DOSE CONVERSION FACTOR FOR URANIUM-BEARING ORE DUST

PURPOSE

This Note explains how to calculate the DCF for uranium-bearing ore dust, using the International Atomic Energy Agency (IAEA) method of computation[1].

INTRODUCTION

The effective dose due to the inhalation of radioactive ore dust is given by:

$$\mathbf{Dose_{Dust} = Conc_{Dust} \times DCF_{Dust} \times t_{Worker} \times VRate_{Worker}}$$

where

$Dose_{Dust}$	dose due to the inhalation of radioactive dust, in $mSv.a^{-1}$
$Conc_{Dust}$	ambient concentration of ore dust, in $mBq.m^{-3}$ (this quantity is measured, for example using the MyRIAM)
DCF_{Dust}	dose conversion factor for inhalation of radionuclides, $mSv.mBq^{-1}$
t_{Worker}	time period of worker exposure, in $h.a^{-1}$
$VRate_{Worker}$	average breathing rate of worker, in $m^3.h^{-1}$.

From the above it is apparent that an appropriate dose conversion coefficient (DCF) for uranium-bearing ore dust is needed to compute the effective dose due to the inhalation of radioactive ore dust.

ASSUMPTIONS

Following the IAEA procedure, one assumes the following simplifications:

- dust that is inhaled is from uranium-bearing ore *only*
- the dust is in full radioactive equilibrium
- the ratio of natural uranium isotopes U^{238} and U^{235}, as found in the inhaled dust, has the same abundance ratio as found in nature, i.e. 1 to 0.046
- the particle size distribution of the dust inhaled has an AMAD of 5 µm
- the chemical form of each radionuclide contained in the dust corresponds to the ***slowest lung absorption class,*** as described in Table II-V (Schedule II) of the IAEA reference (refer to footnote 1 below).

[1] IAEA Safety Series No. 115 (1996), *International Basic Safety Standards for Protection Against Ionizing Radiation and for the Safety of Radiation Sources*

METHOD

Using the radionuclides from the two uranium decay chain, as listed in the table below, and with the dose coefficients from Table II-III (Schedule II) of the IAEA report referenced in footnote 1 above, one computes the effective inhalation dose per unit intake of **alpha activity,** and taking all radionuclides of the U^{238} and U^{235} to compute the gross alpha activity concentration. The DCF is then the sum of the weighted effective inhalation dose coefficients divided by the gross alpha concentration from the two decay chains, and is expressed in $mSv.Bq^{-1}$ or $Sv.Bq^{-1}$.

Series	Radionuclide	Type	Type of emitter	Inhalation dose coeff's. (5 um AMAD) (Sv/Bq)	Specific Activity (Bq/g)	Effective 5 um inhalation dose coeff's. (Sv/αBq)
URANIUM	Uranium-238	S	α	5.7E-06	1.00	5.7E-06
	Thorium-234	S	β	5.8E-09	1.00	5.8E-09
	Protactinium-234m		β	0.0E+00	1.00	0.0E+00
	Uranium-234	S	α	6.8E-06	1.00	6.8E-06
	Thorium-230	S	α	7.2E-06	1.00	7.2E-06
	Radium-226	M	α	2.2E-06	1.00	2.2E-06
	Radon-222		α	0.0E+00	1.00	0.0E+00
	Polonium-218		α	0.0E+00	1.00	0.0E+00
	Lead-214	F	β	4.8E-09	1.00	4.8E-09
	Bismuth-214	M	β	2.1E-08	1.00	2.1E-08
	Polonium-214		α	0.0E+00	1.00	0.0E+00
	Lead-210	F	β	1.1E-06	1.00	1.1E-06
	Bismuth-210	M	β	6.0E-08	1.00	6.0E-08
	Polonium-210	M	α	2.2E-06	1.00	2.2E-06
ACTINIUM	Uranium-235	S	α	6.1E-06	0.046	2.8E-07
	Thorium-231	S	β	4.0E-10	0.046	1.8E-11
	Protactinium-231	S	α	1.7E-05	0.046	7.8E-07
	Actinium-227	S	β	4.7E-05	0.046	2.2E-06
	Thorium-227	S	α	7.6E-06	0.046	3.5E-07
	Radium-223	M	α	5.7E-06	0.046	2.6E-07
	Radon-219		α	0.0E+00	0.046	0.0E+00
	Polonium-215		α	0.0E+00	0.046	0.0E+00
	Lead-211	F	β	5.6E-09	0.046	2.6E-10
	Bismuth-211		α	0.0E+00	0.046	0.0E+00
	Thalium-207		β	0.0E+00	0.046	0.0E+00
	Gross alpha activity concentration (αBq/g)				**8.322**	2.9E-05
	Weighted dose conversion coefficient (alpha only) (mSv/Bq)					**0.00350**
	Weighted dose conversion coefficient (alpha only) (Sv/Bq)					**3.500E-06**

In case the ore is characterised by thorium, the thorium decay chain is added to the above.

The DCF computed in this Note is for uranium-bearing ore dust only, and a different DCF applies for dust originating from uranium concentrates and uranium-deficient tailings.