ICRP radon dose coefficients

Summary

ICRP recommends a system of radiological protection and also calculates and publishes dose coefficients for use in the implementation of the system of protection. For inhaled radon-222 and progeny, a dose coefficient of 3 mSv per mJ h m\(^{-3}\) (approximately 10 mSv per WLM) is recommended for most circumstances of exposure in workplaces, equivalent to 6.7 nSv per Bq h m\(^{-3}\) using an equilibrium factor of 0.4. ICRP has further indicated that the same value will apply to exposures in homes. If circumstances of occupational exposure warrant more detailed consideration and reliable alternative data are available, site-specific doses can be assessed using methodology provided by ICRP. The International BSS reference levels of 300 Bq m\(^{-3}\) for homes and 1000 Bq m\(^{-3}\) for workplaces correspond to 14 mSv and 13 mSv per year, respectively, using this dose coefficient. Reviews of available epidemiological and dosimetric data support the use of ICRP data as central rather than conservative values.

Development of ICRP dose coefficients for radon

ICRP publishes extensive sets of equivalent and effective dose coefficients for radiological protection purposes, considering exposures to external sources and the inhalation or ingestion of radionuclides by workers and members of the public. Uniquely, for inhalation of radon-222 and progeny, ICRP has used the “epidemiological approach” to calculate dose coefficients, also called the “dose conversion convention”. ICRP Publication 65 used a lifetime lung cancer risk from radon of 2.83 \(\times 10^{-4}\) per WLM and ICRP Publication 60 (ICRP 1991) detriment values to calculate dose conversion values of 5 mSv per WLM for workers and 4 mSv per WLM for the whole population. ICRP Publication 115 (ICRP, 2010) provided an updated review of epidemiological data and, focusing on more recent data and lower levels of exposure, a revised value for lifetime lung cancer risk of 5 \(\times 10^{-4}\) per WLM was proposed. In a statement issued in Publication 115, ICRP took account of this change and lowered its upper reference level for radon in homes to 300 Bq/m\(^{3}\) from the value of 600 Bq/m\(^{3}\) given in the 2007 Recommendations (ICRP, 2007). Taking account of the different lengths of time spent in homes and workplaces, a level above which the requirements of occupational protection would apply was set at 1000 Bq/m\(^{3}\). ICRP also indicated its intention to in future calculate dose coefficients for radon isotopes in the same way as for all other radionuclides, using biokinetic and dosimetric models.

ICRP Publication 137 (ICRP, 2017) is the third part in a series of reports providing dose coefficients and associated data for occupational exposures to radionuclides, and includes radionuclides of radon. For inhalation of \(^{222}\)Rn and progeny, the values calculated were 3.3 mSv per mJ h m\(^{-3}\) (12 mSv per WLM) for mines, 5.7 mSv per mJ h m\(^{-3}\) (20 mSv per WLM) for indoor workplaces and 6.7 mSv per mJ h m\(^{-3}\) (24 mSv per WLM) for the specific case of tourist caves. In these calculations, the reference worker is assumed to spend two-thirds of the time in exercise. Using a more realistic breathing rate for sedentary occupations such as office work gives a dose coefficient of 4 mSv per mJ h m\(^{-3}\) (14 mSv per WLM). Using the same methodology, the dose coefficient for homes will also be about 4 mSv per mJ h m\(^{-3}\) (14 mSv per WLM). For comparison, use of the epidemiological dose conversion approach, using a risk coefficient of 5 \(\times 10^{-4}\) per WLM and stochastic detriment values from the 2007 Recommendations (ICRP, 2007) gives dose coefficients of 3.3 mSv per mJ h m\(^{-3}\) (12 mSv per WLM) for adults and 2.5 mSv per mJ h m\(^{-3}\) (9 mSv per WLM) for the whole population.
Noting that inhaled $^{222}\text{Rn}$ and progeny is a special case for which there is good epidemiology as well as dosimetry, and taking account of the two methods of calculation of dose coefficients with their associated uncertainties, ICRP recommend a single rounded value for use in most circumstances of occupational exposure of 3 mSv per mJ h m$^{-3}$ (approximately 10 mSv per WLM), equivalent to 6.7 nSv per Bq h m$^{-3}$ applying an equilibrium factor of 0.4. ICRP has also indicated that this value is applicable to exposures in homes. Using this dose coefficient, the reference level of 300 Bq / m$^3$ corresponds to 14 mSv per year for homes (7000 hours). The value of 1000 Bq / m$^3$ referred to in the BSS (IAEA, 2014) for occupational exposures corresponds to 13 mSv per year (2000 hours).

For occupational exposures to radon in which conditions such as aerosol characteristics are significantly different from the reference conditions, where estimated doses warrant more detailed consideration, and reliable data are available, it is possible to calculate site-specific dose coefficients using data provided by ICRP. A second higher value of 6 mSv per mJ h m$^{-3}$ (approximately 20 mSv per WLM) was referred to in ICRP Publication 137 - this may be seen as an example of requirements for more specific calculations when warranted.

Dose coefficient for the inhalation of thoron ($^{220}\text{Rn}$) progeny were given in Publication 137 for mines and indoor workplaces: 1.4 mSv per mJ h m$^{-3}$ (4.8 mSv per WLM) and 1.6 mSv per mJ h m$^{-3}$ (5.6 mSv per WLM), respectively. On the basis of these calculations, a single rounded value was recommended of 1.5 mSv per mJ h m$^{-3}$ (5 mSv per WLM) for all situations of exposure. As in the case of inhalation of $^{222}\text{Rn}$ progeny, data are provided for site-specific calculations should these be warranted.

References


ICRP, 1993. Protection against radon-222 at home and at work. ICRP Publication 65; Ann ICRP 23(2).

