

Special Contribution

Ireland's National Radon Control Strategy and Supporting Research

Stephanie Long*

*Office of Radiological Protection and Environmental Monitoring, Environmental Protection Agency,
Clonskeagh, Dublin 14, Ireland*

Received 21 May 2018; revised 28 June 2018; accepted 29 June 2018

In Ireland radon is a significant public health issue and is linked to up to 250 lung cancer deaths each year. Much work was carried out to address this issue during the 20-year period from 1992 to 2012. Despite this, the Government recognised that a cross-Agency approach was required to comprehensively address this problem and subsequently, the four-year National Radon Control Strategy (NRCS) was launched in 2014. This paper summarises the highlights of the work carried out to implement the NRCS between 2014 and 2018 and it also sets out the research carried out during this period to underpin this work.

Key words: Radon, national strategy, radon related research

1. Introduction

The first study of radon in Ireland was carried out between 1985 and 1989. This was a population weighted study of 1,300 homes which showed that about four percent of the homes tested were above the national reference level of 200 Bq/m³ and that the west of the country was most affected¹.

Between 1989 and 1992 further studies were carried out in the west of Ireland which showed significant regional variations. Following this a national geographically based survey was carried out between 1992 and 1999. During this period 11,300 homes were tested during 5 separate surveys. The survey locations were based on the Irish National Grid, which is made up of 10 km grid squares. Those grid squares where it was predicted that more than ten percent of homes are above 200 Bq/m³ were categorised as High Radon Areas (HRAs). Approximately

one third of the country was categorised as a HRA, seven percent of homes were predicted to have indoor radon concentrations above 200 Bq/m³ and the arithmetic mean indoor concentration in Irish homes was calculated to be 89 Bq/m³. In 2002 this predictive radon risk map was published² and since then it has formed the basis for implementation of radon related building regulations³, workplace testing requirements⁴ and public awareness work carried out by the EPA. The results of this work were combined with the radon related lung cancer risks as set out by Derby, *et al.*⁵ and used to estimate that up to 250 cases of radon related lung cancers are diagnosed every year in Ireland. Radon is the most significant source of radiation exposure to the Irish public, comprising 56 percent cent of the total dose⁶.

2. Tackling radon in Ireland 1998 to 2014

Following the publication of the radon risk map, much work was carried out to address the public health hazard created by radon in Ireland. For example, between 1998 and 2002 all Irish schools were tested and remediated⁷.

Good progress was made in testing and remediating

*Stephanie Long: Office of Radiological Protection and Environmental Monitoring, Environmental Protection Agency, Dublin 14, Ireland
E-mail: s.long@epa.ie

social housing by local government and many state workplaces have also been tested and remediated. Legal directions were used to instruct employers in private workplaces to measure radon with limited success, however these campaigns were useful in highlighting opportunities to strengthen legislation and testing the robustness of EPA procedures⁸.

In 1998 building regulations were established to ensure that radon preventive measures are included in new buildings in HRAs. Specifically, these regulations require that all new buildings are installed with a standby sump and new buildings in High Radon Areas with both a sump and a barrier.

Public awareness work in HRAs received good media coverage and in 2010, levels of awareness were shown to be high at 75%⁹. Further details of the work carried out to address radon during this period have been set out previously¹⁰.

Despite the good progress made in addressing this health issue, by 2012 the total number of homes tested still remained low at about 4 percent of the housing stock. It was estimated that if testing continued at that rate, it would take another 400 years for all homes in the country to be tested. In addition, the remediation rate for homes that tested above 200 Bq/m³ were also disappointing at 22 percent. Finally, the regulatory approach to radon in workplaces has proved difficult to implement with only about 3,000 workplaces tested to date⁶.

Recognising the scale of the problem, the Health Services Executive (the body with responsibility for public health) and the Radiological Protection Institute of Ireland (which has since merged with the Environmental Protection Agency) published a joint position statement on radon in 2010 calling for a coordinated national response on radon to be set out in a National Radon Control Strategy. Following this recommendation, the Minister for the Environment tasked an inter-Governmental group with developing a strategy, which would comprehensively address the radon problem in Ireland. This strategy, Ireland's National Radon Control Strategy¹¹, was published in 2014 and set out 31 actions in 6 thematic areas to be implemented over a four-year period. In addition, the research needed to underpin these actions was set out in an appendix to the strategy¹¹.

3. Implementation of the national radon control strategy (NRCS) 2014 to 2018

The NRCS contains recommendations on a broad range of measures aimed at reducing the risk from radon to people living in Ireland. These are set out in six thematic areas as follows:

1. Raising awareness of radon and encouraging individual action;

2. Promoting confidence in radon services;
3. Installation of preventive measures in new buildings;
4. Using property transactions (sales and rental) to drive action on radon;
5. Provision of advice and guidance for individual householders and employers with high-radon readings;
6. Addressing radon in workplaces and public buildings.

The same inter-Governmental group was given responsibility for implementation of the NRCS. In summary, at the end of the four-year period a total of 18 of the 31 actions were complete, with 13 actions being implemented on an ongoing basis or for inclusion in Phase 2 of the NRCS. This paper sets out a summary of the key actions completed during Phase 1 of the NRCS (2014 to 2018). In addition, a summary of the research carried out to support the implementation of this strategy will be given.

3.1. Raising awareness

A dedicated radon web resource was developed to provide the information required about radon in one location. The information is organised according to stakeholder and the website www.radon.ie was launched in 2016.

The EPA has identified 12 priority counties in which radon should be tackled; these are counties that have been identified as being at high risk of having elevated indoor radon levels. Awareness campaigns were successfully carried out in all twelve of these counties. During each week-long campaign, multiple communication channels were used to encourage homeowners to test. Advertisements were placed on local radio and in local papers, Twitter and on-line advertising were also used. A press release was issued focusing on the risks from radon in that locality, this resulted in interviews on local, and sometimes national radio. Both national and local government officials for that county were briefed and public meetings held to inform the local population in more detail. Finally, in many counties, tailored information was also sent to each home in the county. Following the completion of these campaigns a programme of radon awareness was planned, focussing on European Radon Day (November 7th). The first of these was completed in 2017 and included advertisements on national radio, a feature on two television shows, one a science education programme and the other a popular afternoon programme. A Twitter campaign was carried out through the EPA's Twitter account focussing on radiation (@EPARadiation). Finally, a press release was issued resulting in six interviews on local radio. It is planned to maintain and develop an annual radon day focussed on November 7th to maintain good awareness levels about the risks from radon.

3.2. Confidence in radon services

A two-day training course and assessment in remediation was developed and held in 2016. Eighty-nine people, including radon professionals, and staff from state bodies with responsibility for radon, attended this course during 2016.

Following this a registration scheme was developed for remediation contractors in consultation with the radon industry. To be included on the register, contractors must provide evidence that they have attended the remediation training course, that they are tax compliant and insured. Contractors also agree to provide anonymised data to the EPA on an annual basis. Likewise, a registration scheme was established for radon measurement. To be included on the register of measurement services, evidence of successful proficiency testing within the previous 12 months is required. In addition, companies must show that they are tax compliant and insured and must agree to provide anonymised data to the EPA on an annual basis.

Although these registers are voluntary, homeowners and employers are strongly advised to employ registered measurement and remedial services, these are listed on www.radon.ie.

3.3. Prevention in new buildings

A short targeted training course on the installation of radon preventive measures was developed for construction site staff¹². This course was rolled out by the Construction Industry Federation (the professional body representing the construction industry in Ireland) and the course was attended by 78 people during 2017.

3.4. Property transactions

During 2017, the Law Society of Ireland revised their “Conditions of Sale” document to include three questions regarding radon:

- (a) Has a radon test been carried out?
- (b) If a radon test has been carried out, please supply the report.
- (c) Has any action to reduce radon levels been undertaken?

This information is passed from the seller’s solicitor to the buyer’s solicitor. While it is not compulsory for a homeowner to test or remediate their home for radon before selling it or to answer these questions, it is anticipated that, in time, radon will become a standard part of the conveyancing process.

3.5. Supporting individuals

Actions taken to support individuals at risk from radon include working in partnership with the Irish Cancer Society to ensure that a coordinated message is communicated and working with the national quit smoking campaign (www.quit.ie) to ensure that smokers are aware of the significantly increased risks they are at

when exposed to radon.

Since the lack of financial support has been identified as a significant barrier to testing and remediation, the EPA is currently working with its Government Department to develop a pilot scheme that would offer free testing and subsidised remediation.

3.6. Radon in workplaces

The Health and Safety Authority (the national body with responsibility for ensuring workplace health and safety) includes radon in its inspection programme and requires all workplaces in HRAs to test for radon and remediate where necessary.

To date, weak legislation has meant that addressing radon in workplaces has proved difficult, however, the implementation of the EU Basic Safety Standards Directive has provided an opportunity to strengthen workplace requirements from 2018 onwards.

4. Research carried out in support of the strategy

In addition to the actions recommended in the NRCS, the research needed to support the delivery of the strategy has also been identified¹¹. This research was set out in four thematic areas:

1. Establishing current baseline values to measure the effectiveness of the NRCS;
2. Better targeting of measures and resources;
3. Improving the effectiveness of preventive measures and remedial work;
4. Developing better ways for communicating radon risk and raising awareness.

The research carried out under each of these themes is summarised below:

4.1. Establishing current baseline values to measure the effectiveness of the NRCS

4.1.1. The geographically weighted average radon concentration.

Since the completion of Ireland’s radon risk map, there have been several developments that are likely to impact on the national average indoor radon concentration. The building regulations requirement in place since 1998 requires that all new homes built in HRAs are installed with a radon proof membrane. There has also been a significant building boom with approximately 35% of homes in the country built since 1999. To establish the current national indoor average for radon in homes in Ireland, a new survey protocol was designed using 60 of the original 10 km grid squares stratified by radon risk category and geographical location. Measurements were carried out in 649 homes during 2014 and the results were used to calculate the current national average indoor radon concentration of 77 Bq/m³. This is a 13% reduction

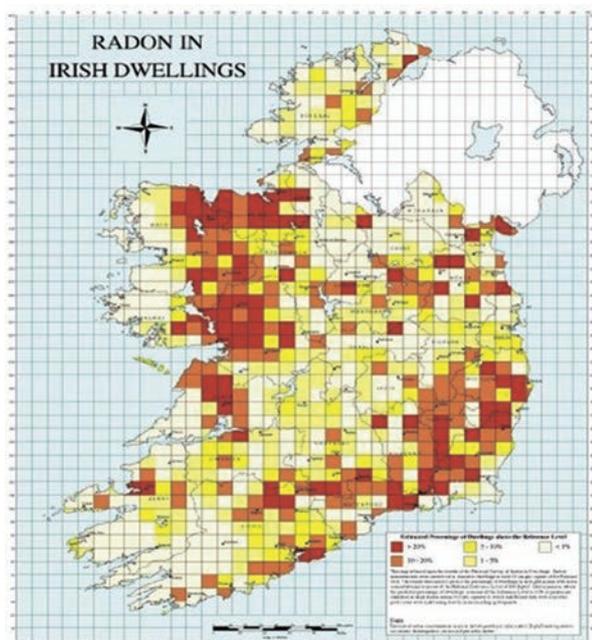


Fig. 1. Ireland's Radon Risk Map.
Source of the map: The Environmental Protection Agency of Ireland.

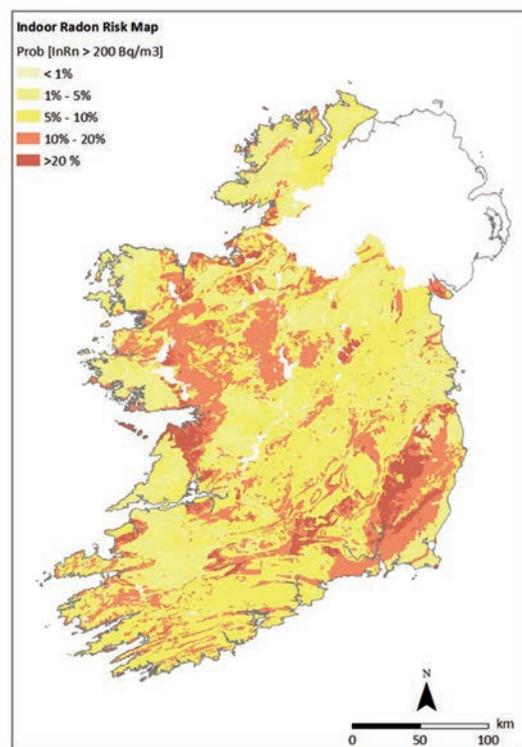


Fig. 2. Radon Risk Map Incorporating Geological Parameters.
Source of the map: Elio J *et al.* Logistic regression model for detecting radon prone areas in Ireland¹⁶.

from the average of 89 Bq/m³ measured previously and is attributed to the implementation of the Building Regulations¹³.

4.1.2. The population weighted average indoor concentration

The second part of this study was then carried out to determine the population weighted national average. During this study 650 homes, stratified by population, were tested for radon during 2016 and a population weighted average of 98 Bq/m³ was calculated¹⁴. The population weighted average concentration had previously been calculated as 91 Bq/m³. This increase is attributed to an increase in the population of 18% between 2002 and 2016. This new population weighted average concentration will be used to calculate the current number of radon related lung cancers in Ireland.

4.1.3. The rate of radon remediation

Three surveys were carried out to establish the remediation rate for homes that have tested above 200 Bq/m³ (in 2011, 2013 and 2015). The results of these surveys of 151 participants consistently show a remediation rate of 22%. In addition, it was clear that the installation of a fan assisted sump was the most popular remedial method and that an average reduction of between 87% and 90% was achieved through this method¹⁵.

4.1.4. Public awareness of radon

Market research has shown that 75% of the Irish public have heard of radon, 33% of adults are aware that radon contributes to lung cancer and 58% are aware where further information is available. Awareness is higher among those that are over 45 years old. Despite high awareness levels, only 21% of those surveyed would be likely to have their home tested for radon.

4.2. Better targeting of measures

4.2.1. Development of the radon risk map

The radon risk map that was published in 2002 has been used to implement building regulations, workplace measurement requirements and to focus public awareness campaigns on the highest risk areas. In the meantime, a significant number of additional home measurements were carried out by members of the public. Almost 32,000 of these data were geocoded and logistic regression used to develop a radon risk model that incorporated bedrock geology, soil geology, soil permeability and aquifer type¹⁶. This significantly refined radon risk map is currently being validated and will ultimately replace the existing map. (Figs. 1 and 2)

4.3. Improving effectiveness

4.3.1. Energy efficient buildings

International studies have shown that the installation

of energy efficient measures can increase indoor radon concentrations^{17, 18}). Since there was no Irish data on this topic a study was commissioned to model the predicted changes in ventilation (and consequent changes in indoor radon concentration) for a range of retrofit scenarios. In summary, the results show that where energy retrofitting reduces ventilation, there is a corresponding increase in radon and where ventilation levels are maintained, radon levels are unaffected. Once these results have been published the Building Standards Technical Guidance Document on ventilation in new buildings will be revised to take account of these findings.

4.3.2. Optimum specifications

A three-year study to characterize the hardcore used during the construction of buildings is underway at present. This study will model hardcore permeability and porosity; these results will be validated with laboratory measurements and will ultimately feed into the revision of Building Standards Technical Guidance Document on radon preventive measures³ ensuring future new builds optimise radon prevention.

4.3.3. Long term effectiveness

As mentioned above, all Irish schools were tested and remediated between 1998 and 2002. A recent study revisited 16 of the schools that had remediation work carried out to assess the long term-effectiveness of this work. It was found that radon concentrations in 26% of rooms that had previously been remediated now had concentrations in excess of the reference level of 200 Bq/m³ for schools. It also found that only 15% of schools regularly maintained or checked the existing remediation systems. These difficulties arose due to staff change-over and poor awareness of the work that had been carried out. This study has highlighted the need for maintenance of remedial systems and additional supports for those schools with responsibility for managing radon exposure to staff and students.

Radon concentrations are minimized in new schools through the installation of radon barriers in all new school buildings, followed by testing within 5 months.

4.4. Better ways of communicating

4.4.1. Health psychology study

A review of radon awareness campaigns relative to other health information campaigns was carried out from a health psychology perspective. This study concluded that the impact of EPA radon awareness campaigns are broadly similar to those of other mass media public health information campaigns and that limited behavioral change can be achieved through the provision of information alone. The review also concluded that responsibility for addressing radon should not rest so

heavily on the householder but that stronger government regulation is required to effect real change. It was further recommended that regulations should be supported by high-quality information targeting different sectors of the population¹⁹).

5. Next Steps

During 2018 the implementation of Phase 1 of the NRCS will be reviewed to assess the status of each action, the impact of the measures taken to date; stakeholder experience of the strategy, lessons learnt, outstanding issues and identification of further actions that are now appropriate. This review will feed into the development of Phase 2 of the NRCS which is likely to focus on the development of financial incentives, the continued development of awareness raising work, continuing professional development and training for construction professionals and further development of the radon risk map. It is planned that Phase 2 will be launched in early 2019 and cover the period from 2019 to 2022.

Conflict of Interest Disclosure

I declare that no conflict of interest exists that could undermine the objectivity, integrity or perceived value of a publication of this work.

References

1. Mc Laughlin J and Wasiolek P. Radon levels in Irish dwellings. *Rad Prot Dosim.* 1988;24:383–6.
2. Fennell SG, Mackin GM, Madden JS, McGarry AT, Duffy JT, O'Colmáin M, Colgan PA and Pollard D. Radon in dwellings, the Irish national radon survey. RPII-02/1. Dublin: Radiological Protection Institute of Ireland; 2002.
3. Building Regulations 1997. Technical guidance document C. Site preparation and resistance to moisture. Dublin: Stationery Office; 2004.
4. Health and Safety Authority of Ireland. Radon in workplaces. Available from: <http://www.hsa.ie/eng/Topics/Radon/>
5. Darby S, *et al.* Radon in homes and risk of lung cancer: collaborative analysis of individual data from 13 European case-control studies. *BMJ.* 2005;330:223.
6. Radiation doses received by the Irish population. Dublin: Radiological Protection Institute of Ireland; 2014. Available from: <http://www.epa.ie/pubs/reports/radiation/radiationdosebyirishpopulation.html>.
7. Synnott H, *et al.* Radon in Irish primary and post-primary schools: the results of a national survey. Dublin: Radiological Protection Institute of Ireland; 2004. Available from: https://www.epa.ie/pubs/reports/radiation/RPII_Radon_Schools_Report_2004.pdf
8. Colgan PA, *et al.* Current status of programmes to measure and reduce radon exposure in Irish workplaces. *J Rad Prot.* 2004; 24:121–9.
9. Millward Brown Landsdowne. Understanding the public's view of radon: learnings from focus groups: study of awareness levels. 2010. Available from: <http://www.epa.ie/pubs/>

- conferencesandevents/nrf/nrfeight/RPII_NRF_Focus_10.pdf
10. Long S and Fenton D. An overview of Ireland's national radon policy. *Radiat Prot Dosim.* 2011;145:(2-3):96–100.
 11. Ireland's National Radon Control Strategy. Dublin: Radiological Protection Institute of Ireland. Available from: <https://www.dccae.gov.ie/en-ie/environment/publications/Documents/4/National%20Radon%20Control%20Strategy.pdf>
 12. Construction Industry Federation targeted training course on the installation of radon preventive measures. Available from: <https://ciftraining.ie/product/radon-prevention-measures-site/>
 13. Dowdall A, *et al.* Update of Ireland's national average indoor radon concentration – Application of a new survey protocol. *J Environ Radioact.* 2017;(169-170):1–8.
 14. Walsh P. A revision of the number of radon related lung cancers in Ireland. Presented at the 14th National Radon Forum, 2017. Available from: <http://www.epa.ie/pubs/conferencesandevents/nrf/fourteenthnationalradonforum/Paul%20Walsh.pdf>
 15. Dowdall A, Fenton D and Rafferty B. The rate of remediation in Ireland 2011-2015: establishing a baseline rate for Ireland's National Radon Control Strategy. *J Environ Radioact.* 2016;162-163:107–12.
 16. Elio J *et al.* Logistic regression model for detecting radon prone areas in Ireland. *Sci Total Environ.* 2017;(599-600):1317–29.
 17. Goyette Pernot J and Pampuri L. Indoor air quality in new or renovated energy-efficient buildings. Preliminary results of radon measurement campaigns in French and Italian parts of Switzerland. ROOMS 2014, Bad Ischl, Austria. 2014. Available from: <http://radoneurope.org/index.php/activities-and-events-2/other-activities-and-events/>
 18. Milner J, *et al.* Home energy efficiency and radon related risk of lung cancer: modelling study. *BMJ.* 2014;348:f7493.
 19. Hevey, D. Review of public information programmes to enhance home radon screening uptake and home remediation. 2015. EPA Report No 170. Available from: <http://www.epa.ie/pubs/reports/research/health/research170.html>.