

GOING UNDERGROUND: WHY RADON GAS IS A PARTICULAR PROBLEM IN BASEMENTS



Radon, the naturally occurring radioactive gas, seeps from the ground into buildings through the earth-retaining surfaces. In properties without basements the gas enters the building through the ground floor. A property with a basement, cellar or other partly-below ground area, however, will have several earth-retaining surfaces. Given the increased surface area in contact with the ground through which the gas can permeate, the potential for a property with a basement to contain high levels of the carcinogenic gas is significantly increased.

The Health Protection Agency recognises that this is the case, stating in its Environmental Radon Newsletter that "it is clear that basements have a higher radon potential than ground floors, and that high radon concentrations can be found in basements anywhere in the country, regardless of Affected Area status".

It is, therefore, necessary for any property, domestic or commercial, that has a basement to be treated in the same manner as a property located in a known radon Affected Area. Measures to control radon entry should be taken in all basements as, due to the nature of radon movement, its entry into the basement is foreseeable, even if at the present time a test reveals relatively low concentrations are present. The need for radon protection is detailed in the Building Regulations, and addressed specifically in Approved Document C. These regulations apply to both new buildings, extensions and any basement conversion works. Approved Document C is currently being reviewed, with clearer and updated guidance due to be published in 2010.

Unfortunately, most methods used to control radon gas ingress into properties without basements are unviable, at least in part, for use below-ground, due to the way in which radon is drawn into properties.

Only a small percentage of the radon within a property will have passively infiltrated from the ground and through the building material. The primary mechanism by which radon enters a building is advection; the 'sucking' of the gas from the soil to the point of lowest pressure. In the majority of cases, the pressure within a building is lower than the pressure outside or in the surrounding

soil and so the gas is actively drawn out of the ground and into the property.

Adjusting this pressure differential is one of the most successful methods of controlling radon entry; however, doing so in a property with a basement is not as straightforward as in a property without, given the number of earth-retaining surfaces.

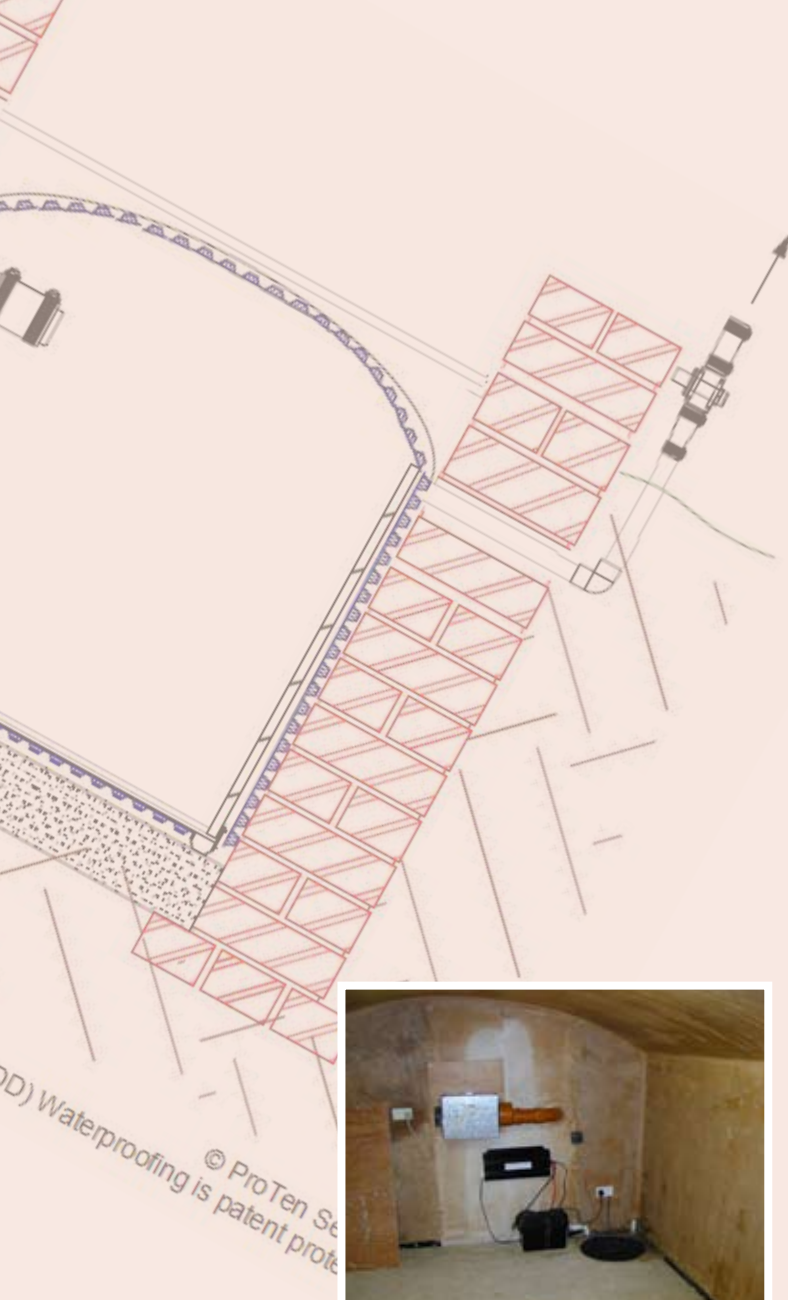
One of the most common solutions to controlling radon entry into properties without basements is to create a sump beneath the property. This void becomes the lowest point of pressure, and so the radon gas in the surrounding earth is drawn to this point, where it can then be vented out to a known safe location. It is virtually impossible to create a radon sump when the property has a basement, however, as the basement itself acts as a giant sump due to the number of earth-retaining surfaces.

Another traditional option for controlling radon entry is to install a physical barrier across the earth-retaining surfaces. If this were to be done in a basement situation, the membrane used would not only need to be certificated as radon retardant, but also as able to withstand hydrostatic pressure.

Any basement or cellar that is to be used for living or working accommodation should be appropriately waterproofed in accordance with the British Standard. The recommended method for below-ground waterproofing in BS 8102: Code of Practice for the Protection of Structures against Water from the Ground is a drained cavity drainage membrane (CDM) system. This document is also currently under review, and the revision due to be published in the coming year will include reference to radon.

Several manufacturers' CDM materials have been certificated as radon retardant; however, most have not gained certification for the jointing material, meaning that the system could not be said to fully protect against the ingress of radon. One manufacturer has had its entire CDM system certificated for radon control; however, it would be unwise and potentially dangerous to use this in isolation for the purpose of radon control for two reasons.

The first problem that would arise from solely using a membrane in the basement of a property would be that any radon in the



Given the serious consequences of exposure to high levels of radon, it must be recognised that the importance of providing radon protection in a basement is greater than for waterproofing. A system should, therefore, be chosen primarily on its radon-protection merits, but should also adhere to BS 8102. It is vital to draw a distinction between materials that are waterproof and those that are gas-proof, as instances have been observed whereby a basement is completely dry yet contains radon in excess of 6,000 bq/m³. Account must also be taken of the effect works in the basement will have on the rest of the property.

The only current method of successfully protecting a basement from radon (without elevating levels in other areas of the property) and achieving waterproofing to the required standard is patented under the name Aquis Double Defence (ADD) Waterproofing.

Developed by ProTen Services, who have over 20 years' experience in dealing with both radon and structural waterproofing, ADD Waterproofing is a unique system proven to perform. A CDM is used internally to line all earth-retaining surfaces within the basement. This provides waterproofing to BS 8102 standard and is the primary defence against radon ingress. The edges of the membrane are all completely sealed to prevent radon entry into the basement. A positive pressure unit is installed in the basement to serve two functions. Firstly, it raises the pressure of the whole building, so that the radon in the ground is not simply displaced to the ground floor accommodation. A pressure gradient is formed across all internal surfaces meaning that, should the membrane be punctured, the pressure 'buffer' will prevent gas from seeping through. Secondly, the positive pressure prevents condensation from forming in the basement, which would otherwise occur due to the membrane being sealed at all peripheries.

The final element of ADD Waterproofing is to use the air gap behind the CDM as a collection point for radon from the surrounding soil. An exhaust pipe with an inline fan then extracts the gas from behind the membrane and releases this into the air outside at a safe location away from the accommodation.

It is the combination of these techniques that enables a property with a basement to be protected from radon. Aquis Double Defence ensures that a basement area is safe to occupy, whilst other waterproofing techniques may encourage occupants to spend more time in a basement area and be exposed to high levels of the gas and also elevate radon levels in other areas of the property.

Extreme care must be taken when selecting a contractor to implement measures designed to control radon in below-ground areas. The Radon Council is the industry's independent regulatory body and holds a list of approved contractors. Whilst it is important to use a trained and competent contractor when dealing with radon in any circumstance, this becomes even more critical when a basement is involved.

Some structural waterproofing contractors have begun to make moves into this industry; however, radon is a complex issue and any persons employed to address the issue must be specifically trained to do so. Controlling radon in basements requires an acute understanding of the science involved in its movement into properties and any contractor used for such projects must be expected to demonstrate this understanding in his proposals. Upon completion of any works designed to control radon entry into a property, a test must be conducted. A test should be carried out both in the basement and in a ground floor room to confirm that the radon level throughout the property is below the Action Level.

- For further information, or to arrange a CPD seminar on the subject, please contact rebecca.kench@protenservices.co.uk or telephone 01225 447960

ground could simply find an alternative passage through the ground and ultimately still end up inside the property. This would potentially result in an increase in the radon level in the ground floor accommodation, where it is likely that the occupiers would be spending more time than in the basement.

The second drawback to using a CDM alone to prevent radon ingress into a basement is its vulnerability to defect. Unless at the very foot of the wall, a puncture in the CDM would not affect its waterproofing performance. Moisture coming through the exterior building fabric depressurises in the membrane's cavity (air gap) before trickling down to floor level, so even if the membrane is punctured, this would not result in a leak spurting out through the membrane. A puncture in the membrane would, however, affect its ability to control the ingress of radon gas, yet it would go unnoticed as radon cannot be seen, smelt or tasted.

It has been noted that some of the advice given in official guidance documents relating to radon control in basements is inaccurate and misleading. It is suggested by some that waterproofing techniques such as liquid bitumen, cementitious coatings and plastic-based coatings may be suitable for radon protection. It is widely accepted in the waterproofing industry that such techniques do not reliably prevent water penetration, due to their inability to withstand thermal movement, severe hydrostatic pressure, traffic vibration and so forth. It is, therefore, clear that a system that does not provide a barrier against liquid will certainly not provide a barrier to gas.