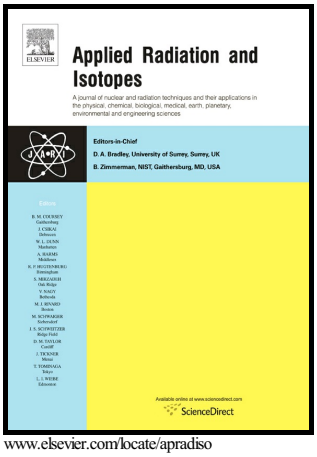

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Effective Dose Calculation Program (EDCP) for the Usage of NORM-added Consumer Product

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Abstract

The aim of this study is to develop the Effective Dose Calculation Program (EDCP) for the usage of Naturally Occurring Radioactive Material (NORM) added consumer products. The EDCP was developed based on a database of effective dose conversion coefficient and the Matrix Laboratory (MATLAB) program to incorporate a Graphic User Interface (GUI) for ease of use. To validate EDCP, the effective dose calculated with EDCP by manually determining the source region by using the GUI and that by using the reference mathematical algorithm were compared for pillow, waist supporter, eye-patch and sleeping mattress. The results show that the annual effective dose calculated with EDCP was almost identical to that calculated using the reference mathematical algorithm in most of the assessment cases. With the assumption of the gamma energy of 1 MeV and activity of 1 MBq, the annual effective doses of pillow, waist supporter, sleeping mattress, and eye-patch determined using the reference algorithm were 3.444 mSv $year^{-1}$, 2.770 mSv $year^{-1}$, 4.629 mSv $year^{-1}$, and 3.567 mSv $year^{-1}$, respectively, while those calculated using EDCP were 3.561 mSv $year^{-1}$, 2.630 mSv $year^{-1}$, 4.740 mSv $year^{-1}$, and 3.780 mSv $year^{-1}$, respectively. The differences in the annual effective doses were less than 5%, despite the different calculation methods employed. The EDCP can therefore be effectively used for radiation protection management in the context of the usage of NORM-added consumer products. Additionally, EDCP can be used by members of the public through the GUI for various studies in the field of radiation protection, thus facilitating easy access to the program.

KEYWORDS: EDCP, GUI, NORM, consumer products, equivalent dose, effective dose, Monte Carlo simulation, database, computational human phantom

Introduction

In 2012, the Act on Protective Action Guidelines Against Radiation in the Natural Environment was enacted to expand the scope of radiation safety management and to manage domestic circulation of the natural radioactive materials, also called Naturally Occurring Radioactive Material (NORM) in Korea [1]. Especially, the law includes safety management of NORM-added consumer products that are frequently used in day-to-day life, such as eye-patches, waist supporters, bracelets, and sleeping mattresses, etc. High levels of radioactivity in consumer products could cause unwanted radiation exposure to the general public. In this regard, to investigate the potential hazard of products, the International Atomic Energy Agency (IAEA) established a radiation safety act to regulate consumer goods [2]. To understand the potential hazard of NORM, the research group in Korea, LEE et al. and Jang et al. reported the risks of products containing NORM by measuring the radioactivity with High Purity Germanium (HPGe) detectors [3] [4]. Moreover, Yoo et al. suggested a method to evaluate the annual effective dose, which uses full models of NORM, including artifacts, based on Monte Carlo (MC) simulation employing the International Commission on