media interviews were completed involving both local partners and HPA staff.

This study was supported financially by the Scottish Government.

Centre for Radiation, Chemical and Environmental Hazards
Chilton, Didcot
Oxfordshire OX11 0RQ

Approval: October 2012
Publication: October 2012
£15.00
ISBN 978-0-85951-726-3

CONTENTS

1 Introduction 1

2 Health risks from indoor radon and radon potential in Scotland 1

3 The work programme 2
3.1 Variations to accommodate a new Scottish radon map 3
3.2 A generic phased approach 3
3.3 Regional variations 4
3.4 Measuring radon in homes in targeted areas 5
3.4.1 Identification of dwellings in targeted risk areas 5
3.4.2 Offers of free and reduced-price radon tests 5
3.4.3 The measurement package 7
3.4.4 Arrangements for social housing 7
3.5 Reporting radon measurement results 8

4 Summary of radon measurement results 8

5 Radon information events 9
5.1 Seminars for housing professionals 9
5.2 Information days for householders 10
5.2.1 Practical arrangements for radon information days 10
5.2.2 Attendance at radon information days 10

6 Discussion 12

7 Conclusions and recommendations 13

8 Glossary 13

9 Acknowledgements 14

10 References 14

APPENDIX A Example materials 15
A1 Example leaflet 15
A2 Example contact letter 16
A3 Example measurement result letter 18
A4 Example press release 20

APPENDIX B Detailed results by postcode divisions 21

1 INTRODUCTION

In early 2009, the Health Protection Agency (HPA) published a report of radon concentrations in dwellings throughout Scotland (HPA, 2009). The report briefly reviewed the health effects of exposure to radon and its short-lived decay products and reported the completion of a project, funded by the Scottish Government, to map the distribution of radon levels in Scottish homes. It contained the first complete radon probability map for the whole of Scotland, including the inhabited off-shore islands. The report recommended that a phased programme should be undertaken in the highest probability areas with the twin objectives of:

- identifying homes with radon concentrations at or above the radon Action Level;
- encouraging owner-occupiers and landlords to reduce high radon levels.

The current report details a three-year programme, funded by the Scottish Government, to meet these objectives.

2 HEALTH RISKS FROM INDOOR RADON AND RADON POTENTIAL IN SCOTLAND

Indoor radon is a recognised carcinogen, the single biggest source of public radiation exposure and the second largest identified cause of lung cancer after smoking. In 2010, the HPA updated its advice on the limitation of human exposure to radon, maintaining the Action Level at 200 Bq m^{-3} and introducing the concept of a Target Level (HPA 2010) at 100 Bq m^{-3}. Remediation work on homes with high radon levels should aim to reduce levels to below the Target Level. The combined risks of smoking and radon exposure are substantial so HPA advises that householders with smokers or ex-smokers should also seriously consider reducing radon levels where these are above the Target Level.

It is possible to use various methods to predict the percentage of homes in an area that will have high radon levels but it is not possible to predict the level in any individual home with a reasonable degree of confidence. A suitable measurement in the home is required – generally a 3-month measurement is made to average out short term variations.

Maps of radon potential (HPA 2007, 2009, 2011) identify areas where homes are most likely to have high radon levels – those above the radon Action Level of 200 Bq m^{-3}. Radon potential is the estimated percentage of homes that will have an annual average radon concentration above the Action Level.

For some years, HPA has worked closely with the British Geological Survey (BGS) to refine radon potential mapping (HPA, 2007) using empirical radon data from

measurements in homes and geological information such as underlying rock type and the depth and composition of any relevant overburden. This work for Scotland culminated in the joint publication of a more detailed data set and indicative map during the targeted programme reported here (HPA 2011). More details on the steps taken to accommodate this new map within the programme are given in the next section.

In areas with low radon potential, very few homes will have high levels and many would have to be measured to identify those where remediation is warranted. In areas with a high radon potential, measurements would be expected to identify a much greater percentage of homes with high levels, making it practical and affordable to run targeted programmes in such areas.

3 THE WORK PROGRAMME

The overall objective of the programme is to combat the health risks to individuals from high exposures to radon in Scottish homes.

The programme was similar to previous work undertaken elsewhere in the UK and had the following aims:-

- To increase awareness about radon in the population and in organisations with particular emphasis on the communities in the areas with the greatest probability of high radon levels and in those organisations with responsibility for health and well-being and/or the standard of homes.
- To identify homes with high levels of radon by offering a free home radon test to all householders in the areas where radon potential is at least 5%
- To advise and encourage owner-occupiers and landlords to reduce the radon levels in homes with significantly elevated radon levels

Previous programmes have shown that householders are more likely to take up offers of testing and carry out remediation if they can discuss these issues with someone locally (DETR, 2000). Clear local authority involvement and commitment has also been shown to improve public participation. This was sought in the current programme, through local councils and health boards, and was achieved in most areas. Overall programme co-ordination and in-depth support was provided by the HPA. Technical advice on remedial building works was provided by the Building Research Establishment (BRE) through a commercial contract with HPA.

Initially the programme was planned with two distinct elements:

- a proactive programme in the highest risk areas (the 5% and greater areas on the 2009 radon map); and
- an information campaign in the other areas with more modestly elevated radon potential (1% to 5% radon potential areas on the 2009 radon map).

The original plan envisaged four phases of the proactive programme: Orkney; Highland (Helmsdale, Fort Augustus & Aviemore); Aberdeenshire (Dee Valley and around Inverurie); and Southern Scotland (Scottish Borders and Dumfries and Galloway). Each phase was planned to run for a nominal year with phases started at approximately six month intervals.

3.1 Variations to accommodate a new Scottish radon map

As noted earlier, a more detailed radon data set and indicative map for Scotland were published part way through the programme. This caused an increase in the estimated number of homes in radon Affected Areas (that is, areas with a radon potential of least 1%) and, in particular, identified a further 2,000 homes that would qualify for a free radon test in the original target regions covered by the programme. Following discussions with Scottish Government officials, modifications were made to the programme: to take advantage of the new, more detailed data set; to reflect the introduction of the radon Target Level (100 Bq m^{-3}); and to keep within budget and timetable. Some careful programme management was required to manage the budget because of exceptionally good householder response rates in some phases of the programme. The modifications increased the emphasis and resources on homes in the areas in the current programme with the greatest risk. The initial plan had been to post an information pack to all householders in the 1% to 5% areas with an offer of a reduced-priced radon measurement accessed through the local council. This strategy was tested in Aberdeenshire and Moray with results that were not encouraging. Consequently, this part of the programme was replaced with more intense local media campaigns.

The 2011 Scottish radon map identified some additional areas of at least 5% radon potential, outside the Regions for which the programme was originally designed. The available budget could not support the extension of the proactive programme to all of these newly identified areas. It was agreed with Scottish Government officials that the programme would be modified to include the Shetland Isles, a compact and easily defined area which could be run alongside the programme in the Orkney Isles to the mutual benefit of both regions. The new map also identified, for the first time, a large number of very small areas of elevated radon potential distributed in a number of local authority areas in central Scotland. It was agreed with Scottish government that HPA would prepare proposals for a future programme to address these areas.

3.2 A generic phased approach

The same general approach was followed in each region. This was an evolution of the successful programmes run by HPA elsewhere in the UK and generally consisted of the elements detailed in Table 1. There is considerable overlap between the parts of the programme and several parts operate concurrently depending on local circumstance.

Table 1 Elements of a targeted regional radon programme

Elements	Description
Initial planning	Identifying the areas involved, followed by initial discussions with the local council seeking cooperation and the support of the Health Board.
Material and data preparation	Preparing letters and leaflets, extracting and cleaning data on addresses and existing radon measurements, identifying known social housing.
Initial training	Normally a day visit to the local council for round table discussions, an information seminar to council and health board officials and a short presentation to elected councillors if required. In addition, seminars are held for other professionals involved in the provision of housing such as solicitors, surveyors, builders, housing association officers.
Awareness raising	Issuing of press releases and media interviews, normally led by the local council with HPA staff available for technical input.
Offers of testing and measurement period	Initial contact letter posted to all unmeasured homes in the target areas (greater than 5% radon potential). A reminder letter goes to non-responders after 4 to 6 weeks. Measurement kits despatched by post to positive responders.
Advice for homes with high radon levels	All householders with a radon level at or above the Target Level (100 Bq m^{-3}), including those from previous radon programmes, are invited to a series of radon solution days to discuss their result, obtain advice and collect a voucher for a free retest following remediation works.
Remediation and retesting	As householders and landlords install radon remedies, free retests are offered to confirm the radon levels have been reduced to an acceptable level. This aspect of the programme tends to be prolonged and continues under HPA management after the formal end of the programme.
Closure	The involvement of council officers in the programme, in particular the training events and the solution days, means there is a legacy of radon information left within the council.

3.3 Regional variations

The second part of the initial plan, the information campaign in the lower risk areas (1% to 5% radon potential on the 2009 radon map) was a novel feature, explored in this programme. This was undertaken in Aberdeenshire and Moray. The results were not encouraging (see Table 4) and, as explained above, the remainder of this part of the overall programme was cancelled. Apart from this change, local programmes followed the above format with only small variations as noted in Table 2.

Table 2 Local variations to the general programme format

Region	Variation
Aberdeenshire	A second week of radon solution days was held due to the disruption caused by the early deep snow in late November 2010 and the need to service the additional high homes identified using the new map.
Dumfries & Galloway, Highland, Orkney, Scottish Borders, Shetland	Professionally produced and printed information leaflets for householders were only used in Aberdeenshire and Moray. In other regions, information was printed on the back of the contact letter to comply with restrictions on "paid-for communications" in the public sector.
Scottish Borders	The local health board and council played a limited role in the programme.
Orkney	A planned seminar for elected members had to be cancelled at short-notice at the council's request for operational reasons.
Dumfries & Galloway and Scottish Borders	Due to the limited numbers of high-testing homes, the radon solution days were replaced by individual letters offering one to one telephone consultations.

3.4 Measuring radon in homes in targeted areas

3.4.1 Identification of dwellings in targeted risk areas

In each of the local authority regions, all the domestic dwellings in areas of at least 5% radon potential were identified using the Royal Mail Address Point File. The resultant data-set of addresses was compared with the UK National Radon Database and addresses with an existing valid radon measurement were removed since these would not need to be re-measured, although addresses with previously identified high radon levels were sent invitations to local solution events. For several regions, the local registered social landlords, usually the Council and/or Housing Associations, provided property lists of the homes they own. These lists were also compared with the data set and the properties identified flagged so they could be processed separately. This procedure gave a rounded total of 12,800 individual dwellings excluding the homes known to be provided by the social landlords. Information for individual areas is shown in Table 3. Tables 3-7 include the administrative area code used by the Office for National Statistics. The codes reported here have since been replaced by a new system.

In the case of Aberdeenshire and Moray, the same procedure was repeated to identify approximately 7,400 unmeasured dwellings in the areas with 1 to 5% radon potential based solely on the 2009 map. Further information for individual areas is shown in Table 4.

3.4.2 Offers of free and reduced-price radon tests

Each of the target addresses in the areas of at least 5% radon potential was sent a letter and small information pack offering a radon measurement free of charge. The exact wording and contents of the package varied slightly from region to region. The initial programme in Aberdeenshire used a bespoke leaflet (see Appendix A) and three letters: an individually addressed letter to 'The Occupier' from HPA; and two standard letters, not individually addressed, from the Council and the Health Board. Each of these letters carried the relevant logos and contact information. At the bottom of the HPA letter was a

tear-off reply slip, pre-completed with the address details and a machine readable bar code, for the householder to sign to accept the offer and to return in the pre-paid and pre-addressed envelope provided.

In the later stages of the programme, the three letters and the bespoke leaflet were, in general, replaced with a single letter which carried the logos of the HPA, the Council and the Health Board. Information about radon was printed on the reverse of the letter. This initiative saved paper, reduced packaging time and costs and virtually eliminated packing errors by reducing the number of items per letter. If no reply was received after six weeks, a second reminder letter was sent. An example of the initial letter is shown in Appendix A.

Table 3 Distribution of free test offers

Code	Region		Positive responses	
		Number of households invited	Number	Percentage
QB	Aberdeenshire	5,223	2,146	41.1
QE	Scottish Borders	704	233	33.1
QH	Dumfries and Galloway	65	27	41.5
QT	Highland	2,236	855	38.2
QX	Moray	1	0	0.0
RA	Orkney	4,082	2,043	50.0
RD	Shetland	498	243	48.8
	Totals	**12,809**	**5,547**	**43.3**

In Aberdeenshire and Moray, householders in areas of 1 - 5% radon potential, were sent a similar package but offering a reduced-price test through the Council. This offer was made available to any householder in the region. Reduced price tests were available in the other Regions but these were made through press releases. Some registered social landlords took advantage of this reduced price offer to test their properties in the areas with radon potential in the range 1-5%.

Table 4 Distribution of reduced price tests

Code	Region	Number of households sent information	Positive responses	
			Number	Percentage
QB	Aberdeenshire	5,840	113	1.9
QE	Scottish Borders	N/A*	0	
QH	Dumfries and Galloway	N/A*	0	
QT	Highland	N/A*	4	
QX	Moray	1,575	11	0.7
RA	Orkney	N/A*	20	
RD	Shetland	N/A*	2	
	Totals	**7,415**	**150**	

*Not Applicable - no information letters sent, see text

3.4.3 The measurement package

Householders who accepted either offer were sent the standard radon measurement pack by post. This consisted of two passive integrating radon detectors, one for the main living area and one for a regularly used bedroom, placement instructions, a short questionnaire and a pre-paid return envelope. Detectors are intended to remain in place for 3 months.

3.4.4 Arrangements for social housing

During the initial discussions with each Council, an offer was made to work with the relevant social landlords, normally the Council or Housing Associations, to ensure that the radon levels in any social housing in the highest risk areas were measured. In many regions, the landlords provided their property list to HPA so that properties could be flagged as being in the following bands of radon potential: at least 5%, between 1% and 5%; less than 1%. The properties in the higher risk areas qualified for a test under the programme and different procedures were adopted by different landlords to complete the testing. In some cases, local officers delivered the measurement kits to individual homes. In others, the kits were posted direct from HPA following a letter from the landlord to the tenant. In addition, some landlords also took up the offer of reduced-price testing to measure their properties in the 1% to 5% areas. Social housing on Orkney was included in the main programme, rather than as a separate direct arrangements for the social landlords. For these homes, it is only known whether they are tenanted or owner-occupied so it is not possible to identify specific social landlord properties for Orkney in Table 5.

Table 5 Distribution of homes tested for social landlords

Code	Region	Number of homes tested
QB	Aberdeenshire	329
QE	Scottish Borders	193
QH	Dumfries and Galloway	3
QT	Highland	132
QX	Moray	322
RA	Orkney	-
RD	Shetland	74
	Total	**1,053**

3.5 Reporting radon measurement results

Each household participating in the programme that completed the measurement, other than the occupants of known social housing, received a report of their results (see example in Appendix A). This detailed the two results for individual rooms as measured and gave an estimate of the annual average concentration for the home, based on established weighting and correction factors for room occupancy and time of year in which the measurement was made. The report provided advice on whether remedial action was recommended to reduce the radon concentration. This was based on a comparison of the assessed annual average concentration with the radon Action and Target levels.

The results of measurements in known social housing were reported to the relevant landlord with an offer to prepare individual letters for tenants. In most cases, the landlord preferred to inform the tenants of the result themselves.

All results from this programme were also reported to the relevant local council at regular intervals. This was normally in the form of an electronic spreadsheet sent a week or so before individual householders received their results. This enabled the council officers to assimilate the information and to be prepared to answer questions from the householder, elected members or the media.

4 SUMMARY OF RADON MEASUREMENT RESULTS

In round terms, nearly 6,800 measurement kits were deployed and, by the time of writing (1st May 2012), over 5,800 results obtained. A few further results will become available as some householders are late in returning their detectors for analysis. There is always a small proportion of participating addresses for which results are not obtained. There are a variety of reasons for this including illness, death, moving house or loss of the detectors by the householder. The observed completion rate of over 85% is in line with previous surveys. A summary of results for each region is contained in Table 6. More detailed results by divisions of the postcode are in Appendix B.

Table 6 shows that the programme succeeded in identifying significant numbers of Scottish homes with high radon levels that should be reduced. The scope of the

programme was those areas where at least 5% of homes were expected to be over the radon Action Level. As can be seen, of those homes measured, the actual percentage over this level was nearly 18%. A further 21% of measured homes were in the concentration range of 100-200 Bq m^{-3} in which HPA advises that householders should give serious consideration to reducing levels, especially if the household includes smokers or ex-smokers, since these groups are at a greater combined long term risk from the combined effects of smoking and radon than lifelong non-smokers.

To avoid undue precision, numerical values in Appendix B, apart from percentages, have been rounded to whole numbers. To avoid giving misleading averages based on small numbers of results, and to preserve confidentiality for individual householders, geographical divisions with fewer than 5 results have been omitted. This latter restriction means that not all results are shown in the more detailed tables.

Table 6 Radon measurement results by Region

Code	Region	Results				At or above TL and below AL		At or above AL	
		Number	Arithmetic average (Bq m^{-3})	Geometric average (Bq m^{-3})	Highest (Bq m^{-3})	Number	%	Number	%
QB	Aberdeenshire	2,275	142	92	6,800	571	25.1	448	19.7
QE	Scottish Borders	333	73	50	480	45	13.5	22	6.6
QH	Dumfries and Galloway	28	108	64	660	2	7.1	6	21.4
QT	Highland	853	120	69	2,900	150	17.6	125	14.7
QX	Moray	221	33	26	270	5	2.3	1	0.5
RA	Orkney	1,834	169	83	6,900	387	21.1	378	20.6
RD	Shetland	267	109	51	900	37	13.9	44	16.5
	Totals	**5,811**				**1,197**	**20.6**	**1,024**	**17.6**

5 RADON INFORMATION EVENTS

The initial contact with each Region was with the Environmental Health Department, or the equivalent, following up a letter from the Scottish Government. This was normally followed by a round-table meeting at council premises. At the same time, an offer was made to provide an introductory talk about radon in homes to the Council officers, elected members and representatives of the Health Board. The attendance at such events ranged from a few to a room full.

5.1 Seminars for housing professionals

In addition to the initial briefing provided to all participating regions, a more in-depth seminar was organised, normally towards the end of the programme in each region. The exact number and format of such events varied but normally consisted of presentations

by radon specialists from HPA and BRE followed by a question and answer session. The audience consisted of council officers (environmental health, building control, housing and planning) and local professionals such as architects, builders, estate agents, housing managers, solicitors and surveyors. Staff from local health boards were invited, although in some cases separate events were held in their normal seminar programme.

5.2 Information days for householders

5.2.1 Practical arrangements for radon information days

Once the majority of the results were available and towards the end of the nominal year programme in each region, information on radon, the associated health risks and advice on remedial measures was offered to the occupants of households with a high radon concentration: this was defined as at or above the Target Level of 100 Bq m^{-3}. The opportunity was taken to include those homes with high levels that had been identified in previous programmes (HPA, 2009). In most regions, this was achieved by running a series of drop-in events in locations within easy travelling distance for the householders. The venues were places such as village halls, community or sports centres or function rooms in local hotels. The events normally ran from mid-morning into the evening. The events were also publicised through the news media. A press release (Appendix A shows an example) was issued and in most cases interviews were given to local newspapers, TV and radio.

The events were staffed by the HPA Radon team, technical building experts from the Building Research Establishment, officers from the local council and, in some cases, representatives of social housing landlords and the smoking cessation team of the local health board. Commercial radon remediation contractors were invited to attend or to send a supply of information leaflets. Radon remediation contractors attended events in Aberdeenshire and Highland.

Householders who attended were offered advice and information, the chance to ask questions about radon and to discuss their own individual homes and how particular features might impact on the radon concentrations and the steps taken to reduce them. Householders were also provided with a voucher for a free confirmatory retest once any remedial work was completed. This latter aspect helps HPA to understand the performance and prevalence of radon remediation. It does not provide reliable information about the number of households that remediate since most remediation contractors provide such a test and in such cases, some householders may not see the need for yet another test.

5.2.2 Attendance at radon information days

Table 7 summarises the radon events, the number of people invited, the numbers who attended and the locations. As mentioned earlier the initial series of events in Aberdeenshire was disrupted by the heavy snowfall in November 2010. The initial event

at Stonehaven had to be cancelled due to travel difficulties and though the remaining events did run, many people from rural locations were unable to attend as only the main roads were passable. To accommodate them, and the householders identified in the second phase of the programme based on the 2011 map, a second series of events was organised in the autumn of 2011.

Table 7 Attendance at radon events

		Number			Locations	
Code	Region	invites	attendees	days	Number	Towns
QB	Aberdeenshire	2,785	300	6	3	Ballater, Banchory, Inverurie
QT	Highland	605	68	4	4	Inverness, Fort Augustus, Helmsdale, Boat of Garten
RA	Orkney	762	260	4	2	Kirkwall, Sandwick
RD	Shetland	109	16	2	1	Lerwick
	TOTAL	**4,261**	**644**	**16**	**10**	

At an initial glance, the attendances at the radon events in Aberdeenshire and Highland could be perceived as disappointingly low, at just over 10%. However, a comparison with the number of high homes identified in the current programme (about 2,100 including those in known social housing for which invites were not relevant) indicates that over half the invitations went to homes identified in previous measurement programmes, some of which were made before the year 2000. It is not surprising that the engagement for these earlier measurements was lower than for the more recent measurements.

The response in Shetland was low but is possibly understandable in view of the scattered nature of the population of the Shetland Isles. To address this, a supply of booklets and leaflets from HPA and BRE were provided to the Shetland Islands Council. The Council agreed to write to the non-attendees offering advice on remediation, possibly after a visit to the house, and making the offer of the free confirmatory retest following remedial works.

The good response in the Orkney Islands, over a third of invitees attended, is worthy of note. Most of the invitees had only recently received their results. Invites to local radon events generally have better response when they are received shortly after individual household report letters have been received. It is thought that attendance was boosted because the Orkney Island Council and the Orkney Health Board ran an effective media campaign around the events.

The small number of homes identified with high radon levels in southern Scotland, in Dumfries and Galloway and Scottish Borders, and their widely scattered locations, indicated that a series of local radon events was not a practical proposition. A total of 75 homes above the Target level were identified during the programme. The solution adopted, other than for known social housing properties, was to write to individual householders offering a one to one telephone discussion and 186 letters were sent to current and previous households with a high radon level. Similarly, the housing

managers of the relevant social landlords were contacted offering advice and information.

6 DISCUSSION

Overall the programme was a success with positive outcomes for all three aims. Information and awareness about radon, its occurrence, the health risks and methods to reduce these risks was disseminated to all the targeted Councils and many local professionals involved in the housing market. Over 1,000 homes were identified with radon at or above the UK action level as were a further 1,200 homes with a radon between the target level and the action level. Over 600 householders attended an information session and received advice on methods to reduce the radon level in their home. As noted above, it is difficult to obtain reliable information about exactly how many householders undertake remediation. Indeed, some may commission successful remediation without further communication to HPA. However, some information will be obtained in the year or two following the programme. This may give some limited indication of remediation rates but is likely to deliver greater value by building the evidence base about which techniques are used more often and their performance in different settings. In turn, this informs future HPA advice to householders and those providing remediation services.

It is expected that the remediation rate for social housing will be high since it is the responsibility of the landlord, this forms part of the overall communications with social landlords, and work can be factored into the routine property maintenance programme.

Overall, the participation rate of householders in response to offers of a free radon measurement was towards the highest achieved in similar programmes elsewhere in the UK. The programme also reflected earlier HPA experience that a high level of visible involvement by the local partners leads to a better response rate.

The outcome of the exploratory information campaign with an offer of a reduced-priced measurement in Aberdeenshire and Moray is disappointing. Despite careful planning and a professionally produced leaflet, the take up rate was less than 2%.

As noted earlier, the programme overall was well targeted and nearly 18% of the homes measured were at or above the radon Action Level. As is shown in the more detailed table in Appendix B, there is some variation in the distribution of high radon levels, including some areas in which the proportion of high homes ranges from none up to nearly 65%. It is outside the scope of this programme to investigate possible reasons for this, not least because the results in some areas include the combined influence of the earlier and more recent radon maps which use different methodologies. It should also be noted that as number of homes in a group reduces, the statistical variation in the observed results grows.

By the end of the programme, many council officers had a good understanding about radon and its management. It is important that this legacy of knowledge is not lost. One way to achieve this would be regular information events, say on an annual basis.

7 CONCLUSIONS AND RECOMMENDATIONS

The programme successfully identified over 1,000 homes with a radon concentration at or above the UK radon Action Level, representing approximately 18% of those measured.

Opportunities were provided for householders, local government officers and health professionals with responsibilities for public health and other professionals involved in the housing market, to obtain information about radon and to ask questions directly to experts.

It is suggested that the legacy of knowledge about radon, the health risks and remedial actions is regularly refreshed through appropriate events which might include exploration of further means to encourage those householders with measured high radon levels to undertake remediation.

It may also be effective to explore further follow-up opportunities and remind those householders, with a high radon level that may not have been remediated, that they and their families are still receiving significant radon exposures and that they should seriously consider taking action.

8 GLOSSARY

Averages. The numerical radon results in this report are presented in two ways: arithmetic average and geometric average. The arithmetic average is the normal value used to describe numerical results: it is the sum of all the results divided by the number of results. The geometric average is the n^{th} root of n results multiplied together.

Becquerel. Symbol Bq. The unit of the amount or activity of a radionuclide. Describes the rate which transformations occur. 1 Bq = 1 transformation per second.

Becquerel per cubic metre of air. Symbol Bq m^{-3}. The amount of a radionuclide in each cubic metre of air. Often referred to as the activity concentration.

BRE. The Building Research Establishment Ltd. An independent and impartial, research-based consultancy, testing and training organisation for the built environment.

Radon Action Level. The recommended upper limit for the activity concentration of radon in UK homes. Its value, expressed as the annual average radon gas concentration in the home, is 200 Bq m^{-3}.

Radon Affected Areas. Parts of the country with a 1% probability or more of present or future homes being above the Action Level.

Radon Target Level. Remediation of existing homes with high radon levels should aim to reduce the radon concentration to below the Target Level. Its value, expressed as the annual average radon gas concentration in the home, is 100 Bq m^{-3}.

Further information about radon, including maps, health risks, measurement and reducing levels, can be found at the web links below

- Health Protection Agency – main web site
- www.hpa.org.uk/Topics/Radiation/UnderstandingRadiation/UnderstandingRadiationTopics/Radon

- HPA's dedicated radon web site
- www.ukradon.org

- Building Research Establishment web site
- www.bre.co.uk/radon

9 ACKNOWLEDGEMENTS

The authors would like to thank everyone in the HPA radon team and the Chilton communications team for their efforts throughout this programme as well as colleagues in Scottish Government and Regional Councils for their sustained support for and interest in the programme.

10 REFERENCES

DETR(2000) Department of the Environment, Transport and the Regions. Review and Evaluation of the Radon Remediation Pilot Programme. DETR/RAS/00.004. London

HPA (2007) Indicative Atlas of Radon in England and Wales. JCH Miles, JD Appleton, DM Rees, BMR Green, KAM Adlam, AH Myers. HPA-RPD-033

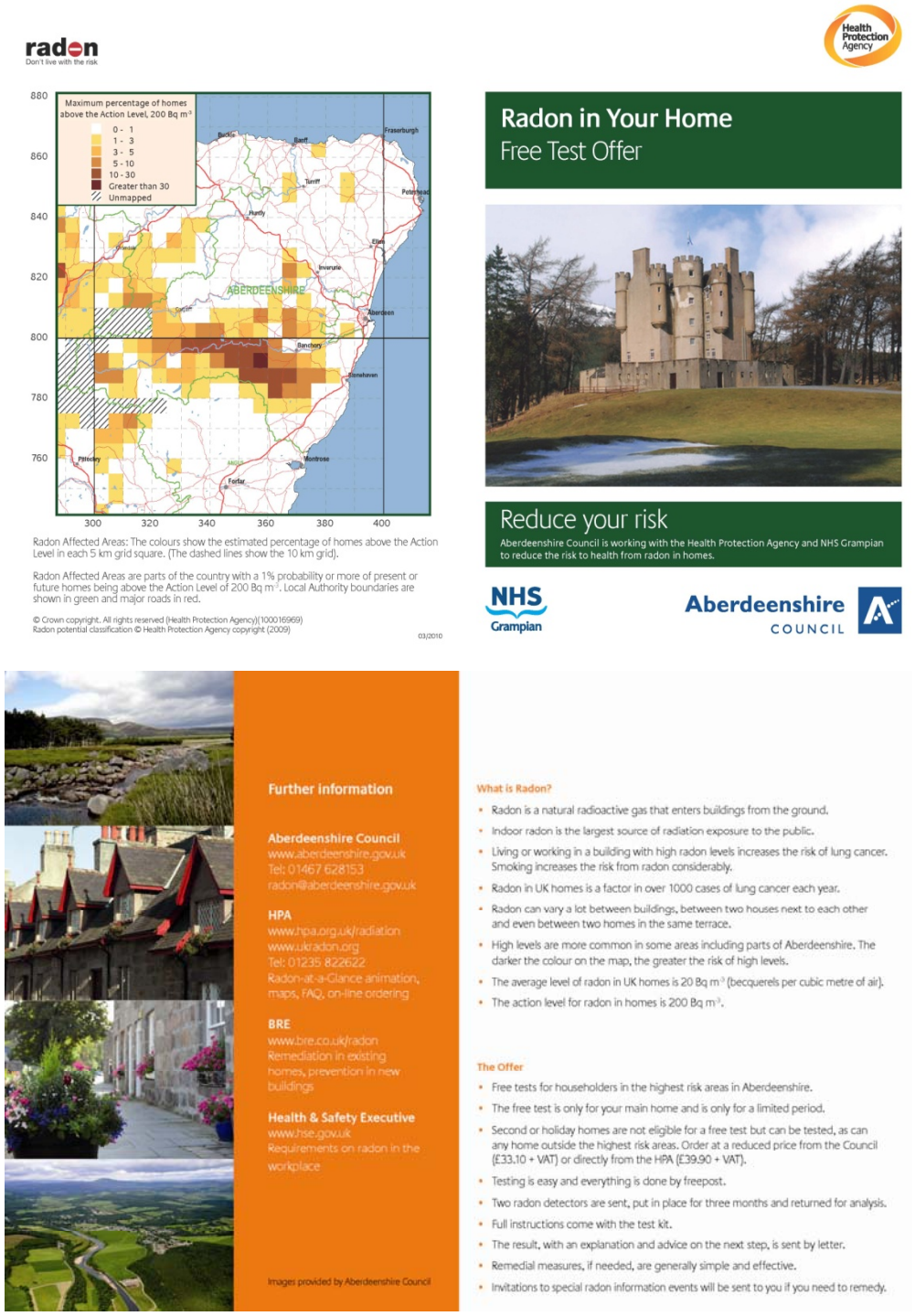
HPA (2009) Radon in Dwellings in Scotland: 2008 Review and Atlas, B M R Green, J C H Miles and D M Rees. HPA-RPD-051

HPA (2010) Limitation of Human Exposure to Radon. HPA–RCE-15

HPA (2011) Indicative Atlas of Radon in Scotland. J C H Miles, J D Appleton, D M Rees, K A M Adlam, C Scheib, A H Myers, B M R Green and N P McColl HPA-CRCE-023

APPENDIX A Example materials

A1 EXAMPLE LEAFLET



A2 EXAMPLE CONTACT LETTER

Radon Studies Group
Health Protection Agency
Chilton, Didcot, Oxfordshire
OX11 0RQ

01235 822622
Radon@hpa.org.uk
www.hpa.org.uk/radiation

The Occupier
«A1»
«A2»
«A3»
«A4»

Our ref: STRA_FTT/«ID»
XX May 2011

Dear Sir or Madam

RADON IN HOMES IN ORKNEY

Orkney Islands Council is working with the Health Protection Agency (HPA) to identify and reduce high levels of radon in homes with the support of the Scottish Government. NHS Orkney also supports the programme, as prolonged exposure to high radon levels increases the risk of lung cancer, especially for smokers or ex-smokers. Exposure to the combination of radon gas and cigarette smoke creates a greater risk for lung cancer than either factor alone. The majority of radon related cancer deaths occur among smokers and ex-smokers.

Testing for radon is easy: the kit comes by first class post and is completely free if this is your main home. To order your free test, complete the reply slip below, sign it and return to us in the enclosed pre-paid envelope. Reduced price tests are available for holiday or second homes from the Council. Additional information about radon and this offer is given overleaf.

A letter will be sent to you explaining your result and providing you with advice. If works to reduce radon levels in your home are required, you will be invited to special local information events.

Although the test is voluntary, by taking part you will discover if you and your family are at risk from radon in your home. You will help us to assess the health risk in your area and to ensure that any money spent on radon reduction is used appropriately.

The result of your test will be given to the Council. Individual data will be treated in confidence and the overall data will be analysed to provide information on how to reduce the health risk from this proven cause of lung cancer.

I look forward to receiving your reply. Please contact the radon team at the address above if you have any queries or comments on this survey.

Yours faithfully

Martyn Green
Radon Studies

PS This is a free offer, but it is for a limited period only so reply today

---

«A1»
«A2»
«A3»
«A4»

STRA_FTT/«ID»/«Batch»

XX May 2011

«ID»

For admin use only

I accept a free radon measurement as described in the invitation letter and I confirm this is my main residence.
Please complete the form below in black ink and block capitals.

Title Mr ☐ Mrs ☐ Miss ☐ Other ☐☐☐☐

Initial(s) ☐☐☐ **Surname** ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

This number will not be passed on to a third party

Telephone ☐☐☐☐☐☐☐☐☐☐☐☐ If Ex Directory please tick here ☐

Signed

What is Radon?

- Radon is a natural radioactive gas that enters buildings from the ground.
- Indoor radon is the largest source of radiation exposure to the public.
- Living or working in a building with high radon levels increases the risk of lung cancer.
- Smoking increases the risk from radon considerably.
- Radon in the home contributes to over 1,000 UK lung cancer cases each year.
- High levels are more common in some areas of Scotland, including parts of the Orkney Islands.
- The average radon level in UK homes is 20 Bq m^{-3} (becquerels per cubic metre of air)
- The Action Level for radon in homes is 200 Bq m^{-3}
- The Target Level for remediation is 100 Bq m^{-3}

The Offer

- Free tests are available for a limited period and only for main homes in selected areas known to have the highest probability of elevated radon concentrations or in areas which on-going studies indicate might also be in the same category.
- Free tests are not available for second or holiday homes*.

The Test

- Testing is easy and everything is done by free post.
- Two small radon detectors are sent, put in place for three months and returned for analysis.
- Full instructions come with the test kit.
- The result, with an explanation and advice on the next step, is sent by letter.
- Remedial measures, if needed, are generally simple and effective.
- Invitations to special local information events will be sent to you if you need to remedy.

* You can buy a test kit for any home in Orkney from the Council at a reduced price of £41.28 (£34.40 + VAT) or directly from the HPA for £49.80 (£41.50 + VAT).

Further information

- **Orkney Islands Council**
  - Web site: www.orkney.gov.uk
  - Telephone: Information: 01856 873535 and ask for Environmental Health
    Payments: 01856 873535 and ask for Customer Services
  - Pay on line: www.orkney.gov.uk and follow the link Radon
  - e-mail: radon@orkney.gov.uk
- **The HPA**
  - Web sites: www.UKRadon.org and www.hpa.org.uk
  - Telephone: 01235 822622
  - e-mail: radon@hpa.org.uk
- **The Building Research Establishment**
  - Web site: www.bre.co.uk/radon

ORKNEY ISLANDS COUNCIL

NHS Orkney

Health Protection Agency

A3 EXAMPLE MEASUREMENT RESULT LETTER

Radon Studies
Health Protection Agency
Chilton, Didcot, Oxfordshire
OX11 0RQ

01235 822622
Email: Radon@hpa.org.uk
www.ukradon.org

Name
Address 1
Address 2
Address 3
Postcode

Radon Measurement Report

Our Ref: LR_AT/9999999 23 January 2012

This report provides the result from the radon detectors sent by HPA on 11th September 2011.

Measurement address: Address1, Address 2, Address 3, Postcode

The result is 690 Bq m^{-3} (See over for the individual detector results)

The Action Level is 200 Bq m^{-3}. The Target Level is 100 Bq m^{-3}.

You should reduce the level, ideally to below the Target Level

How can you reduce your radon level?

We do not have enough information about the ground floor construction of your house to suggest the best method. See the enclosed guide.

After completing work to reduce radon levels, it is important to retest the property to check that radon levels have been reduced sufficiently: the retest may be free.

Important notes:

Please note that events for advice on radon reduction will be held in your area in March. Invitations will be sent nearer the time.

If you are not the owner of the property, your landlord should be told the result. If this test was paid for by someone else, HPA will also send the result to them.

A high radon level increases your risk of developing lung cancer; smokers and ex-smokers are more at risk than non-smokers. If you have any queries, contact us or refer to www.ukradon.org.

Mrs J Smithard – Radon Services Team Leader

KEEP THIS REPORT WITH YOUR HOUSE DOCUMENTS

An explanation of the Radon Measurement Report

Measurement address

It is assumed that the measurement address overleaf is where the detectors were placed.

The result

The annual average radon level of **690** is estimated from the living area and bedroom detector results.

Living area: 990
Bedroom : 800

If results are not available from both the living area and bedroom, the annual average is estimated from the remaining detector result.

A correction is applied to compensate for seasonal differences. Radon levels are usually higher in the winter than in the summer. The estimated annual average can be compared to the Action Level and Target Level described below.

All results are in Bq m^{-3}

The advice is based on:

1. The result of this test and any other information we have recorded
2. The UK Action Level of 200 Bq m^{-3} and the UK Target Level of 100 Bq m^{-3}

The Action Level is the threshold at which action should be taken to reduce the radon level.

The Target Level is the level you should aim to get below when reducing radon.

If the annual average radon level is between the Target Level and the Action Level and if any of the occupants are smokers or ex smokers you should seriously consider reducing the radon level to below the Target Level.

The average indoor radon level in UK homes is 20 Bq m^{-3}.

How can you reduce your radon levels?

The choice of the most effective method to reduce radon levels is dependent upon factors such as:

The initial radon level
The floor construction; whether it is solid, suspended, or a mix
If there is a basement

See the enclosed leaflet 'Reducing your risk' and www.ukradon.org

Important notes

A valid radon result depends on the test being conducted according to instructions. If we believe there are added uncertainties, it will be indicated in the report.

If this is one of a series of tests in the property, consider all the results and take into account any work or change in use or occupier.

Further information can be obtained from www.ukradon.org
Telephone: 01235 822622

A4 EXAMPLE PRESS RELEASE

Press Release

Monday, January 16, 2012

HPA helps solve radon problems in Orkney homes

Hundreds of householders across Orkney are being advised to act to protect their health, after HPA tests detected high levels of radioactive gas radon.

Last summer, the Health Protection Agency, in a project funded by the Scottish Government, invited more than 4,000 households across the Orkney Islands to apply for a free test for radon, a naturally occurring gas present in all homes.

Radon cannot be seen, smelt or tasted and for most people it is the largest single part of their annual radiation exposure. Each year radon is believed to lead to over 1,000 lung cancer deaths in the UK.

More than 2,000 people took up the free test offer and the HPA sent out kits which were then placed in homes and over 1,700 have already been returned for analysis after three months. Most householders have now been sent their test results.

In all more than 330 homes, almost 20 per cent of those tested, were over the Action Level – the point at which HPA recommends that householders take action to deal with the problem. The results show that 13 of the properties has radon levels 10 times higher than the Action Level.

Neil McColl, head of radon at the HPA's Centre for Radiation, Chemical and Environmental Hazards, said: "Whenever we run testing programmes we always find a number of properties with high readings. This has been the case in Orkney where we have discovered that almost one in five of those tested had high levels of the radioactive gas.

"These findings are no surprise. Orkney has long been known to be widely affected by radon. What the results do show us once again is that if you are in a radon affected area, like much of Orkney , you should get your home tested – if you haven't already done so.

"To those who have had detectors in place for three months but who have not yet returned them to us, it isn't too late. If you get them back to us as soon as possible we'll do the analysis and get you your results. That said we want to stress that only those who have had them in place for three months should return them. If your detectors have not been in place that long you don't need to get them to us just yet."

Experts from the HPA, together with staff from the local Council and the Building Research Establishment, are staging drop-in events next week for anyone wanting more information, and invites have already gone to all those who tested and have a high level.

The events will be held in the Pickaquoy Centre, Kirkwall, between 3-8pm on Monday, January 23 and between 10am-8pm on Tuesday, January 24. The team then head for Sandwick where they will hold a session in the Sandwick Community Hall between 10am-8pm on Wednesday, January 25. The next day, Thursday, January 26, it's back to the Pickaquoy Centre in Kirkwall where an event will be run between 10am-3pm.

Contact: Health Protection Agency Press Office, Centre for Radiation, Chemical and Environmental Hazards, Chilton, Didcot, Oxfordshire OX11 0RQ, www.hpa.org.uk.

Tel +44 (0) 1235 822745 or 01235 822876 Fax +44 (0) 1235 822746 Email chilton.pressoffice@hpa.org.uk

APPENDIX B Detailed results by postcode divisions

Table B1 Radon measurements in postcode areas with at least five results

Post code area	Post Town	Results				At or above TL and below AL		At or above AL	
		Number	Arithmetic average (Bq m^{-3})	Geometric average (Bq m^{-3})	Highest (Bq m^{-3})	Number	%	Number	%
AB	Aberdeen	2,496	132	82	6,800	576	23.1	449	18.0
DG	Dumfries	28	108	64	660	2	7.1	6	21.4
IV	Inverness	317	72	52	720	44	13.9	18	5.7
KW *	Kirkwall	1,995	170	85	6,900	418	21.0	425	21.3
PH	Perth	375	135	74	2,900	75	20.0	60	16.0
TD	Galashiels	330	73	50	480	44	13.3	22	6.7
ZE	Shetland	267	109	51	900	37	13.9	44	16.5

* Note that the KW postcode area includes much of north-east Scotland as well as the Orkney Islands.

Table B2 Radon measurements in postcode districts with at least five results

Post code district	Results				At or above TL and below AL		At or above AL	
	Number	Arithmetic average (Bq m^{-3})	Geometric average (Bq m^{-3})	Highest (Bq m^{-3})	Number	%	Number	%
AB12	5	286	131	1,100	0	0.0	1	20.0
AB15	7	59	49	110	1	14.3	0	0.0
AB21	35	51	43	270	0	0.0	1	2.9
AB30	29	110	77	380	4	13.8	6	20.7
AB31	517	122	90	950	128	24.8	81	15.7
AB32	128	89	71	490	34	26.6	7	5.5
AB33	50	83	54	640	7	14	5	10.0
AB34	754	127	88	1,100	207	27.5	152	20.2
AB35	432	221	140	5,000	136	31.5	147	34.0
AB36	9	83	73	170	3	33.3	0	0.0
AB37	20	29	26	71	0	0.0	0	0.0
AB38	121	33	27	160	3	2.5	0	0.0
AB39	10	125	84	390	2	20.0	2	20.0
AB43	6	57	51	110	1	16.7	0	0.0
AB45	27	54	39	280	2	7.4	1	3.7
AB51	233	164	89	6,800	36	15.5	42	18.0
AB52	6	102	72	250	1	16.7	1	16.7
AB53	23	110	91	290	8	34.8	2	8.7
AB55	80	33	24	270	2	2.5	1	1.3
DG13	10	180	126	660	1	10.0	4	40.0
DG14	18	68	44	330	1	5.6	2	11.1
IV14	56	73	61	180	14	25.0	0	0.0

	Results				At or above TL and below AL		At or above AL	
Post code district	Number	Arithmetic average (Bq m^{-3})	Geometric average (Bq m^{-3})	Highest (Bq m^{-3})	Number	%	Number	%
IV15	5	91	55	300	0	0.0	1	20.0
IV2	8	20	18	38	0	0.0	0	0.0
IV3	44	108	60	720	5	11.4	5	11.4
IV4	16	48	43	85	0	0.0	0	0.0
IV5	45	50	39	190	5	11.1	0	0.0
IV6	5	48	41	100	1	20.0	0	0.0
IV63	134	73	54	270	18	13.4	11	8.2
KW15	679	136	70	6,900	130	19.1	109	16.1
KW16	343	171	85	3,800	80	23.3	70	20.4
KW17	812	195	95	3,700	177	21.8	199	24.5
KW8	149	190	111	1,800	29	19.5	46	30.9
PH22	12	119	87	400	2	16.7	2	16.7
PH23	34	107	89	210	16	47.1	2	5.9
PH24	75	76	60	420	7	9.3	5	6.7
PH32	158	168	94	2,000	38	24.1	37	23.4
PH33	50	39	30	150	3	6.0	0	0.0
PH34	17	537	266	2,900	4	23.5	11	64.7
PH35	26	76	55	240	4	15.4	3	11.5
TD14	181	45	34	250	7	3.9	3	1.7
TD5	143	107	80	480	35	24.5	19	13.3
TD9	5	64	58	110	1	20.0	0	0.0
ZE1	53	152	87	860	12	22.6	12	22.6
ZE2	214	99	45	900	25	11.7	32	15.0

Table B3 Radon measurements in postcode sectors with at least five results

	Results				At or above TL and below AL		At or above AL	
Postcode district	Number	Arithmetic average (Bq m^{-3})	Geometric average (Bq m^{-3})	Highest (Bq m^{-3})	Number	%	Number	%
AB12 5	5	286	131	1,100	0	0.0	1	20.0
AB15 8	7	59	49	110	1	14.3	0	0.0
AB21 0	35	51	43	270	0	0.0	1	2.9
AB30 1	29	110	77	380	4	13.8	6	20.7
AB31 4	131	128	95	950	40	30.5	19	14.5
AB31 5	187	92	69	910	31	16.6	14	7.5
AB31 6	199	146	111	790	57	28.6	48	24.1
AB32 6	78	81	63	490	19	24.4	4	5.1
AB32 7	50	101	85	460	15	30.0	3	6.0
AB33 8	50	83	54	640	7	14.0	5	10.0
AB34 4	72	75	61	310	13	18.1	5	6.9
AB34 5	682	132	92	1,100	194	28.4	147	21.6
AB35 5	432	221	140	5,000	136	31.5	147	34.0
AB36 8	9	83	73	170	3	33.3	0	0.0
AB37 9	20	29	26	71	0	0.0	0	0.0
AB38 7	117	33	27	160	3	2.6	0	0.0
AB39 3	10	125	84	390	2	20.0	2	20.0
AB43 6	6	57	51	110	1	16.7	0	0.0
AB45 3	27	54	39	280	2	7.4	1	3.7
AB51 0	11	78	65	210	0	0.0	1	9.1
AB51 5	30	406	149	6,800	6	20.0	11	36.7
AB51 7	191	132	83	1,200	30	15.7	30	15.7
AB52 6	6	102	72	250	1	16.7	1	16.7
AB53 4	21	117	100	290	8	38.1	2	9.5
AB55 4	79	30	23	120	2	2.5	0	0.0
DG13 0	10	180	126	660	1	10.0	4	40.0
DG14 0	18	68	44	330	1	5.6	2	11.1
IV14 9	56	73	61	180	14	25.0	0	0.0
IV15 9	5	91	55	300	0	0.0	1	20.0
IV2 6	8	20	18	38	0	0.0	0	0.0
IV3 8	44	108	60	720	5	11.4	5	11.4
IV4 7	16	48	43	85	0	0.0	0	0.0
IV5 7	45	50	39	190	5	11.1	0	0.0
IV6 7	5	48	41	100	1	20.0	0	0.0
IV63 6	84	71	53	270	13	15.5	6	7.1
IV63 7	50	76	55	270	5	10.0	5	10.0
KW15 1	679	136	70	6,900	130	19.1	109	16.1
KW16 3	343	171	85	3,800	80	23.3	70	20.4
KW17 2	812	195	95	3,700	177	21.8	199	24.5

	Results				At or above TL and below AL		At or above AL	
Postcode district	Number	Arithmetic average (Bq m^{-3})	Geometric average (Bq m^{-3})	Highest (Bq m^{-3})	Number	%	Number	%
KW8 6	149	190	111	1,800	29	19.5	46	30.9
PH22 1	12	119	87	400	2	16.7	2	16.7
PH23 3	34	107	89	210	16	47.1	2	5.9
PH24 3	75	76	60	420	7	9.3	5	6.7
PH32 4	158	168	94	2,000	38	24.1	37	23.4
PH33 7	50	39	30	150	3	6.0	0	0.0
PH34 4	17	537	266	2,900	4	23.5	11	64.7
PH35 4	26	76	55	240	4	15.4	3	11.5
TD14 5	181	45	34	250	7	3.9	3	1.7
TD5 8	143	107	80	480	35	24.5	19	13.3
TD9 0	5	64	58	110	1	20.0	0	0.0
ZE1 0	53	152	87	860	12	22.6	12	22.6
ZE2 9	214	99	45	900	25	11.7	32	15.0