

Environmental Dosimetry – Measurements and Calculations

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1. Introduction

According to UNSCEAR (2008) the largest contribution to external exposure comes from naturally occurring, gamma-emitting, radioactive elements in the ground. Apart from ^{40}K , these elements are members of the decay chains starting with ^{238}U and ^{232}Th , respectively. Both of these radionuclides have half-lives comparable to the age of the earth and have been present in the earth's crust since its formation. The half-life of ^{40}K is of the same order of magnitude. However, nuclear weapons fallout and debris from accidents at nuclear facilities may at some sites contribute even more to the exposure.

Calculation of the external dose rate from field gamma spectrometric measurements requires knowledge of how the primary fluence rate, *i.e.* the number of unscattered photons per unit area and time, from different distributions of radioactive elements, at or in the ground, affects the detector response. Likewise, determination of external dose rate based on gamma spectrometry of soil samples must include a calculation of the primary fluence rate from the actual soil inventory.

The main topic of this chapter is to describe, and compare, some of the methods that can be used to estimate external dose rate from environmental sources of ionizing radiation from radioactive elements. The external dose rate from radioactive sources at or below ground may be estimated in several ways. One method is to simply measure the dose rate with a properly calibrated intensimeter or other type of dose meter (*e.g.* ionization chamber or thermoluminescent dosimeter, TLD). Another method is to calculate the dose rate based on gamma spectrometric measurements, *e.g.* field gamma spectrometry or soil sampling. However, due to assumptions of the relation between primary and scattered radiation, as well as calibration requirements, the dose rate estimations from these methods seldom agree in practical situations. The topics mentioned above will be exemplified with reference to actual measurements by field gamma spectrometry and intensimeter, as well as model calculations of fluence rates from different environmental geometries.

2. Primary fluence rate from different source geometries

The quantity fluence has been defined by the International Commission on Radiation Units and Measurements, ICRU, (ICRU, 1998) as $\Phi = dN/da$, *i.e.* the number of particles per unit area. According to the definition, dN is the number of particles (here photons) incident on

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