

**THE LONG TERM DURABILITY OF RADON PROTECTIVE
MEASURES USED IN NEW UK DWELLINGS**

CHRIS SCIVYER, KIM NOONAN
BUILDING RESEARCH ESTABLISHMENT LIMITED,
GARSTON, WATFORD, HERTS, UK

ABSTRACT

This paper describes work undertaken by BRE for the Building Regulations Division of the UK Department of the Environment Transport and the Regions, as part of a project into radon protective measures used in new dwellings. The aim of the project was to establish whether the radon protective measures that are routinely installed in the UK provide long term protection against radon and do not result in any long term building defects.

A sample of 73 houses monitored for radon shortly after construction were contacted ten years later to see whether radon levels remain low and check for signs of any construction defects. The results of the study have confirmed that the protective measures continue to provide adequate radon protection, without causing any adverse side effects. This offers confidence that the measures will continue to provide protection over the life time of the buildings.

KEYWORDS: Radon, Preventative, Construction, Performance, Lung cancer,

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BUILDING RESEARCH ESTABLISHMENT LIMITED,
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INTRODUCTION

This project was undertaken as part of long term research into radon protective measures used in new dwellings undertaken by BRE for the Building Regulations Division within the Construction Directorate of the Department of the Environment Transport and the Regions. The aim of the project was to establish whether the radon protective measures that are routinely installed within the UK, in compliance with BRE Report BR211 Radon : guidance on protective measures for new dwellings [1] which support Requirement C2 of Schedule 1 of the Building Regulations for England and Wales [2], provide long term protection against radon and do not result in any long term building defects.

Guidance on radon protective measures for new dwellings was first published as Interim Guidance in support of Requirement C2 of Schedule 1 of the Building Regulations for England and Wales in 1988 [3]. BRE carried out an extensive monitoring exercise over the 1989/90 and 1990/91 winters to test whether the radon protective measures recommended in the interim guidance worked in the field. The results demonstrated the effectiveness of the measures in reducing radon levels shortly after construction. However they could not demonstrate whether the measures would continue to provide adequate protection over the whole life of the building.

In addition, the radon protective measures recommended in areas of higher radon risk require the installation of a radon barrier through the external walls of the dwelling. As modern external walls usually feature a cavity, provision has to be made to ensure that the barrier, where it passes through the cavity, allows any moisture within the cavity to drain to the outside of the building. This is achieved by providing a cavity tray. Although cavity trays are regularly used for shedding water above doors and windows there have in the past been some buildability problems associated with their installation e.g. poor construction practice leading to damp ingress through walls due to mortar droppings bridging the cavity. There was some concern within the industry that the widespread use of cavity trays might lead to an increase in dampness problems.

This paper describes the work carried out recently by BRE in assessing the long term durability of radon protective measures installed in the South West of England.

DESCRIPTION OF THE PROJECT

The earlier field trials carried out by BRE between 1989 and 1991 as reported in BRE Client Report N209/92 [4] involved measurements in some 423 recently constructed

dwellings on 33 sites located in Cornwall and Devon the area of the UK with the most serious radon problem. A considerable amount of information about the dwellings was collected at the time, including construction details, specification details, site observational information as well as the results of radon measurements. The sample included dwellings built with radon protective measures (which feature full radon barriers) as well as some built without radon protective measures (built prior to the introduction of the Interim Guidance in 1988) which provided a control set against which the protected houses could be assessed. The protected properties measured as part of this study provided an ideal target group for inclusion in the new study looking into long term durability.

242 dwellings were selected to be invited to join in the new survey. These dwellings were selected on the basis that they include radon protective measures (full radon barrier) and were found to have indoor radon levels below the recommended action level of 200Bqm² when measured during the earlier study.

At the time that BRE carried out the earlier study an undertaking was given to the occupiers that their radon results would be treated in confidence. BRE undertook to inform occupiers of their results but agreed not to disclose them to any third party. The reasoning for taking this line at that time was that it was the standard approach adopted by the National Radiological Protection Board who were implementing the Governments free radon measurement programme. They had adopted this approach in order to encourage householders to take up measurement, without fear that their results might result in blight on their homes at time of resale.

This earlier assurance of confidentiality was to impact on the new survey in that extra care had to be taken when contacting householders to ensure that there was no breach of confidentiality. The principal concern being that over the period since the earlier study many of the homes may have transferred ownership. It was imperative that BRE did not inform new householders of earlier results, in case that a previous house owner had withheld the information from the buyer at the time of purchase. To resolve this problem all of the targeted houses were sent a letter addressed to 'The Occupier'. The letter offered the householder a free radon test for which they would receive the measurement result. The letter explained why BRE were conducting the survey but did not reveal to the occupier if BRE had carried out earlier measurements within their homes. It is interesting to note that only one occupier contacted us to inform us that BRE had measured his home previously. The mail-shot was sent out to 242 homes and resulted in positive responses from 89 Householders.

In addition to inviting householders to participate in the measurement exercise a questionnaire accompanied the letter. The principal aim of the questionnaire was to establish whether any changes had been made to the dwellings since they were originally monitored. This was designed to assist BRE in better understanding cases where radon levels had altered significantly from the earlier study. For example, if double-glazing had been installed in place of single glazing one might expect the property to be more airtight than before, resulting in a possible increase in radon level, similarly an extension of a property would result in a greater ground floor area, possible additional points of entry for radon, e.g. underfloor vents left open into a conservatory, or possible damage to the radon barrier when building the extension.

In addition to seeking information on alterations made to the property, householders were asked whether they were aware of any structural problems with their home, in particular damp patches. The aim here was to try to identify any homes that may be suffering due to the radon protective measures. It was intended that where homes were identified as having problems further investigation would take place. This was to be undertaken with a telephone interview with the householder followed up where necessary by a house visit.

All detectors used in the study were supplied by NRPB and comprised standard NRPB yellow etch track radon detectors, identical to those used in the earlier measurement exercises. As with the earlier studies detectors were arranged to be dispatched to houses during the first week of January. This was so that the detectors would remain in place for a three month period – early January to early April during the period of the year when the highest indoor radon levels might be expected. Again, as in the earlier study pairs of detectors were provided with a request that they be placed in the main living area and main bedroom. The results from the two detectors were then combined and corrected to provide whole-house seasonal corrected annual average results.

RESULTS

Measurement results were obtained from 75 homes, however for two of these homes the ownership changed during the study period so their results have not been included in the analysis. Disappointingly 14 homes failed to return detectors despite several reminders. In all cases where results were obtained they remain below the 200Bqm^2 action level recommended by NRPB. Slightly more results - 49 as compared to 24 showed reductions in radon level. A statistical 'T' test was carried out on the sample of 73 results which showed that the new results were significantly lower than the earlier results. However the actual reductions in radon levels were quite small. The overall conclusion therefore is that the radon protective measures continue to provide a fairly constant level of radon protection over time.

Although the overall conclusion is that the measures continue to work over time there were some differences between the original and new radon measurement results. Most of these differences can probably be explained by differences in weather conditions during the two surveys and detector errors. However all of the results were analysed to see whether there were any changes in ownership or use of the dwellings, or whether any building works had been carried out since the original measurements were taken that might lead to changes in the indoor radon levels. As BRE had undertaken site observation studies when these dwellings were built, details regarding construction were available. These together with the information gained from the householder questionnaires and where necessary direct conversations with householders, were used to try to better understand the variations in the old and new measurements.

There are two cases where the levels have increased to within 20% of the action level, which is the error in the radon detector results. As such it could be argued that in both cases the results could be interpreted as being at or even above the recommended action level. These two houses were given closer examination.

The first house was one of six measured on this site, no major alterations have been carried out since construction and the original occupiers remain in residence. The only significant feature about this house is that has an unusual radon barrier. It is the only house in the original study that was completed with a liquid applied barrier. Although the particular material used has been successfully used as a damp barrier, it and other liquid applied radon barrier materials were permitted at the time although not generally recommended by BRE. Generally the industry view is that although these materials have a role to play they are unlikely to provide long term soil gas protection unless a very high standard of detailing and installation is applied. It should be noted that the radon level has increased from 96 Bqm² to 160 Bqm² which is still well below the UK action level, and that the house has a sump which could be activated to provide sub-slab depressurisation.

The second house is one of four measured on the site. In all cases radon results remain within the acceptable 20% detector error. However the radon level in this house has always been far higher than any of the other houses on the site. One reason for this maybe that it was built when techniques were first being developed. The contractor tried a range of different radon protective measures on this site. The house continues to be occupied by the original owner who has made no significant changes to the property. However a visit to the property did reveal that very few vents had been fitted to provide ventilation to the underfloor void, and several of these had become blocked with soil and other garden debris. From BRE's experience with existing buildings this could have a significant impact on the radon levels in the house.

In looking through the remaining 71 dwellings there do not appear to be any obvious conclusions that can be made as to why in some cases radon levels have increased and in others they have reduced. There have been a considerable number of houses change hands since the earlier study. However the radon levels in these houses have fluctuated at similar rates to those where the occupiers have not changed. It can therefore be concluded that there appears to be no significant influence from change of ownership.

There are three cases where the householders have remained the same but they have added either a conservatory or small extension. In two cases the radon levels are lower 29% and 43% respectively, and in the other the level is higher by 63%. In all three cases the level remains below 100 Bqm².

In addition to considering the results of the radon measurement householders had been asked by questionnaire whether they were aware of any building defects within their homes. The question asked had been deliberately vague : 'Are you aware of any problems with your home such as damp patches, staining, damaged paintwork of walls downstairs?' the intention had been to try to establish whether installing radon protective measures had resulted in any building defects. Of particular concern had been the potential for wall cavities to have been poorly constructed, such that mortar droppings could build-up on the cavity tray and lead to moisture bridging the cavity. Each of the householders who responded 'yes' to the question were contacted to discuss in more detail the problems that they referred to. Twelve home owners identified problems, but after discussing their problems with them it was possible to

eliminate all of defects as having been caused by the inclusion of radon protective measures.

For the record the defects reported included :

- Cold bridging above a window lintel
- Moisture ingress above a window lintel
- Several cases of damage to wall and timber finishes due to condensation problems
- Structural cracking above patio doors
- Damp ingress halfway up the sides of patio doors
- A sunken rainwater drain
- Cracking render between upstairs bedroom window and patio doors below

The principal findings from this study are that the protective measures installed ten years ago appear to be performing well. In terms of radon, measurement results indicate that they continue to provide a similar level of protection to when they were first built. In addition the dwellings do not appear to show any signs of adverse side effects caused by the inclusion of the radon protective measures within the properties.

DISCUSSION

The principal conclusion is that the protective measures recommended within the 1988 Interim Guidance and subsequent 1991 and 1992 editions of BRE Report BR211 'Radon : guidance on protective measures for new dwellings', continue to provide acceptable radon protection ten years after construction, without any signs of adverse side-effects to building structure or finishes.

As the materials used to provide the radon protection in this study are all derivatives of materials with a long pedigree of use within the construction industry there is no reason suspect that they will not continue to perform adequately in the future.

The results of this study are important as they provide strong evidence for designers and builders that the measures currently being recommended in the UK work in both the short and long term. The information is also important for use in demonstrating to potential house purchasers that radon protective measures work. The results of this study are significant not only in a UK context but also internationally, as BRE is unaware of any similar work having been carried out elsewhere.

ACKNOWLEDGEMENTS

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