RADON EXPOSURE VERSUS EXPOSURE TO OTHER SOURCES OF IONISING RADIATION

H. Vanmarcke and J. Paridaens

Belgian Nuclear Research Centre, SCK•CEN, Radiation Protection Department
Boeretang 200, B-2400 Mol, Belgium
Tel: +32 14 332829; Fax: +32 14 321056; E-mail: hvanmarc@sckcen.be

INTRODUCTION

The purpose of this contribution is to situate the radon issue within the whole field of radiation protection. There is among health physicists a fairly general consensus that exposure to radon decay products constitutes the largest and most variable contribution to the population exposure. It is therefore ironical that precisely this exposure is the subject of constant disputes with regard to the validity of the risk estimates and to the desirability of inciting the population living in radon prone areas to take action. At the forefront of the discussion is the different perception of the radon risk by the population but also by many experts. The apathy for the radon risk has to do with the nature of the risk:

- Nature and not man is responsible for the risk (good mother nature). This is why the radon risk is perceived much smaller than for instance the risks associated with nuclear power plants or nuclear waste, although the effective doses show a completely inverse picture. (The effective dose is by definition supposed to be proportional to the stochastic risks of ionising radiation.)
- Most of the exposure takes place at home and not at work (in your home you will find tranquility and a sense of security). There is moreover no one to blame except the ordinary citizen who has unknowingly increased his risk by applying generally accepted building techniques.

THE TOLERANT ATTITUDE AGAINST EXPOSURE TO NATURAL RADIATION SOURCES AND RADON EXPOSURE IN PARTICULAR IS REFLECTED IN THE NATIONAL AND INTERNATIONAL REGULATIONS

For the purpose of illustration, the exemption levels for solid, liquid and gaseous discharges and the dose constraints for discharges of nuclear power plants are compared to the action levels for radon gas in dwellings.

Exemption levels for solid waste

The European Basic Safety Standards Directive (EU-BSS, 1996) contain tables for the exemption of radioactive substances from the requirements for reporting and obtaining prior authorisation. The exemption levels are derived from the following criteria:

1. In normal circumstances, the effective dose of any member of the public is limited to 0.01 mSv/y;
2. In accidental situations, the probability of an effective dose of 1 mSv/y may not exceed 10^{-2}/y;
3. The impact on the population as a whole is restricted to 1 man-Sv per year of practice.
Exemption levels for liquid and gaseous discharges

These levels are based on the individual dose limit of 1 mSv/y. The concentrations are derived directly from the annual limit of intake using conservative dilution and consumption hypothesis.

Dose constraints for discharges of nuclear power plants

The authorised discharge limits generally adopted are drawn from the US legislation (US NRC, 1993). The adopted design objectives in terms of maximum annual doses are:

1. Liquid discharges: 0.03 mSv/y to the whole body, 0.1 mSv/y for each organ;
2. Gaseous discharges: noble gases 0.05 mSv/y whole body, iodine and aerosols 0.15 mSv/y for each organ.

Action levels for radon

According to ICRP Publication 65 (1993) people can receive 3 to 10 mSv/y at work and another 3 to 10 mSv/y at home without any incentive to apply remedial measures. The corresponding radon concentrations are 200 to 600 Bq/m³ in dwellings and 500 to 1500 Bq/m³ at workplaces. These concentrations are much higher than the natural background. Indeed, depending on geological and meteorological circumstances, only 10 to 100 Bq/m³ is unavoidable.

Moreover, in deriving the lung cancer risk, the ICRP has not followed the classical approach based on the dosimetric model of the respiratory tract (ICRP 66, 1994) but has instead developed a specific approach based on the epidemiology of radon in mines which results in a two to four times lower dose conversion factor (designated as a conversion convention). Sensitivity analysis (Marsh and Birchall, 1998) indicates that the difference between the dosimetric and epidemiological approach can not be explained by uncertainties in the parameters of the lung model. The implication is that there may be systematic errors in at least one of the ICRP recommended values for the risk-weighting factors:

- $W_R$: the radiation weighting factor of 20 for alpha particles;
- $W_T$: the tissue weighting factor of 0.12 for the lungs;
- the total detriment at high dose rate of 0.112 Sv⁻¹;
- DDREF: the dose and dose-rate effectiveness factor of 2.

There are three orders of magnitude between the exemption of solid waste, 0.01 mSv/y and the exempted exposures of radon at home, and at work 3 to 10 mSv/y. The ICRP and the radiation protection community accept in one area what is considered unacceptable in other areas. This approach is in line with the difference in risk perception among the general public, for instance between exposure to natural sources of ionising radiation and exposure to artificial sources.

Another example of the tolerant attitude against natural radioactivity can be found in the European Basic Safety Standards Directive (EU-BSS, 1996) by calling some of the "ICRP 60 practices" work activities. Certain minerals contain significant levels of the naturally occurring uranium and/or thorium decay series in conjunction with elevated quantities of other elements for which they are extracted. Processing of these materials may lead to selective concentration of certain radionuclides in by-products, residues and end-products causing enhanced exposure to ionising radiation of
workers or members of the public. As these human activities increase the overall exposure to radiation they should, according to ICRP publication 60 (1991), be classified as practices.

The European Basic Safety Standards Directive (EU-BSS, 1996) deviates from ICRP 60 because some of the "ICRP 60 practices" are called work activities. Indeed, the Directive makes distinction between practices, which are functional applications of ionising radiation, such as the use of natural radionuclides in view of their radioactive, fissile or fertile properties, and work activities where the unintentional presence of natural radioactivity lead to a significant increase in the exposure of workers or members of the public.

The reason for the separate treatment is the realisation of the fact that the stringent regulation of artificial radioactivity cannot be applied to the extremely international non-nuclear industry.

The provisions on work activities are given in Title VII of the Directive. The control regime for protecting workers and members of the public from exposures arising from work activities is very general and almost entirely left to the Member States. The Directive states that the Member States should identify, by means of surveys or by any other appropriate means, work activities which lead to a significant increase in the exposure of workers or members of the public. When identified, the Member States should set up appropriate means for monitoring exposure and if necessary apply all or part of the system of radiological protection.

Offering flexibility for the Member States, so that they can take national circumstances into account, will result in different decisions for similar exposure situations. The economical implications of these decisions can influence the profitability of the industry and may lead to unacceptable differences in competitive position between Member States. The European Union is aware of this problem and has recently published a document providing technical guidance to national authorities for the implementation of Title VII (EU, 1997).

REFERENCES


