

EXERCISE 1: Dose Conversion Coefficient (DCC) – Comparison

Aim

To compare the methods used for calculating internal and external dose conversion coefficients (dose per unit concentration or dose conversion factors) to a limited range of ICRP reference organism geometries and radionuclides.

Description

Participants will use their models to determine dose conversion coefficients for five reference organism geometries selected from the proposed ICRP list (Pentreath, pers. comm.). These have been selected from the proposed list for terrestrial and freshwater ecosystems. They are: duck, frog, salmonid egg, earthworm (elongated) and rat. Dimensions for these organisms as defined for the ICRP are given in Table 1, along with an indication of the DCCs to be reported for different environmental media compartments for each organisms. The organisms have been chosen to represent different geometry size classes ranging from very small (0.25x0.25x0.25 cm) to medium-sized (30x10x8 cm). The shapes proposed are all ellipsoids with the exception of the elongated earthworm (10x1x1cm), which may be considered as a cylinder.

Participants will determine the DCCs for each geometry for seven radionuclides:

| <i>Beta</i> | <i>Gamma</i> | <i>Alpha</i> |
|---------------------------------|--|-----------------------|
| H-3 (Emax 0.019/0.006 MeV) | Am-241 (0.026, 0.033, 0.059 MeV) | Am-241 (5.570 MeV) |
| C-14 (Emax 0.157/0.05 MeV) | Cs-137 (0.66 MeV) | U-238 (4.257 MeV) |
| Sr-90 (Emax 0.546/0.196 MeV) | Co-60 (1.17/1.33 MeV) | |
| | U-238 (only example energies given) | |
| | (0.013, 0.016, 0.020 MeV) | |

The radionuclides were selected to cover a range of energies and the different types of radiation. Some current participants do not have Co-60 in their model and therefore will be unable to provide results for this nuclide.

Proposed models

RESRAD-BIOTA
England & Wales Environment Agency
EDEN
EPIC-Doses3D
ERICA-FASSET
Atomic Energy Canada Ltd. Approach
ECOMOD
Potential other contributors from Canada – to be confirmed

Method

Assumptions:

Where no assumptions on the calculation method exist use the following assumptions:

1) The radionuclide distribution in the media for organisms living in soil should be uniformly contaminated to a depth of 50cm. Organisms should be set to a depth of 25cm.

2) The radionuclide distribution in the media for organisms living on soil should be uniformly contaminated to a depth of 10cm.

Table 1: Reference organism geometries for which DCCs are to be determined.

| Organism | a (cm) | b (cm) | c (cm) | Mass (g) | S (cm ²) | S/V (cm ⁻¹) | Ecosystem |
|--------------------------|-----------|-----------|-----------|-------------|----------------------|----------------------------|-------------|
| Duck | 30 | 10 | 8 | 1.3E+03 | 6.3E+02 | 5.0E-01 | Freshwater |
| Frog | 8 | 3 | 2.5 | 3.1E+01 | 5.2E+01 | 1.7E+00 | Freshwater |
| Salmonid egg | 0.25 | 0.25 | 0.25 | 8.2E-03 | 2.0E-01 | 2.4E+01 | Freshwater |
| Rat | 20 | 6 | 5 | 3.1E+02 | 2.5E+02 | 7.9E-01 | Terrestrial |
| Earthworm (elongated) | 10 | 1 | 1 | 5.2E+00 | 2.5E+01 | 4.7E+00 | Terrestrial |

Abbreviations

- a Major axis of ellipsoid
- b Minor axis of ellipsoid
- c Second minor axis of ellipsoid
- S Surface area of ellipsoid
- S/V Surface area to volume ratio of the ellipsoid

Table 1 (cont.) Reference organism DCC which should be reported.

| Organism | Underground | Shore (soil surface) | Benthic interface | Water | Air |
|--------------------------|--------------------|-------------------------|----------------------|-------|-----|
| Duck | | Y | | Y | Y |
| Frog | | Y | | Y | |
| Salmonid egg | | | Y | Y | |
| | | Soil surface | | | |
| Rat | Y (depth 25 cm) | Y | | | |
| Earthworm (elongated) | Y (depth 25 cm) | Y | | | |

Output

- 1) DCCs should be determined for the whole organism only.
- 2) DCCs should be reported as

INTERNAL: $\mu\text{Gy h}^{-1}$ per Bq kg^{-1} (fresh weight)

EXTERNAL WATER: $\mu\text{Gy h}^{-1}$ per Bq l^{-1}

EXTERNAL SOIL/SEDIMENT: $\mu\text{Gy h}^{-1}$ per Bq kg^{-1} (dry weight)

EXTERNAL AIR: $\mu\text{Gy h}^{-1}$ per Bq m^{-3}

- 3) Please add details about whether progeny have been included in the calculation of the DCC and on what basis into the assumptions section of the spreadsheet (see Table 2).

The results spreadsheet should be completed by each participant. The results spreadsheet format is provided below in Table 2.

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Table 2: Results output structure

| Participant | Model used | | | | | | |
|--------------|-----------------------|--------------|----------------------|--------------------|------------------------|---------------------------------|-------------------------|
| Radionuclide | Organism | Internal DCF | External DCF (water) | External DCF (Air) | External DCF (In-Soil) | External DCF (On-Soil/On-Shore) | External DCF (Sediment) |
| H-3 | Duck | | | | | | |
| | Frog | | | | | | |
| | Salmonid egg | | | | | | |
| | Rat | | | | | | |
| | Earthworm (elongated) | | | | | | |
| C-14 | Duck | | | | | | |
| | Frog | | | | | | |
| | Salmonid egg | | | | | | |
| | Rat | | | | | | |
| | Earthworm (elongated) | | | | | | |
| Sr-90 | Duck | | | | | | |
| | Frog | | | | | | |
| | Salmonid egg | | | | | | |
| | Rat | | | | | | |
| | Earthworm (elongated) | | | | | | |
| Am-241 | Duck | | | | | | |
| | Frog | | | | | | |
| | Salmonid egg | | | | | | |
| | Rat | | | | | | |
| | Earthworm (elongated) | | | | | | |
| Cs-137 | Duck | | | | | | |
| | Frog | | | | | | |
| | Salmonid egg | | | | | | |
| | Rat | | | | | | |
| | Earthworm (elongated) | | | | | | |
| Co-60 | Duck | | | | | | |
| | Frog | | | | | | |
| | Salmonid egg | | | | | | |
| | Rat | | | | | | |
| | Earthworm (elongated) | | | | | | |
| ALPHA | | | | | | | |
| Am-241 | Duck | | | | | | |
| | Frog | | | | | | |
| | Salmonid egg | | | | | | |
| | Rat | | | | | | |
| | Earthworm (elongated) | | | | | | |
| U-238 | Duck | | | | | | |
| | Frog | | | | | | |
| | Salmonid egg | | | | | | |
| | Rat | | | | | | |
| | Earthworm (elongated) | | | | | | |

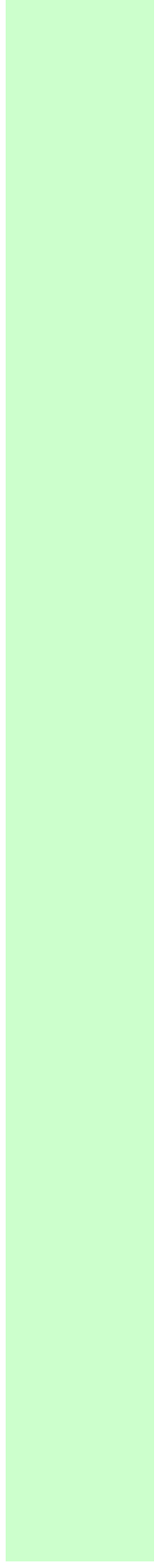
| | | |
|-----------------------|--|---|
| Participant | | 0 |
| Model used | | 0 |
| Assumptions used: | | |
| Comments: | | |
| Problems encountered: | | |

Participant
Model used

| Radionuclide | Organism | Internal DCF | External DCF (water) | External DCF (Air) | External DCF (In-Soil) | External DCF (On-Soil/On-Shore) | External DCF (Sediment) |
|--------------|--|--------------|----------------------|--------------------|------------------------|---------------------------------|-------------------------|
| H-3 | Duck Frog Salmonid egg Rat Earthworm (elongated) | | | | | | |
| C-14 | Duck Frog Salmonid egg Rat Earthworm (elongated) | | | | | | |
| Sr-90 | Duck Frog Salmonid egg Rat Earthworm (elongated) | | | | | | |
| Am-241 | Duck Frog Salmonid egg Rat Earthworm (elongated) | | | | | | |
| Cs-137 | Duck Frog Salmonid egg Rat Earthworm (elongated) | | | | | | |
| Co-60 | Duck Frog Salmonid egg Rat Earthworm (elongated) | | | | | | |

ALPHA
Am-241

Duck
Frog
Salmonid egg
Rat
Earthworm (elongated)



U-238

Duck
Frog
Salmonid egg
Rat
Earthworm (elongated)

