Radon rocks HIPs

The proposed UK home information packs have brought the problems of testing for radon in buildings to the attention of a wider audience, writes **Richard Corfield**

In recent months the UK government has received yet another bloody nose, this time over the introduction of its much vaunted home information packs (HIPs), which were supposed to simplify the process of house purchasing as well as make it cheaper. HIPs were due to be introduced compulsorily from next June but have now been made voluntary.

One of the items that was due to make a prominent appearance in the HIPs was radon gas, specifically whether it is present in sufficient concentrations to pose a health hazard.

The appearance of this particular line-item in the HIP questionnaire reflects the relatively recent appreciation that radon, a naturally occurring gas that can cause lung cancer, is far more widespread than had previously been thought. Not so long ago radon was thought to be a hazard limited to areas of Devon and Cornwall. Now it is known to be present — in varying but frequently hazardous concentrations — from Land's End in Cornwall to John O'Groats in the north of Scotland; even the sleepy shires of middle England are not immune.

Radon is a colourless, odourless gas formed as part of the radioactive decay chain as uranium, thorium or actinium transmute to other elements. There are 20 known isotopes of radon but the most common is radon-222, with a half life of 3.8 days. Radon-222 is a daughter product of radium and part of the uranium decay chain. The time required for uranium-238 to turn to lead-206 is a staggering four and a half billion years — the age of the solar system.

But what makes radon dangerous? It is a combination of four factors: its short half life, the fact that it is heavier than air and will therefore accumulate in enclosed spaces, its status as an *alpha* particle emitter, and the fact that its daughter product is a radiologically toxic solid. To paraphrase Cold War parlance, radon is 'hot'.

Breathtaking radon

As radon decays into polonium it emits an *alpha* particle. Although *alpha* particles are not very penetrative they are extremely high energy and can damage the DNA of the cells lining the alveoli of the lungs. Given the short half-life of the radon isotopes involved, the chances are relatively high that, if you live in a high radon area, such atomic transformations will occur within the lungs during the normal process of breathing. The higher the concentration, the greater the risk because radon will pool in undisturbed spaces within buildings. Finally, since polonium is a solid with a half life of almost four months it lingers within the body after decay; it cannot be exhaled and like radon it is highly toxic.

Radon comes from the ground, where its distribution is controlled by the underlying geology. This explains why radon potential fluctuates so markedly across the UK, which has one of the most varied geological terrains of any country in the world. It also explains why the British Geological Survey (BGS) is the government agency tasked with mapping the distribution of radon throughout the British Isles. In the West Country the geology is dominated by igneous rocks containing high levels of radon precursors such as uranium and its daughter products. Similarly, in the

In brief

- **The UK government's home information packs will contain a provision for radon gas**
- **The UK has set an action level for radon of 200 becquerels**
- **Accurate radon tests take three months to complete; a one week test is available**
- **Surveyors are increasingly asking for radon surveys to evaluate protection levels needed**

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Peak District, uranium — and therefore radon — tend to be at elevated levels. But strangely radon is also to be found in parts of the country where the underlying geology is not igneous but sedimentary. There is a complex band of rock that traverses the country from Somerset in the west to the Wash in the east with levels of radon that vary from low to very high — the entire gamut of the British Geological Survey's spectrum of radon loading (Figure 1).

This rock type corresponds to the outcrop of middle and upper Jurassic rocks that were the subject of intensive study by the reclusive but brilliant geologist William Jocelyn Arkell in the mid-20th century. Arkell was a scion of the Swindon-based brewing family of the same name that still makes highly successful beers to this day.

Jurassic mix

The rocks dating back to the Jurassic era are sedimentary: they were deposited on the floor of ancient ocean as particles and became compressed into sedimentary rocks by the passage of time. The majority of these particles are the dead and decaying remains of plankton that accumulate in a remorseless and melancholy rain on the seabed. However, mixed in with these particles are other components, including uranium. The uranium is effectively diluted by the other accumulating sedimentary particles so that, during times of high background sedimentation, the uranium is widely dispersed in an effectively inert matrix. Conversely, during times of low sedimentation, the uranium becomes concentrated within the resulting rocks.

During the Jurassic era the continental fragments that would eventually form the UK were much further south than today and some were covered in the waters of a shallow tropical sea. The area between Somerset and the Wash resembled the present day Bahamas — a shallow ocean studded with coral atolls around whose carbonate flanks the sediment accumulated. But this accumulation was not constant; factors such as a decrease in rainfall mean that the sediment run-off from the atolls would have decreased and when that happened the concentration of uranium and ultimately radon in the rocks increased.

Figure 1: Jurrassic rocks cause high radon levels across southern England

A glance at the BGS map of Oxfordshire shows this vividly, with certain subdivisions of the Jurassic, such as the Inferior Oolite and the Middle Lias, showing pink, indicating the highest concentration of radon. The meandering path that these outcrops take across the map reflects that fact that geological strata do not stay horizontal for long. Subsequent earth movements have tilted, folded and faulted them. Consequently, what was once a horizontal layer is now a complex trace on a geological map where its tilted edge crops out on the surface of the land.

The government has set an Action Level for radon of 200 becquerels (atomic disintegrations/m^3 of air). If the radon level is higher than this then something may need to be done. Although in existing buildings there is not yet a legislative requirement for remedial work, property buyers can insist on it. A consequence of this is that radon bonds are now becoming popular. A certain amount of money is held back by the purchaser until a test of radon levels in the home has been carried out and this is then set off against the cost of the remedial work.

The radon test

But how do we test buildings for radon? The most common method is the so-called etch-track detector. Based on a commonly used archaeological dating technique, this relies on the fact that atomic disintegrations leave microscopic scars in certain materials. For the purposes of radon testing, small lenses of spectacle plastic are left in various locations in the property — often an upstairs bedroom and the cellar — usually for a three month period. After this, the lenses are retrieved, etched with acid and examined microscopically. The number of tracks etched into the plastic is proportional to the level of atomic disintegrations in the atmosphere of the property, most of which are due to radon.

Simple, right? Not quite. The amount of time that the etch track detectors need to be left *in situ* is hotly contested among the various commercial firms that offer tests (as opposed to surveys — see below). The Health Protection Agency (HPA) recommends that the three month period be adhered to be-

'The UK has one of the most varied geological terrains in the world'

cause it gives the detectors enough time to get an accurate sample of the level of radon in a property. But few buyers are willing to delay purchase for three months and so various radon test vendors are advertising a test that 'works' in a period as short as a week. The HPA points out that radon loadings in properties can vary as a function of season, which affects the permeability of the ground underlying the property and therefore its radon flux, so a longer time course is advised.

In addition, recent research has shown that the radon flux from the ground can vary as a function of the phase of the moon so that a week is too short a time to get an accurate reading. Other testing methods that do not rely on etch-track methodology, such as direct disintegration counting, will necessarily suffer from the same limitations because of the extreme time-related variability of ground-radon levels.

Putting radon on the map

Another approach to estimating radon levels is to use geological maps to perform a radon survey. This approach is particularly suitable for new buildings where etch-track detectors will not work because there is not yet an enclosed space to measure. Put the HPA's map of actual radon levels as actually measured in homes beside the BGS's 1:625 000 scale geological map, which predicts the level of radon in homes, and there is a striking correlation (Figure 2). Using more detailed geological maps than the 1:625 000 it is possible to evaluate whether a property will require no radon protection; basic radon protection: a specially installed membrane, or full radon protection: a cavity in the sub-floor called a radon sump, which vents to the atmosphere. Since radon loadings can vary on a scale as small as a handful of metres, building control surveyors in affected parts of the UK are increasingly requesting radon surveys to establish what level of protection is required for a particular area.

However, it is important to distinguish whether you need a radon test or a radon survey. For existing buildings, radon tests are still the most accurate means of measuring existing properties because they take into account the degree of ventilation that exists within the structure, which is a major control on indoor radon levels. A radon survey is the only option if a building has not yet been erected.

'Chernobyl effect' fears

But it is important not to be hysterical about radon. Among the general public, mention of the word radiation can conjure up images of the 'Chernobyl effect' – swaths of land sealed off for generations, while teams of bulldozers labour round the clock to entomb glowing embers of deadly nuclear fuel.

Yes, radon is a health hazard but not an insurmountable one. It can be both remediated and prevented. Using the magic of the Internet, a quick *Google* search will reveal suppliers of both radon tests and radon surveys.

In the meantime, and despite the hiccups with the HIPs, radon as a factor in house-buying is likely to be here to stay. As the government might say (or then again might not): 'Get 'em while they're hot!'

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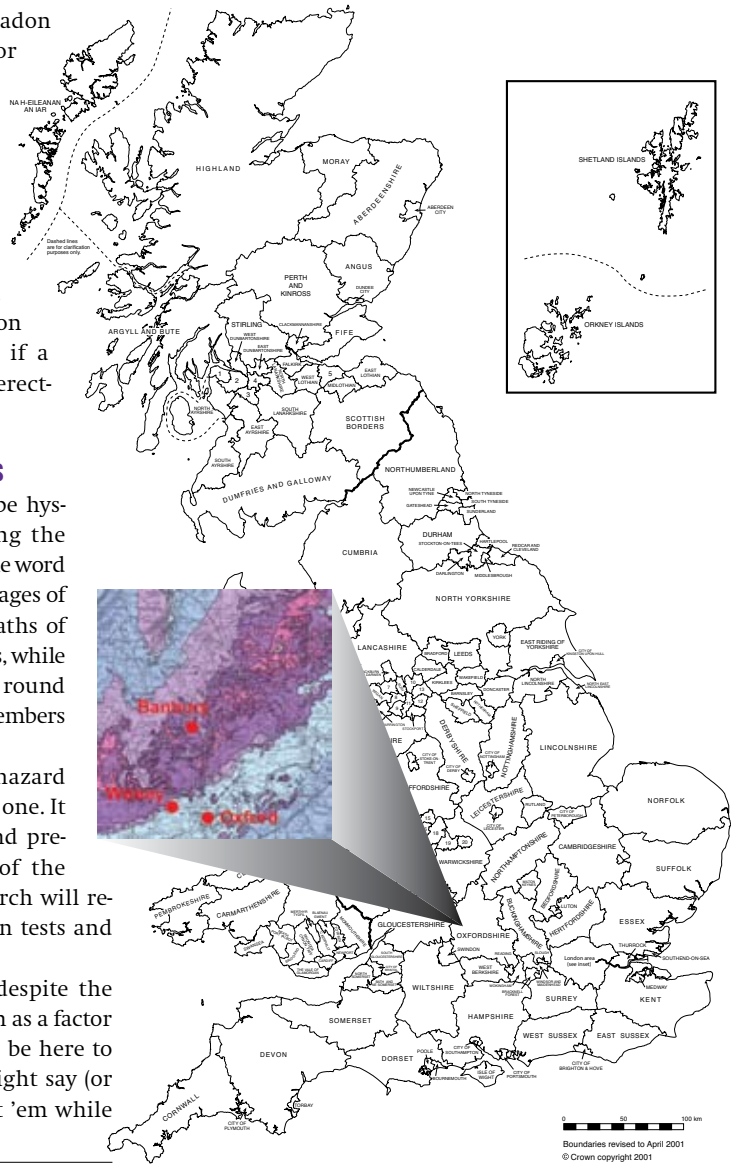

Figure 2: Radon levels fluctuate across Oxfordshire

	Radon potential class	Description	Estimated % of dwellings exceeding action level (>200 bq m^3)
	very high	Ground susceptible to very high levels of radon emissions	>10
	high	Ground susceptible to high levels of radon emissions	3-10
	moderate	Ground susceptible to moderate levels of radon emissions	1-3
	low-moderate	Ground susceptible to low levels of radon emissions but with small sub-areas susceptible to moderate or high levels of radon emissions	<1
	low	Ground susceptible to low levels of radon emissions	<1
	unclassified	Insufficent information available to estimate radon emissions