ON THE MANAGEMENT OF THE INDOOR RADON PROBLEM IN BELGIUM

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The reference value of 63 Bqm^{-3} for radon in Belgium is comparable to the results obtained in neighbouring countries. There exists a significant distinction between the north of the country (average 48 Bqm^{-3}) and the south (average 85 Bqm^{-3}), where much higher concentrations are regularly found. This can be explained mainly by differences in the geology of the underlying soil. The very high concentrations of the order of thousands of Bqm^{-3} found on some occasions raise the problem of remediation. In collaboration with the inhabitants and the local authorities the effect of different techniques are actually being tested and the results will be followed-up.
The risk assessment based upon uranium miner studies leads to an estimation of the etiological fraction for radon of the order of 10 to 30%. As the extrapolation technique for low doses is a matter of controversy, an epidemiological study of the case-control type was set-up by the end of 1987. The preliminary results of this pilot study, indicate a significant increase in risk for the group of the exposed (> 100 Bqm^{-3}) current smokers and non smokers compared to the corresponding non-exposed reference groups (odds ratio resp. 5.2 and 8.6) while for ex-smokers no effect was observed.

INTRODUCTION

The wide-spread use of nuclear technology in our modern society gave rise to great concern about the risks related to the application of artificial radioactivity.
For most of the general population however, the major part of the annual dose from ionising radiation is caused by natural radioactivity. Last years more research is conducted about radon, as it became clear that up to 40% of the total annual effective dose to the population from natural origin is due to radon (1). As part of the C.E.C. research programme on radon an inventory has been made of the indoor radon situation in Belgium. Relying on the lung cancer risk estimates obtained in miner studies, some 10 to 30% of all lung cancers are expected to be caused by radon (2). However extrapolation from high mine levels to low indoor levels and from mine to residence conditions introduces great uncertainties. Some direct epidemiological evidence was gained through a hospital based case-control study. The results as they are available for the moment show a clear increase in risk for the current smokers and the non smokers. No significant effect was observed among ex-smokers.

THE BELGIAN RADON SITUATION

Since more than 5 years the indoor radon situation is being monitored through general and local measurement campaigns. In all the surveys the exposure levels are determined by means of six-months measurements with Karlsruhe-type alpha track-etch detectors (3). The results can remarkably well be divided up into two categories according to geological features. In zone I (fig. 1), corresponding to the northern part of the country, including the extreme southern region as well, the covering soil layer consists mainly of sand and loam and is rather thick, while the primary stone layers are situated at great depth.

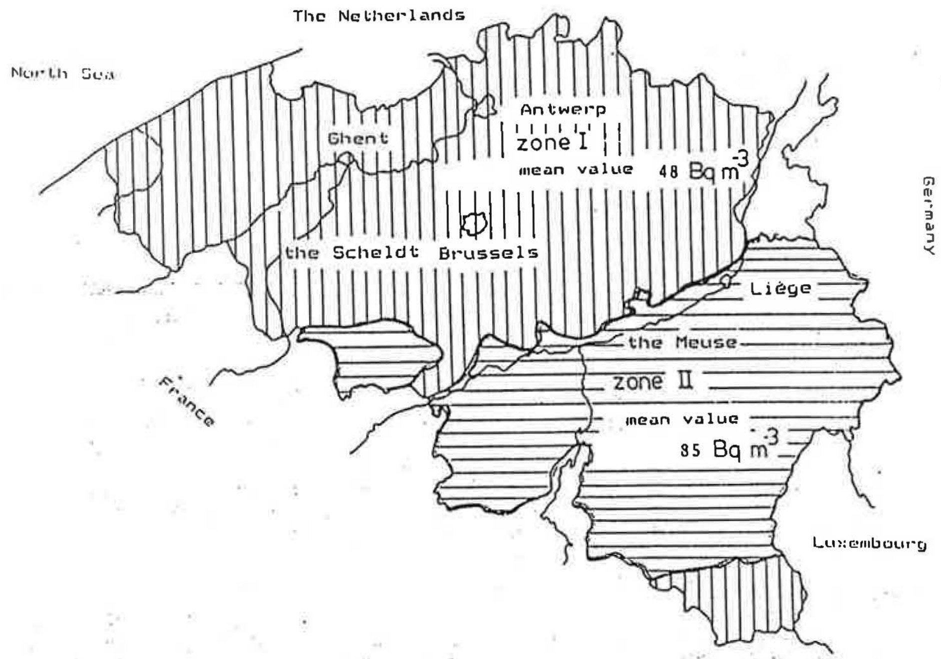

Fig. 1 : Major geological division of Belgium

In this zone the exposure levels are in general low and no great variation is observed (Table I). The highest values are found in the valleys were the upper layers have been eroded. In zone II on the contrary, the primary rock-formations appear much closer to the surface, giving rise not only to a much higher average value, but also to a much greater variation in exposure levels (Table I). At some places were this layer pierces out, extreme high radon concentrations of the order of thousands of Bqm^{-3} have been observed.

Table I : Regional radon distributions in Belgium

Geological Zone	Median (Bqm^{-3})	Mean (Bqm^{-3})	90%-value (Bqm^{-3})	Maximum (Bqm^{-3})
Zone I	32	48	66	300
Zone II	52	85	135	> 4000

Through the systematic analysis of the exhalation characteristics of most commonly used building materials in Belgium (Table II) it became also clear that high radon concentrations can never be explained by the contribution of these products.

Table II : Exhalation and specific activity of common used building materials

Type	Exhalatie-rate (mBq/kg*h)	Specific activity (Bq/kg) min.	mean	max
Bricks	4	15	34	85
Concrete	30	<10	20	60
Phosphogypsum blocks	600		450	
Phosphogypsum board	400	330	440	850

Whatever the outcome of detailed risk estimates may be, concentrations of several thousands of Bqm^{-3} will always require direct remediation. As there exists for the moment no national or regional radon action plan in Belgium, the interventions performed up to now were only possible through the voluntary collaboration of local authorities and the involved inhabitants. The spectacular reduction in exposure obtained through the installation of a subfloor ventilation system appears quite clearly in the radon levels measured at different locations in the dwelling, before and after the action (Table III).

Table III : Radon levels before/after installation subfloor ventilation system

Location	Before (Bqm^{-3})	After (Bqm^{-3})
cellar	15000	380
ground floor	1500	120
1st floor	760	220

As these interventions in existing houses are quite expensive (1000 à 2000 US$) a building code should first of all be worked-out for new houses in the southern area, in order to reduce (or prevent) at minimum cost the infiltration of radon bearing soil gas.

RADON EPIDEMIOLOGY

Although the miner based risk estimates demonstrate clearly the non neglectable role of indoor radon in the etiology of lung cancer, there is still great need for direct epidemiological evidence. Up to now only small-scale studies among the population (mainly in Sweden) have been organised (4). In preparation of the so-called "Ardennes and Eifel" study (5), a large-scale multi-center study with participants of research groups in Belgium, France, Germany, Luxemburg and the U.K. and aimed at collecting complete information about 1500 cases and 4500 controls, a pilot study was set-up in the Belgian Ardennes during 1988-1989. The main purpose was to test the feasibility of this kind of approach. The project was a hospital based study including only incident cases and controls resident for at least 25 years at their present address. Patients fulfilling this criterium were interviewed during their hospital stay by a co-worker about other lung cancer determinants as occupational exposure, active and passive smoking, diet and psycho-social factors. Shortly after the questionning an alpha track-etch detector was installed in the living/kitchen and bedroom of the patients and left in place for a period of six months. During this visit details concerning life-style and house construction were registrated and the answers to the different topics of the questionnaire were checked on their consistency and reliability. Complete information was gathered about 64 cases and 184 controls. The analysis of the yet incomplete data indicate a significant increase in lung cancer risk for the current and non smoking subgroups (Table IV), while no indications could be detected for the two considered categories of ex-smokers.

Table IV : Relation radon-lung cancer

Smoking status	Exposure category (Bqm^{-3}) 0-100	> 100
Current Smoker (quit max. 2y)		
CA	16	8
CO	42	4
Odds Ratio	1.0	5.3
95% Conf. interval		(1.4 - 19.7)
Ex-Smoker (quit >2-9y)		
CA	8	3
CO	18	10
Odds Ratio	1.0	0.7
95% Conf. interval		(0.2 - 3.1)
Ex-Smoker (quit >9y)		
CA	7	2
CO	18	7
Odds Ratio	1.0	0.7
95% Conf. interval		(0.1 - 7.7)
Non-Smoker		
CA	2	3
CO	23	4
Odds Ratio	1.0	8.6
95% Conf. interval		(1.1 - 68.9)

The major conclusions from this pilot study were the feasibility of the set-up and the restricted entry-rate (25%) caused by the residence criterium. Therefore in the further development of the European coordinated project more than one house per subject will be measured on radon.

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