Alicia Mullins

From: Roland Benke
Sent: Wednesday, August 11, 2004 2:01 PM
To: Timothy McCartin; Patrick Laplante; Richard Codell
Cc: Keith Compton; Roland Benke
Subject: RE: ICRP software
Attachments: am241_icrp72_abr.xls; ICRP-66visuals.doc

All:

The first attachment is an abbreviated version of Dick's spreadsheet with a plot showing the potential effects of chemical solubility class and particle size between 1 and 10 microns.

I have prepared some visuals on the new ICRP-66 lung model. Please see the second attachment where particle deposition in the lungs drops off dramatically for particle sizes greater than 10 mircons.

For perspective, also consider the following points on the Airborne Mass Loading Measurements above Cerro Negro Ash Deposits for Heavy and Light Disturbance Activities.
Heavy Disturbance (i.e., driving) over deposits resulted in airborne mass loads of ~0.01 g/m3 where about 95 percent of the measured airborne particle mass was from "large particles" with sizes between 10 - 100 microns.
Light Disturbance (i.e., walking) over deposits resulted in airborne mass loads of ~0.001 g/m3 where about 60 percent was from large particles.

This should highlight our need for analyzing the behavior of large particles with sizes between 10 - 100 microns.

Roland

-----Original Message-----
From: Timothy McCartin [mailto:TJM3@nrc.gov]
Sent: Wednesday, August 11, 2004 6:39 AM
To: plaplante@cnwra.swri.edu; rbenke@cnwra.swri.edu; Richard Codell
Cc: Keith Compton
Subject: RE: ICRP software

I still believe it would be useful to know what the difference between 1 and 10 micron particles

>>> Patrick LaPlante <plaplante@cnwra.swri.edu> 08/10/04 06:46PM >>>
I will defer to Roland but I believe the original issue of concern was that particles up to 100 micron were both resuspendable and "inhalable" (into the body via nose/mouth) but particle size determines the route of exposure within the body and (in a nutshell) particles between about 10 and 100 micron get stuck in the throat, produce a dose at that site, then are swallowed and then produce an ingestion dose whereas particles less than 10 micron enter the lung directly and produce a dose there. The newer dosimetry models have been refined to allow consideration of the effects of particle size and evaluate how the resulting different "body pathways" affect the magnitude of the dose. Thus, we are interested in how particle size impacts internal dosimetry up to 100 micron particles.

An additional consideration is the effect of particle size on the amount of radioactive material inhaled (i.e., the "intake" estimate where larger particles allow the receptor to inhale more mass but any increase in dose may be offset by the lower hazard of the throat/ingestion route of exposure once the material is in the body). Of

course when doses are calculated on a "per unit activity" basis then such effects are not considered. It is reasonable for the purpose of analysis to evaluate the "intake" related issues (what happens outside the body) separately from the internal dosimetry issues. To evaluate particle size effects on intake, we would need an understanding of the particle size distribution in the source term. In the past, limited to no info on particle size distribution deposited to the biosphere resulted in applying the presumably more conservative approach of using all resuspendable mass (TSP, i.e. 100 micron or less) for mass loading in combination with the 1 micron AMAD assuming (i.e., lung emphasizing) dosimetry model used in FGR 11.

Pat

-----Original Message-----
From: Richard Codell [mailto:RBC@nrc.gov]
Sent: Tuesday, August 10, 2004 4:51 PM
To: Roland Benke
Cc: PLAPLANTE@cnwra.swri.edu; Keith Compton; Timothy McCartin
Subject: Re: ICRP software

Roland:
I ran the ICRP72 software for inhalation of Am241 1, 5 and 10 micron amad.
It doesn't go any higher than 10 micron to my knowledge. Is this useful? I can do other nuclides and other categories than inhalation.
Dick

Richard B. Codell, Ph.D.
Senior Hydraulic Engineer
Division of High-Level Waste Repository Safety Office of Nuclear Material Safety and Safeguards U.S. Nuclear Regulatory Commission
11545 Rockville Pike
Rockville MD 20852
Phone 301-415-8167
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EMail RBC@NRC.GOV

>>> Roland Benke <rbenke@cnwra.swri.edu> 08/10/04 03:30PM >>>

Dick:

When you get a chance to pinpoint the inputs and outputs of the ICRP software, please let me know. In particular, we will need to increase the particle size beyond the 1 um and 5 um nominal values.

Roland

Properties Page

Return-path: <rbenke@cnwra.swri.edu>
Received: from PHOENIX (phoenix.cnwra.swri.edu [129.162.200.28])
 by rogain.cnwra.swri.edu (iPlanet Messaging Server 5.2 (built Feb 21 2002))
 with ESMTP id <0I2A00F5UN34N6@rogain.cnwra.swri.edu>; Wed,
 11 Aug 2004 12:54:46 -0500 (CDT)
Date: Wed, 11 Aug 2004 13:00:46 -0500
From: Roland Benke <rbenke@cnwra.swri.edu>
Subject: RE: ICRP software
In-reply-to: <s119ccfc.060@nrcgwia.nrc.gov>
To: 'Timothy McCartin' <TJM3@nrc.gov>, plaplante@cnwra.swri.edu,
 'Richard Codell' <RBC@nrc.gov>
Cc: 'Keith Compton' <KLC@nrc.gov>, Roland Benke <rbenke@cnwra.swri.edu>
Reply-to: rbenke@cnwra.swri.edu
Message-id: <003201c47fcd$20fecfd0$1cc8a281@PHOENIX>
MIME-version: 1.0
X-MIMEOLE: Produced By Microsoft MimeOLE V6.00.2800.1441
X-Mailer: Microsoft Outlook CWS, Build 9.0.2416 (9.0.2910.0)
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X-Priority: 3 (Normal)
X-MSMail-priority: Normal

Am-241, adult member of the public
Inhalation of particulate aerosol: AMAD = 1.000 micron, absorption Type F, f1 = 0.0005
Highest committed equivalent dose coefficient: Bone Surface, 4.4E-03 Sv/Bq
Remainder formulation: default

Time after i	1 day	7 days	30 days	1 year	5 years	10 years	20 years	30 years	45 years	50 years
Effective d	1.20E-08	7.60E-08	3.30E-07	4.00E-06	1.90E-05	3.30E-05	5.50E-05	7.20E-05	9.10E-05	9.60E-05

Am-241, adult member of the public
Inhalation of particulate aerosol: AMAD = 1.000 micron, absorption Type M, f1 = 0.0005
Highest committed equivalent dose coefficient: Bone Surface, 1.7E-03 Sv/Bq
Remainder formulation: default

Time after i	1 day	7 days	30 days	1 year	5 years	10 years	20 years	30 years	45 years	50 years
Effective d	1.50E-07	7.70E-07	2.30E-06	5.10E-06	1.10E-05	1.70E-05	2.60E-05	3.20E-05	4.00E-05	4.20E-05

Am-241, adult member of the public
Inhalation of particulate aerosol: AMAD = 1.000 micron, absorption Type S, f1 = 0.0005
Highest committed equivalent dose coefficient: Bone Surface, 2.1E-04 Sv/Bq
Remainder formulation: default

Time after i	1 day	7 days	30 days	1 year	5 years	10 years	20 years	30 years	45 years	50 years
Effective d	1.70E-07	8.60E-07	2.70E-06	5.90E-06	9.20E-06	1.10E-05	1.30E-05	1.40E-05	1.60E-05	1.60E-05

Am-241, adult member of the public
Ingestion: f1 = 0.0005
Highest committed equivalent dose coefficient: Bone Surface, 9.0E-06 Sv/Bq
Remainder formulation: default

Time after i	1 day	7 days	30 days	1 year	5 years	10 years	20 years	30 years	45 years	50 years
Effective d	2.10E-09	4.70E-09	5.30E-09	1.30E-08	4.30E-08	7.40E-08	1.20E-07	1.50E-07	1.90E-07	2.00E-07

Am-241, adult member of the public
Inhalation of particulate aerosol: AMAD = 1.000 micron, absorption Type F, f1 = 0.0005
Highest committed equivalent dose coefficient: Bone Surface, 4.4E-03 Sv/Bq
Remainder formulation: default

Time after i	1 day	7 days	30 days	1 year	5 years	10 years	20 years	30 years	45 years	50 years
Effective d	1.20E-08	7.60E-08	3.30E-07	4.00E-06	1.90E-05	3.30E-05	5.50E-05	7.20E-05	9.10E-05	9.60E-05

Am-241, adult member of the public
Inhalation of particulate aerosol: AMAD = 5.000 micron, absorption Type F, f1 = 0.0005
Highest committed equivalent dose coefficient: Bone Surface, 5.3E-03 Sv/Bq
Remainder formulation: default

Time after i	1 day	7 days	30 days	1 year	5 years	10 years	20 years	30 years	45 years	50 years
Effective d	1.40E-08	9.20E-08	3.90E-07	4.90E-06	2.30E-05	4.00E-05	6.70E-05	8.70E-05	1.10E-04	1.20E-04

Am-241, adult member of the public
Inhalation of particulate aerosol: AMAD =10.000 micron, absorption Type F, f1 = 0.0005
Highest committed equivalent dose coefficient: Bone Surface, 4.4E-03 Sv/Bq
Remainder formulation: default

Time after i	1 day	7 days	30 days	1 year	5 years	10 years	20 years	30 years	45 years	50 years
Effective d	1.10E-08	7.60E-08	3.30E-07	4.10E-06	1.90E-05	3.40E-05	5.60E-05	7.30E-05	9.20E-05	9.70E-05

Am-241, adult member of the public
Inhalation of particulate aerosol: AMAD = 1.000 micron, absorption Type M, f1 = 0.0005
Highest committed equivalent dose coefficient: Bone Surface, 1.7E-03 Sv/Bq
Remainder formulation: default

Time after i	1 day	7 days	30 days	1 year	5 years	10 years	20 years	30 years	45 years	50 years
Effective d	1.50E-07	7.70E-07	2.30E-06	5.10E-06	1.10E-05	1.70E-05	2.60E-05	3.20E-05	4.00E-05	4.20E-05

Am-241, adult member of the public
Inhalation of particulate aerosol: AMAD = 5.000 micron, absorption Type M, f1 = 0.0005
Highest committed equivalent dose coefficient: Bone Surface, 1.3E-03 Sv/Bq
Remainder formulation: default

Time after i	1 day	7 days	30 days	1 year	5 years	10 years	20 years	30 years	45 years	50 years
Effective d	1.30E-07	6.20E-07	1.80E-06	4.00E-06	8.30E-06	1.30E-05	1.90E-05	2.40E-05	2.90E-05	3.10E-05

Am-241, adult member of the public
Inhalation of particulate aerosol: AMAD =10.000 micron, absorption Type M, f1 = 0.0005
Highest committed equivalent dose coefficient: Bone Surface, 7.9E-04 Sv/Bq
Remainder formulation: default

Time after i	1 day	7 days	30 days	1 year	5 years	10 years	20 years	30 years	45 years	50 years
Effective d	7.50E-08	3.40E-07	9.70E-07	2.20E-06	4.90E-06	7.60E-06	1.20E-05	1.50E-05	1.80E-05	1.90E-05

Am-241, adult member of the public
Inhalation of particulate aerosol: AMAD = 1.000 micron, absorption Type S, f1 = 0.0005
Highest committed equivalent dose coefficient: Bone Surface, 2.1E-04 Sv/Bq
Remainder formulation: default

Time after i	1 day	7 days	30 days	1 year	5 years	10 years	20 years	30 years	45 years	50 years
Effective d	1.70E-07	8.60E-07	2.70E-06	5.90E-06	9.20E-06	1.10E-05	1.30E-05	1.40E-05	1.60E-05	1.60E-05

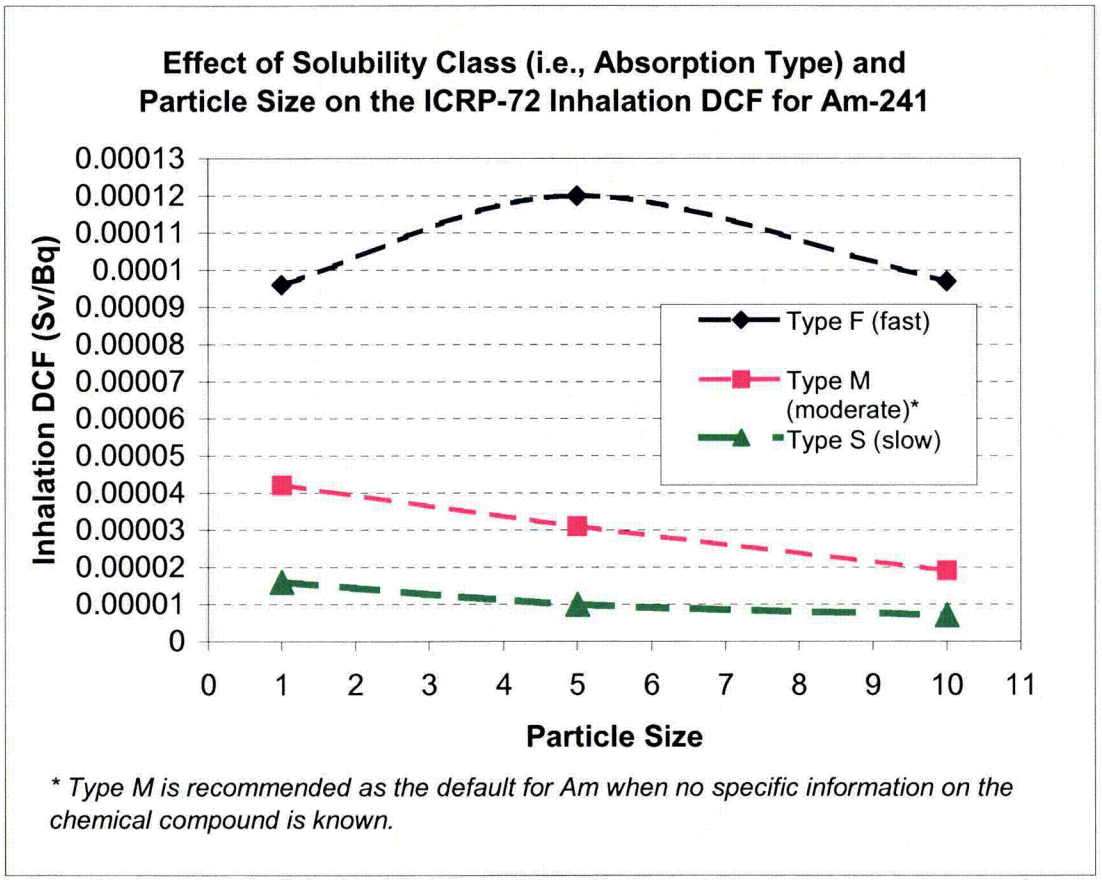
Am-241, adult member of the public
Inhalation of particulate aerosol: AMAD = 5.000 micron, absorption Type S, f1 = 0.0005
Highest committed equivalent dose coefficient: Bone Surface, 1.2E-04 Sv/Bq
Remainder formulation: default

Time after i	1 day	7 days	30 days	1 year	5 years	10 years	20 years	30 years	45 years	50 years
Effective d	1.40E-07	6.90E-07	2.10E-06	4.40E-06	6.30E-06	7.30E-06	8.40E-06	9.20E-06	1.00E-05	1.00E-05

Am-241, adult member of the public
Inhalation of particulate aerosol: AMAD =10.000 micron, absorption Type S, f1 = 0.0005
Highest committed equivalent dose coefficient: ET Airways, 7.8E-05 Sv/Bq
Remainder formulation: split

Time after i	1 day	7 days	30 days	1 year	5 years	10 years	20 years	30 years	45 years	50 years
Effective d	8.40E-08	3.90E-07	1.20E-06	2.90E-06	4.90E-06	5.60E-06	6.20E-06	6.60E-06	7.00E-06	7.10E-06

Particle Size (mircons)	Effective Dose DCF (Sv/Bq) Absorption Type F (fast)	M (moderate	S (slow)
1	9.60E-05	4.20E-05	1.60E-05
5	1.20E-04	3.10E-05	1.00E-05
10	9.70E-05	1.90E-05	7.10E-06



** Type M is recommended as the default for Am when no specific information on the chemical compound is known.*

ICRP-66 Deposition

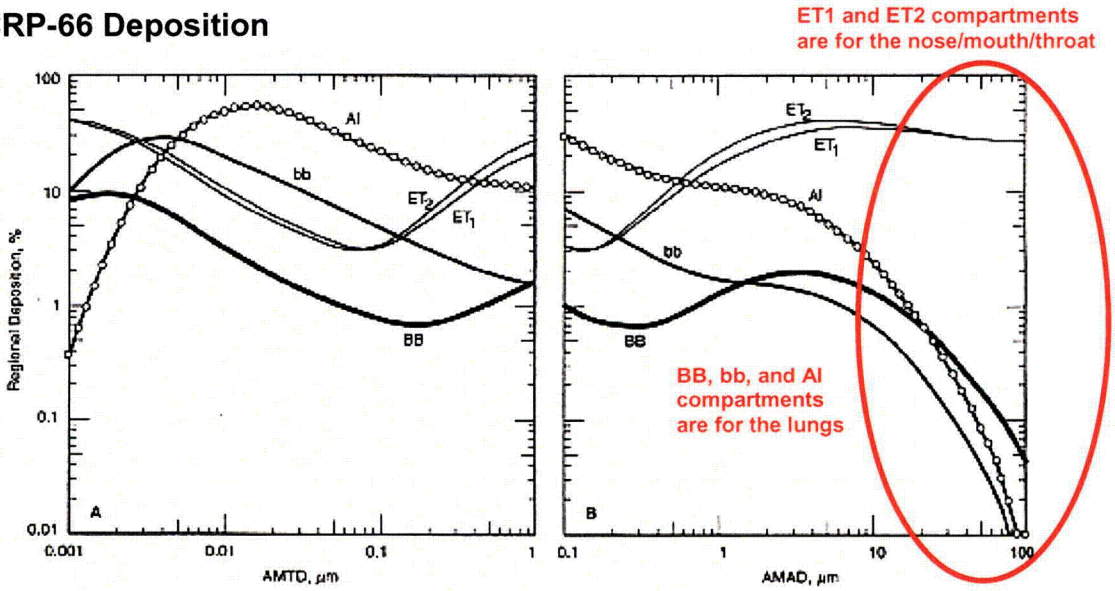


Fig. 43. Summary: fractional deposition in each region of respiratory tract for reference worker (normal nose breather). Deposition is expressed as a fraction of activity present in volume of ambient air that is inspired, and activity is assumed to be log-normally distributed as function of particle size (for particles of density 3.00 g cm^{-3} and shape factor 1.5).

- Deposition of large particles accounted for in the extended size range of ICRP-66
- Large particles are mainly deposited in the nose/mouth/throat with a fast clearance to the gastrointestinal tract or environment

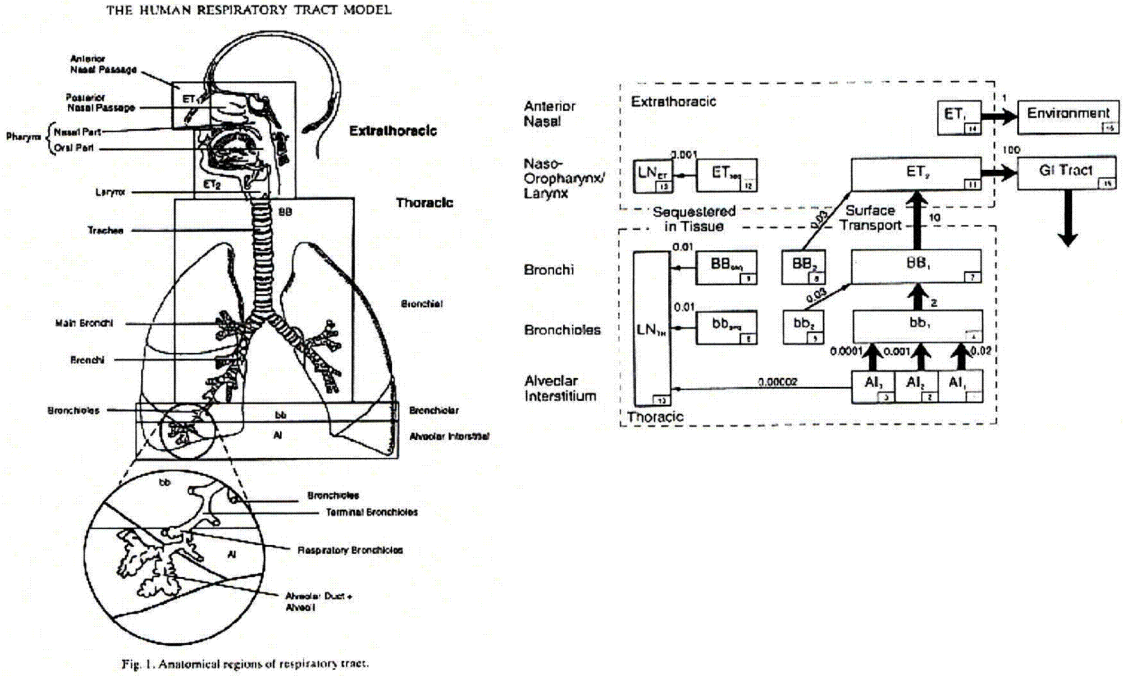


Fig. 1. Anatomical regions of respiratory tract.

Dose calculations for intake of large airborne particles (AMAD > 10 μm)

- Most of the activity (>90 – 99.8 %) delivers dose through the ingestion pathway
- Small fractional deposition into the deeper compartments for inhalation dose
- Small fraction (0.05%) of ET_2 deposition is retained in the epithelium and delivers inhalation dose