Development of a function calculating internal dose coefficients based on ICRP 2007 Recommendations

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1 Introduction

Current Japanese regulatory standards for radiation protection against internal exposures are established based upon committed effective dose coefficients in accordance with 1990 Recommendations of the International Commission on Radiological Protection (ICRP) [1]. There are three kinds of standards: derived air concentrations for work places, and concentration limits for exhaust and drainage from facilities. Therefore, dose coefficients for workers and age dependent dose coefficients for members of the public based upon 2007 Recommendations of ICRP [2] are necessary to fit the standards to the 2007 Recommendations.

ICRP have been publishing a series of publications about occupational intakes of radionuclides (OIR) [3-5] and a data base recording new dose coefficients for workers, OIR Data Viewer [4]. As of April 2018, dose coefficients about 28 elements have been released. However, there are some nuclides which are listed in the Japanese standards, and which are not included in neither the publications nor the data base. In addition, a domestic technical basis of internal dose estimation is important to consider various conditions: characteristics of Japanese, specifics of radiation accidents, for example. On these backgrounds, the authority decided to develop a computation code for internal dosimetry based on 2007 Recommendations of ICRP as a public offering four-year project from 2017, and then Japan Atomic Energy Agency (JAEA) is in charge of this project. The code is planned to have two major functions: calculation of dose coefficients and estimation of intake amount from monitoring data. This paper describes the development of the former function.

2 Overview of the function

A programming language, Java, is adopted to develop the code because Java applications are executable on multiple operating systems. The function calculating committed effective dose coefficients, e (Sv Bq^{-1}), uses a dosimetric methodology summarized in OIR part 1 [3]. Figure 1 shows a flow chart of the function. This function calculates e from basic models and data: nuclear decay data [6], specific absorbed fractions (SAFs) [7], biokinetic models [3-5], and radiation weighting factors and tissue weighting factors [2, 3], as shown in Figure 1. In calculating radiation weighted S values, S_w (Sv), Piecewise Cubic Hermite

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Interpolating Polynomial (PHICP) [8] is used to interpolate the SAFs by radiation energies. In calculating activities and committed equivalent doses, Livermore Solver for Ordinary Differential Equations (LSODE) [9] is applied to solve numerically ordinary differential equations about time dependent changes in activities and equivalent dose rates. To unify the programming language used in the code, the solver packages of PCHIP and LSODE written in Fortran were translated to Java by JAEA; the names of the translated packages are J-PCHIP and J-LSODE. Element specific systemic data are prepared about 14 elements described in OIR part 2.

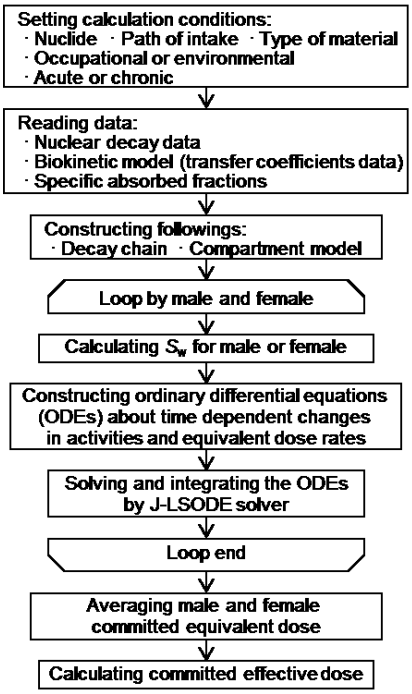

Figure 1. Flow chart of a function calculating committed effective dose coefficients.

3 Quality assurance of the function

Calculation results of e by the function were compared to the values of e recorded in OIR Data Viewer ver. 2.17.10.17 [4]. The number of intake patterns was 454 for 101 kinds of radionuclides. In 426 cases, the values by the function were consistent with the reference values in two digits which is the number of digits of the values recorded in the viewer. In the residual 28 cases, the differences were only 1 in the second digit. These differences can be explained by rounding errors. Consequently, the quality of the function was assured for the 14 elements. However, the nuclides which emit alpha particle, or decay by neutron fission fragments are not included in the 14 elements. Therefore, an additional quality assurance plan will be necessary in the future.

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