Speleological Union of Ireland (SUI) & Irish Cave Rescue Organisation (ICRO)

http://www.caving.ie/
http://www.caving.ie/publications/caving-information-pack/radon/

Radon In Caves

Radon occurs in many caves in Ireland and may represent a significant health risk to cavers who spend long periods of time underground. Radon may well lead to an increased risk of lung and throat cancers even in quite small doses.

For most people living in normal housing, radon seeping into the home throughcracks in the floor can contribute up to half the total annual dose. It is such a significant threat that in some areas of the country, where ground radon is
high, it is obligatory to fit special radon traps under the floor of new houses so that it can be ducted to outside. Some caves have been studied in detail and the results published in Irish Speleology.

The Radiological Protection Institute of Ireland (RPII) are presently providing guidelines to full-time cavers including those cavers operating as guides in some of Ireland's Showcaves. Should you wish to find out more, please contact
the RPII in Dublin.

What is Radon ?

Radon is a naturally occurring radioactive gas. It is produced by the breakdown of uranium in soil, rock and water. All rocks contain some uranium, although most contain just a small amount. Certain types of rock, including granites, dark shales, light-coloured volcanic rocks, sedimentary rocks containing phosphate, and metamorphic rocks derived from these rocks, have higher than average uranium contents.

Why is it found in Caves ?

Radon is continually seeping from the rock. In the outdoors, air currents, reducing its concentration quickly dissipate radon. Caves, on the other hand, will not generally have the same level of airflow and so radon levels can become concentrated. The main source for Radon in the Burren for example is the granite underlying the limestone. Radon is released from this and travels up through the cracks and natural fissures in the limestone to enter the cave cavity.

Radon and Radiation

In Ireland, radon is estimated to represent 50%, (i.e. 1500 microSieverts per year) of the total annual radiation dose received by each of us. It is colourless, odourless and tasteless. Radon 222 decays through a series of short
lived decay products which are radioactive isotopes of solid elements i.e. Polonium, Bismuth and Lead. Two of the short lived radon decay products are alpha particle emitters (polonium-218 and polonium-214). Following inhalation and deposition in the lungs, it is these radon decay products, rather than the gas itself, that deliver the radiation dose to bronchial tissue that is implicated in radiogenic lung cancer.

(ref: Madden, J., Radon in Ireland: an Overview.,Radiological Protection Institute of Ireland, 3 Clonskeagh Square, Clonskeagh, Dublin 14)

Radon studies

As with all pollutants, there is some uncertainty in estimating health risks associated with radon. Radon risk estimates are based primarily on scientific studies of humans following the Hiroshima and Nagasaki atomic bombings and also miners exposed to different levels of radon in their underground work.
Scientists are considerably more certain of radon risk than they are of estimates that are based solely on animal studies. Historically, the existence of a high mortality among miners in central Europe was first recognised in the
early 16th century. It was not until the 19th century that the cause was identified as lung cancer and in 1924 it was attributed to radon gas exposure. Radon's role significance was not identified until the 1950's.

What risk is the caver taking ?

In 1994, the International Commission on Radiological Protection recommended the adoption of a risk factor equivalent to a lifetime risk of death of 0.0001 for chronic exposure to a radon gas concentration of 1 Bq m-3. On this basis, the estimated risk of contracting fatal lung cancer as a consequence of exposure to
200 Bq m-3 is about 2 in 100.

The risks associated with recreational and professional cavers visiting a cave with radon gas concentrations of the order of 7000 Bq m-3 are as follows:

Recreational Caver

Based on 50 hours per year caving.
Estimated annual radiation dose = 1600 microSievert per year. Lifetime risk of premature death from lung cancer = 1 in 12500.

Professional Caver

Based on 600 hours per year caving.
Estimated annual radiation dose = 20,000 microSievert per year. Lifetime risk of premature death from lung cancer = 1 in 1000.

It should be noted that the levels of radon radiation vary in the same location according to the time of year. This can be mainly attributed to the movement of air in and out of the cave, being less so in winter.

Putting this in perspective

The UK National Caving Association Radon Working Group have estimated, on the basis of fatalities in Britain, the risk of death for a recreational caver. Death from an accident during a single caving trip is of the order of 1 in 40,000. They claim that there are about 10,000 recreational cavers, each taking
about 10 caving trips per year, and that in the period 1982-1993 there were 25 fatalities whilst caving. This fatality figure excludes cave diver fatalities.

It is also possible to estimate a ‘ball park’ figure for the lifetime risk of death associated with a single 4 hour trip to a cave with a known radon gas concentration. For a cave where the radon gas concentration is approximately
7000 Bq m-3 then the lifetime risk of premature death from lung cancer, as a consequence of a single exposure, for 4 hours, is approximately 1 in 150,000. What this figure tells us is that the estimated risk of premature death over your lifetime , following a single cave trip in a cave with this radon gas concentration, is about 1/3 to 1/4 the estimated risk of death following an accident during the cave trip.

The estimated dose received by the professional caver in the example above is the same as the maximum permissible radiation dose received by a nuclear radiation worker. Few nuclear industry workers receive radiation doses of this magnitude. In effect radiation workers would not be allowed to work in such an environment for more than 5 years, if they were receiving annual doses of this magnitude.