Updated Guidance for the Management and Remediation of Radon Gas in Buildings

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Introduction

1. At the time of writing, the guideline Action Levels are 200 bq/m$^3$ in the home and 400 bq/m$^3$ in the workplace. This advice given is applicable to techniques designed to ensure the radon concentration within a building is no higher than these levels.

2. All systems for the management or control of radon gas should be designed and installed by competent persons, in this instance, persons with a basic understanding of the science of radon gas and its behaviour in buildings. Current Radon Council certification and a knowledge of structures are the minimum requirements for competence.

Existing Buildings

3. An increased understanding of the science of radon gas means that some techniques previously advocated for radon remediation in existing buildings are no longer appropriate. Equally, advances in technology and material manufacturing now provide better solutions as shown by the following.

4. Anecdotal evidence has emerged that indicates that radon gas can pass through certain materials, including those that provide an effective waterproof barrier (contractors are finding high levels of radon in below-ground areas where waterproofing techniques have been successfully installed. The buildings are dry yet contain high levels of radon). Consequently, material used to retard radon entry should be certificated specifically for this purpose, and it is not acceptable to simply use waterproofing materials. In addition, materials such as bitumen and cementitious coatings are inadequate, as they are prone to failure.

5. It is not safe to rely on simply sealing all cracks in a building as a method of controlling radon entry. Firstly, this is impractical. Stripping out building finishes to locate cracks, which will tend to be cryptic in their location, is disproportionately expensive without assurance that all points of entry have been located. Secondly the cause of movement that generated the cracks in the first place may cause them to reoccur. Also in view of the anecdotal evidence of radon passing through materials, it would be imprudent to rely on the assumption that radon could not pass through building fabric and materials.

6. Past advice included altering the way in which a building is ventilated. In order for a reduction in radon levels to be seen, it would be necessary for the downstairs windows to be left open, whilst the upstairs windows always remained shut. For most homeowners, this proposal would not be viable. Leaving downstairs windows open would leave the property vulnerable to burglary, and given the UK climate it is unlikely that during the colder periods it would be acceptable to have the windows constantly open. There is sufficient availability of alternative remediation methods that do not impose on the occupant’s lifestyle, and so alteration of ventilation in this way is no longer seen as an appropriate technique for mainstream radon remediation.

7. If a property has suspended floors, increasing subfloor ventilation can frequently be used to remediate moderate radon levels (up to 500 bq/m$^3$). To be effective there must be a continuous airflow with no blockages (e.g. load-bearing walls) from
opposite walls of the property. Airbricks should be installed in the approved manner (actual opening to be at least equal to 1500 mm² for each metre wall on two opposite sides).

8. Air management techniques, such as the use of positive pressurisation, have advanced significantly in recent years. The capability of such units is now far greater than when they were first introduced. It is accepted that positive pressure can be used to control radon effectively in suitable buildings to a threshold of 1000 bq/m³. Additionally, in suitably draught-proof buildings, specialists who are expert in indoor air management and radon control have been able to demonstrate the successful remediation of properties containing several thousand bq/m³ using positive pressure.

9. As a general rule, extract fans should not be employed in attempts to control radon levels. Due to the dynamics of radon entry to buildings, extract fans will make the problem more severe. However, the exception to this rule is where an unused area of the building can be effectively converted into a sump, or radon collection area. In this case, entry to the collection area should be permanently excluded and an inline extract fan, or similar, can be used to discharge the radon safely from the property.

10. Retrofit sump systems are a highly effective means of reducing radon levels in an existing building, except where there is a basement (see below: Basements). A passive system, relying solely on the natural stack effect to evacuate the gas from the sump through exhaust pipework is not recommended. Unbeknown to the occupants, downdraughts can occur and cause the radon collected in the sump to be forced into the property and thus elevate radon concentrations. The preferred method is to use an active system with an inline fan within the exhaust pipework, to ensure that the gas is always travelling away from the property. Care must also be taken to position the sump outlet in a safe position. The ideal external exhaust point is above the level of the eaves. If this is not possible, or it is preferred, a low-level outlet can be used, provided it is positioned at least two metres away from the nearest opening, door, window, vent, building and occupied external area, such as a patio, and if the designer is satisfied that unacceptable levels of radon will not migrate inside the building.

11. When carrying out any remediation works, whichever method is chosen, it is vital to conduct a radon test on completion. The purpose of remediation is to ensure the radon concentration within the property is below the guideline Action Level, and so remediation works should not be signed off until it has been demonstrated that this has been achieved.

New Buildings

12. The installation of radon protection in newbuilds is a specialist task. It is recommended that a specialist contractor listed in the Radon Council’s Approved Contractor document is used to ensure that the protection installed is effective at excluding radon from the property.
13. Where a radon barrier (or membrane) is required, it is vital that a suitable material is used and that the entire footprint of the building is covered, including the cavities in all external and party cavity walls. The material should be certificated for the purpose of radon control and should be sufficiently resilient to withstand site conditions. A reinforced membrane will provide the best resistance to tearing and punctures. 2000 gauge polythene is now deemed too vulnerable to defects and so is not recommended for use as a radon barrier.

14. The joints in the material are the areas most susceptible to failure and therefore all jointing systems used should be certificated as suitable for the purpose of radon protection. Heat-welded jointing using hot air is established as the preferred method, achieving an effective seal. If this is not possible, a jointing system that has itself been certificated for the specific purpose of radon control should be used. Cold tape jointing is vulnerable to defect due to site conditions, such as moisture and wind, and also vulnerable to disturbance by following trades. Bonding agents that form adhesion by chemical action will be suitable for use provided they withstand the hazard of use on sites, such as moisture, dust, wind etc and have been demonstrated to be gas proof.

15. It is preferable to preform as much of the membrane off-site, where the jointing can be done in dry and clean conditions. As much continuous material as possible should be used, with as few joints as possible.

16. Proprietary “top hats” to seal around service inlets, preferably using heat-sealing jointing should be used.

17. Where provision for ventilation is required, in addition to a membrane, either subfloor ventilation or provision for a sump system must be installed. If a sump fills with groundwater, its efficacy will be negated, and this factor should be taken into account in the design and specification.

18. Upon completion of a new building it is vital to carry out a radon test to confirm that it does not contain high levels of radon. Without carrying out such a test, it is impossible to know whether the radon protection provided has been adequate or, a sump system should be brought into use.

**Basements**

19. The Health Protection Agency (HPA) has stated “high radon concentrations can be found in basements anywhere in the country, regardless of Affected Area status.”

20. Given the increased surface area in contact with the ground, properties with basements are more likely to contain high concentrations of radon than those without. Particular attention must therefore be given to the control of radon if the property contains a basement.

21. If the basement area is never to be used by the occupants and can be completely sealed-off from the rest of the accommodation, it may be suitable to use the area as a
sump. Radon can be allowed to collect in the basement and be exhausted out using an extract fan attached to pipework (see 19 above).

22. If the basement is to be used as living accommodation, or if it is to be accessed regularly, this is not an acceptable solution. A useable basement requires effective waterproofing which should be designed and installed in accordance with BS 8102, the British Standard for below-ground waterproofing.

23. BS 8102 dictates that water intrusion into a basement is foreseeable (even if there is no evidence of dampness at the present time), and so a suitable waterproofing system that will cope with possible future water ingress should be designed and installed. This should also be the case for the provision of radon control, as the entry of radon into a basement is foreseeable, even if a radon test reveals concentration of the gas is currently low.

24. It is increasingly recognised as best practice in the selection of below-ground waterproofing systems that less than perfect workmanship on site is foreseeable, and the system should be designed to take account of this. The system must also offer access for ease of repair.

25. Increasingly, waterproofing designers and specifiers are discontinuing use of externally applied systems as an effective means of waterproofing of a below-ground structure.

26. Currently surface applied coatings such as liquid bitumen and cementitious coatings are inadequate for the purpose of radon protection as they are prone to defect and leakage.

27. Frequently, cavity drain membrane systems are seen as the most appropriate system for achieving below-ground waterproofing. Some cavity drain membrane systems are certificated as providing an effective barrier to radon gas, however using these to line the internal surfaces of a basement could cause the gas to be simply displaced to the ground floor accommodation.

28. A cavity drain membrane system should not, therefore, be used in isolation for the control of radon ingress. In addition to the risk of moving the gas to another area of the building, the material is vulnerable to being punctured either during construction or at a later date by the occupants. Whilst this would not affect the waterproofing ability (unless at the lower part of the wall membrane) radon gas could pass through such a defect and the occupiers would be unaware that this was happening.

29. Relying on positive pressurisation alone to control radon ingress into a basement would be unrealistic.

30. Radon sumps are also unrealistic as a way of controlling radon in a property with a basement, as the basement itself forms a large area of low pressure in the ground. Although it is reported that radon sumps have been effective in basements, their efficacy must necessarily be erratic. With soil against up to five surfaces, it is impossible to predict with certainty where the sump system should be located to be effective, and is therefore not considered to be a reliable method since trial and error
and successive attempts may be required. Below-ground, the efficacy of a sump will be negated if it is filled with groundwater.

31. Specially designed processes have recently been developed using a modified combination of cavity drain membrane waterproofing system, positive pressurisation and sump creation within the membrane system. These processes are said to achieve waterproofing to the British Standard and effective control of radon levels in a basement without causing elevation of radon in the accommodation above. Such processes should only be designed and implemented by those capable of doing so and who are competent in the design of an effective radon management system which is compatible with waterproofing to British Standard.

32. As with any form of radon management, post-construction or post-conversion testing should be undertaken to demonstrate that radon levels are below the action level, both within the basement and the accommodation above.