User's Manual of DDCC: Databases of Dose Conversion Coefficient

I. INTRODUCTION

The fluence-to-dose conversion coefficients are essential quantities in the shielding design of nuclear facilities and accelerators as well as the evaluation of cosmic-ray doses for aircrews and astronauts. DDCC, Databases of Dose Conversion Coefficient, are EXCEL files that contain numerical values of the dose conversion coefficients for varieties of particles over wide energy ranges. In addition, they have a function to make a plot of the data for 4 user-specified conditions. DDCC are opened for public via its web site whose URL is given below.

The dose conversion coefficients contained in DDCC were calculated using the Particle and Heavy Ion Transport Code system PHITS [1] and the ICRP/ICRU adult reference computational phantoms [2], following the instruction given in ICRP103 [3]. The detailed description of the calculation procedure and the discussions on the results were published in Ref. [4,5]. This manual presents the list of the dose conversion coefficients contained in DDCC, together with the instruction for making a plot of the data.

URL: http://phits.jaea.go.jp/ddcc/

II. DATA CONTAINED IN DDCC

The list of the dose conversion coefficients contained in DDCC is summarized in Table 1. The databases include the conversion coefficients not only for absorbed doses but also for dose equivalents, which can be calculated from the probability densities of doses in terms of LET and lineal energy y coupled with the $Q(L)$ and $Q(y)$ relationships defined in ICRP60 [6] and ICRU40 [7], respectively. The energy ranges covered by the databases are from 1 meV to 100 GeV for neutrons, and from 1 MeV/n to 100 GeV/n for the other particles. The data for the conventional 6 irradiation geometries: anterior-to-posterior (AP), isotropic (ISO), posterior-to-anterior (PA), left-lateral (LLAT), right-lateral (RLAT) and rotational (ROT) are contained in the databases, although data for some irradiation geometries are missed in the neutron and heavy-ion data. For each energy and geometry, the databases include the conversion coefficients for the effective doses as well as the doses in 28 organs or tissues for both male and female, which are indispensable for estimating the effective dose. The numerical values of w_R and w_T defined in ICRP103 [3] were employed in the derivation of the effective dose and the effective dose equivalents from the organ doses and their dose equivalents, respectively.

In the database for heavy ions (DDCC-heavyion.xls), these data are tabulated in the worksheets with the name of the symbol of the element such as “Li7” and “Fe56”, while they are done in those with the name of the irradiation geometries such as “AP” and “ISO” in the other files. The standard deviations (%) of each data are also included in the databases for neutron, proton, He, C, Si and Fe ions. Note that the standard deviations of the data for the other ion species were not calculated, and they are expected to be approximately 2 times higher than the corresponding data for one of the He, C, Si and Fe ions with the closest charge number.

III. MAKING PLOT

DDCC have a function to make a plot of the dose conversion coefficients for 4 user-specified conditions in the worksheet named “plot”. Figure 1 shows a snapshot of the worksheet “plot” in DDCC with some instructions for making a plot for the dose conversion coefficients. The plot data can be specified by selecting the 4 parameters listed in lines 8-11: “dose type”, “ion species” or “irradiation geometry”, “tissue or organ” and “gender”. The meanings of each parameter are as follows:

1. *Dose Type* (Line 8): Select the dose type of the plot data from dose, $Q(L)$-based dose equivalent, and $Q(y)$-based dose equivalent. If you select "No Plot", no data are shown in the graph.
2. *Ion Species* or *Irradiation Geometry* (Line 9): Select the ion species of the plot data in the case of DDCC-heavyion.xls, or select the irradiation geometry from AP, ISO, PA, LLAT, RLAT and ROT for the other cases.
3. *Tissue or Organ* (Line 10): Select the tissue or organ of the plot data. If you would like to plot the effective dose or effective dose equivalent, select "Effective" in this column.
4. *Gender* (Line 11): Select the gender of the plot data. If you select “Effective” in the upper column (line 10), the selection of this parameter does not influence the plot data.

The dose conversion coefficients for the specified conditions are plotted in the graph, and their numerical values are shown in the columns of the lines below 38 and the rows painted by similar colors to the corresponding symbols in the graph.

IV. CONTACT

If you have any questions or requests for these databases, please E-mail to nsed-expacs@jaea.go.jp

REFERENCES

[1] K. Niita, T. Sato, H. Iwase, H. Nose, H. Nakashima and L. Sihver, "Particle and heavy ion transport code system; PHITS" *Radiat. Meas.* **41**, 1080-90 (2006). http://phits.jaea.go.jp

[2] ICRP, Adult reference computational phantoms, *ICRP Publication 110* (2009).

[3] ICRP, The 2007 Recommendations of the International Commission on Radiological Protection, *ICRP Publication 103* (2007).

[4] T. Sato, A. Endo, M. Zankl, N. Petoussi-Henss and K. Niita, "Fluence-to-dose conversion coefficients for neutrons and protons calculated using the PHITS code and ICRP/ICRU adult reference computational phantoms", *Phys. Med. Biol.* **54**, 1997-2014 (2009).

[5] T. Sato, A. Endo and K. Niita, "Fluence-to-dose conversion coefficients for heavy ions calculated using the PHITS code and ICRP/ICRU adult reference computational phantoms", *Phys. Med. Biol.* **55**, 2235-2246 (2010).

[6] ICRP, 1990 Recommendations of the International Commission on Radiological Protection, *ICRP Publication 60* (1991).

[7] ICRU, The quality factor in radiation protection, *ICRU Report 40* (1986).

TABLE 1. List of dose conversion coefficients contained in DDCC

File name	Particle	Energy	Absorbed Dose	Dose Equivalent
DDCC-neutron.xls	neutron	1 meV ~ 100 GeV	Not included	AP, ISO
DDCC-proton.xls	proton	1 MeV ~ 100 GeV	Not included	AP, ISO, PA, LLAT, RLAT, ROT
DDCC-helium.xls	He	1 MeV/n ~ 100 GeV/n	Not included	AP, ISO, PA
DDCC-heavyion.xls	Li ~ Ni	1 MeV/n ~ 100 GeV/n	ISO	ISO

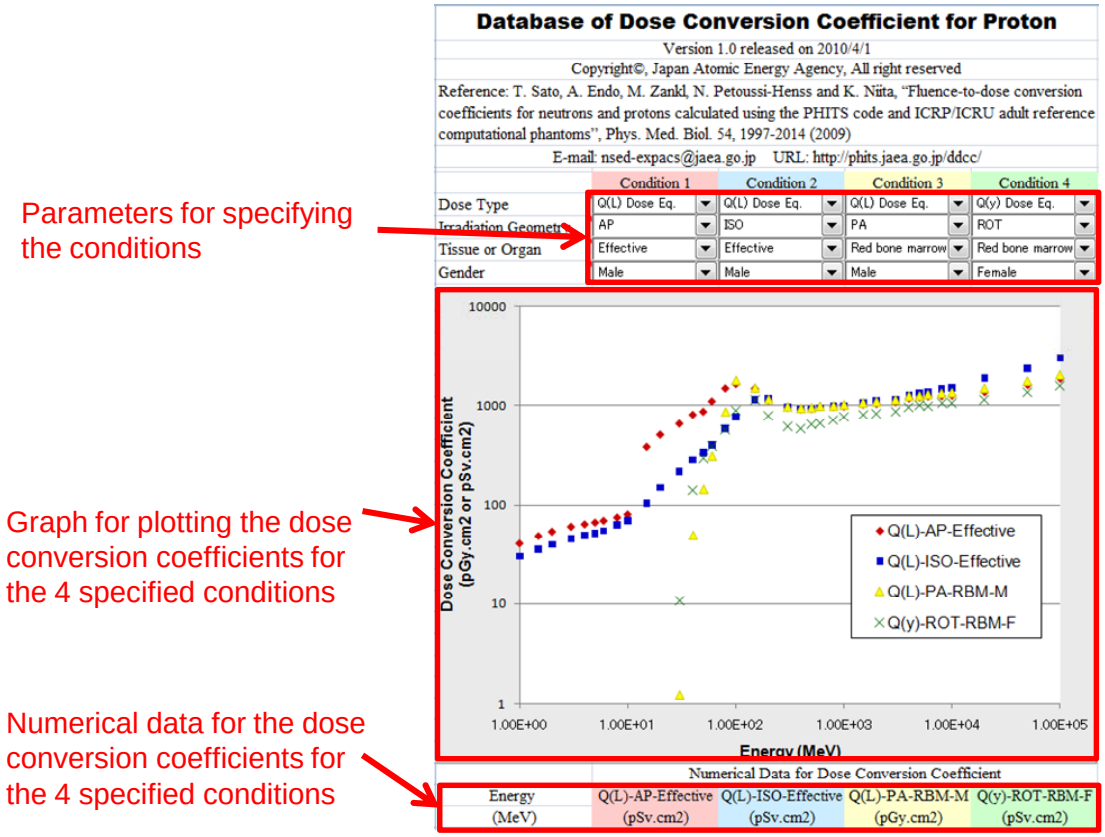

Figure 1. Snapshot of the worksheet "plot" in DDCC with some instructions for making a plot for the dose conversion coefficients