



Radiological Toolbox

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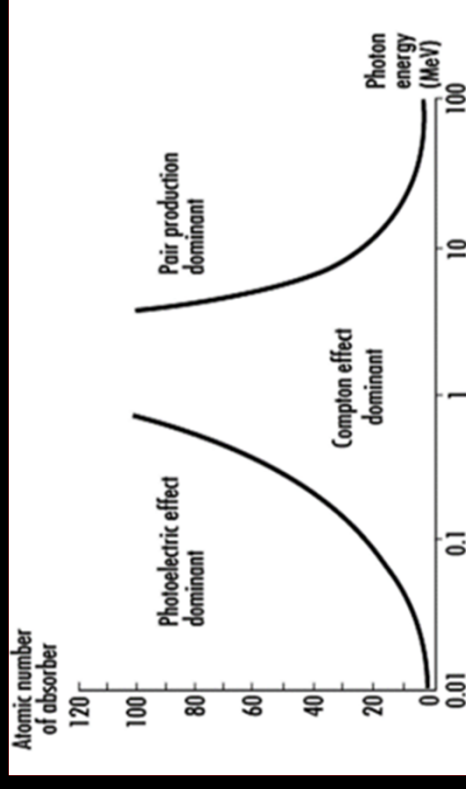


October 27 2020

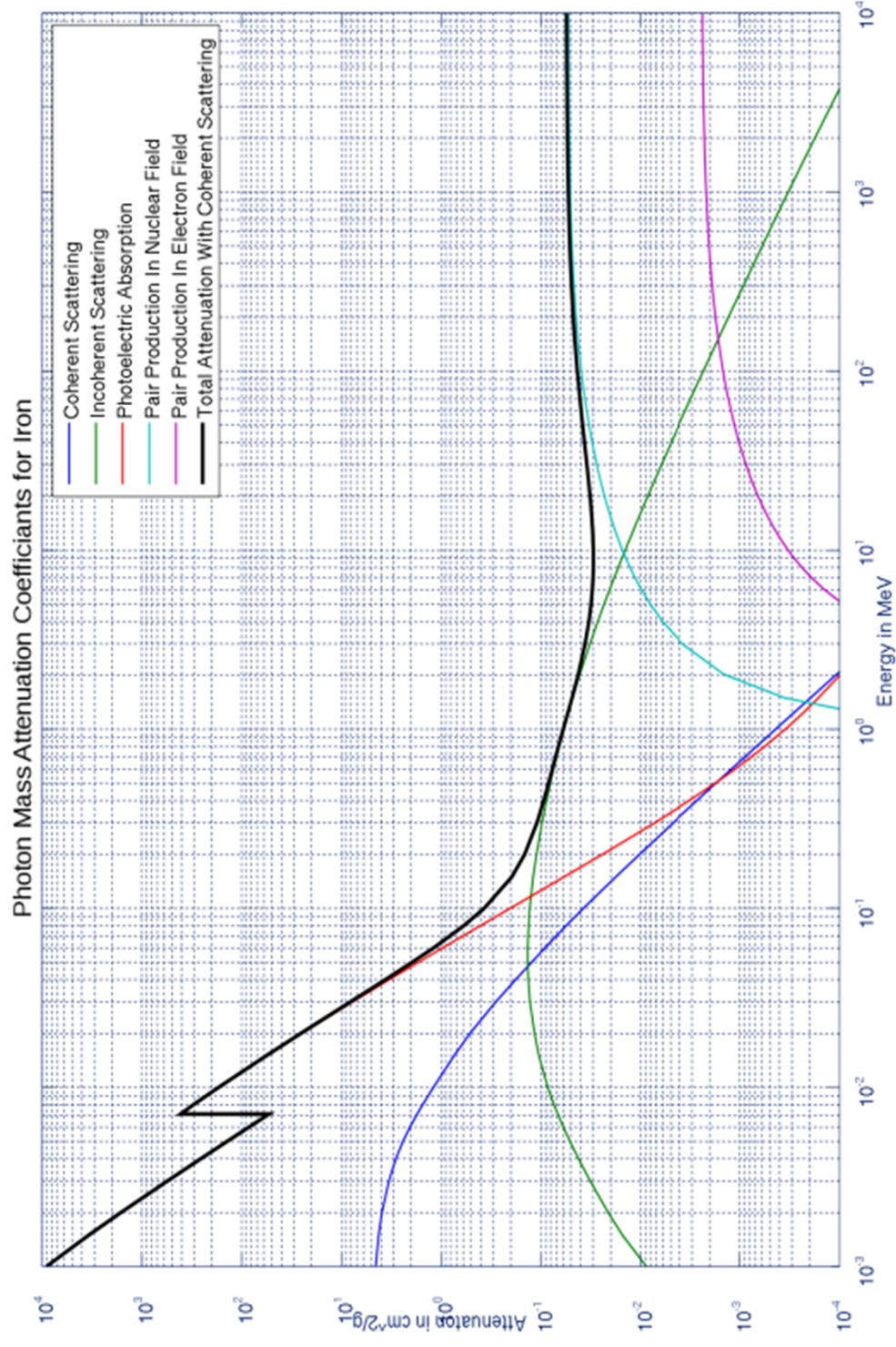
Fall 2020 USERS GROUP Virtual Meeting

(db6) Element Database

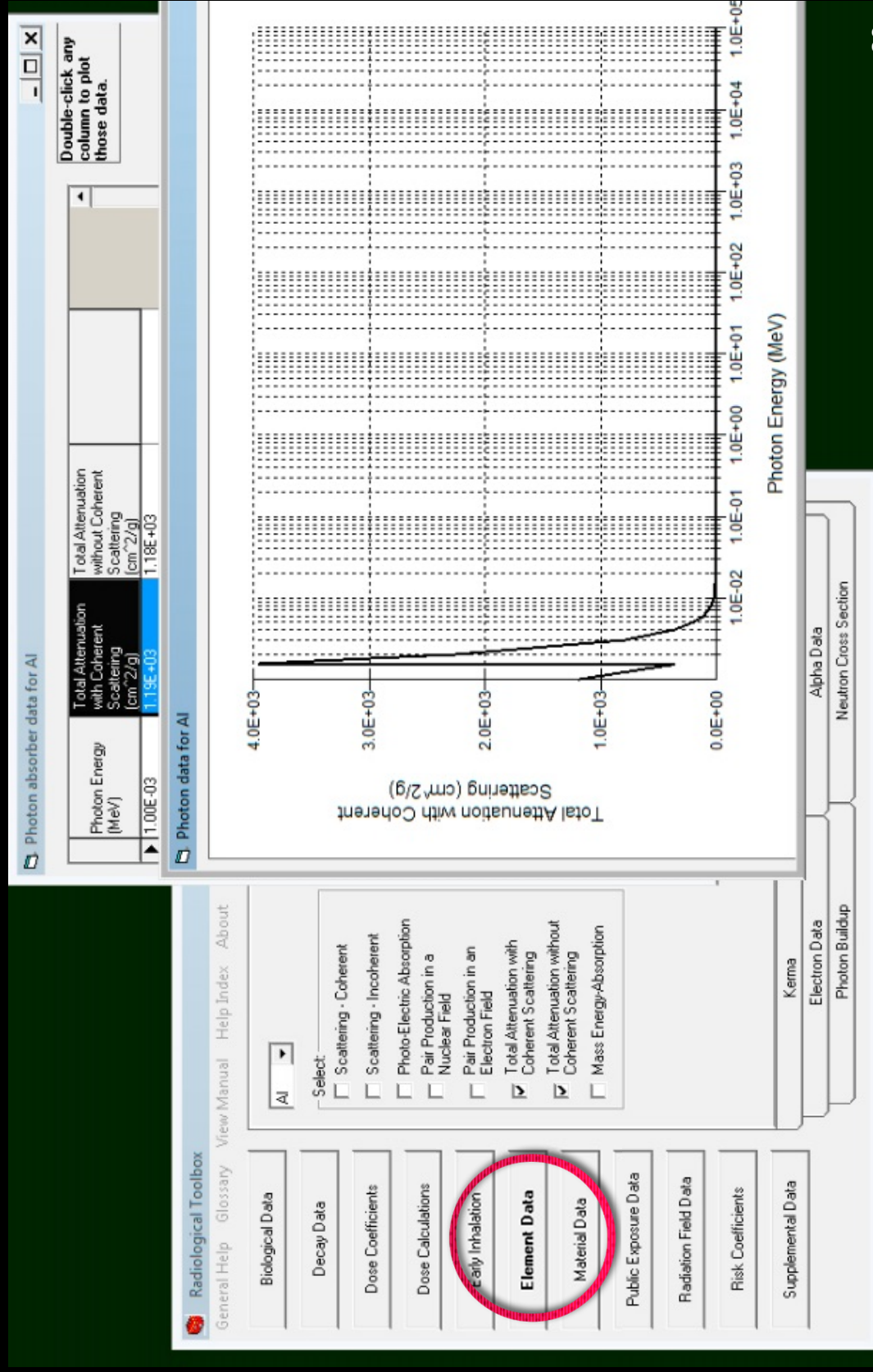
- Interaction coefficients for alpha, electron, photon, and neutron radiations in elemental absorbers.
 - Not available for every element or for each radiation type
 - Can be plotted
- Geometric progression form of the photon buildup factors from ANSI Standard 6.4
 - 0.015 and 15 MeV at distances ranging from 0.5 to 60 MFP
 - The photon and neutron kerma coefficients were taken from KERMAL, RSICC package DLC-143
- Atomic mass and isotopic abundance data 16th edition of the Chart of the Nuclides



Element Data (Fe)

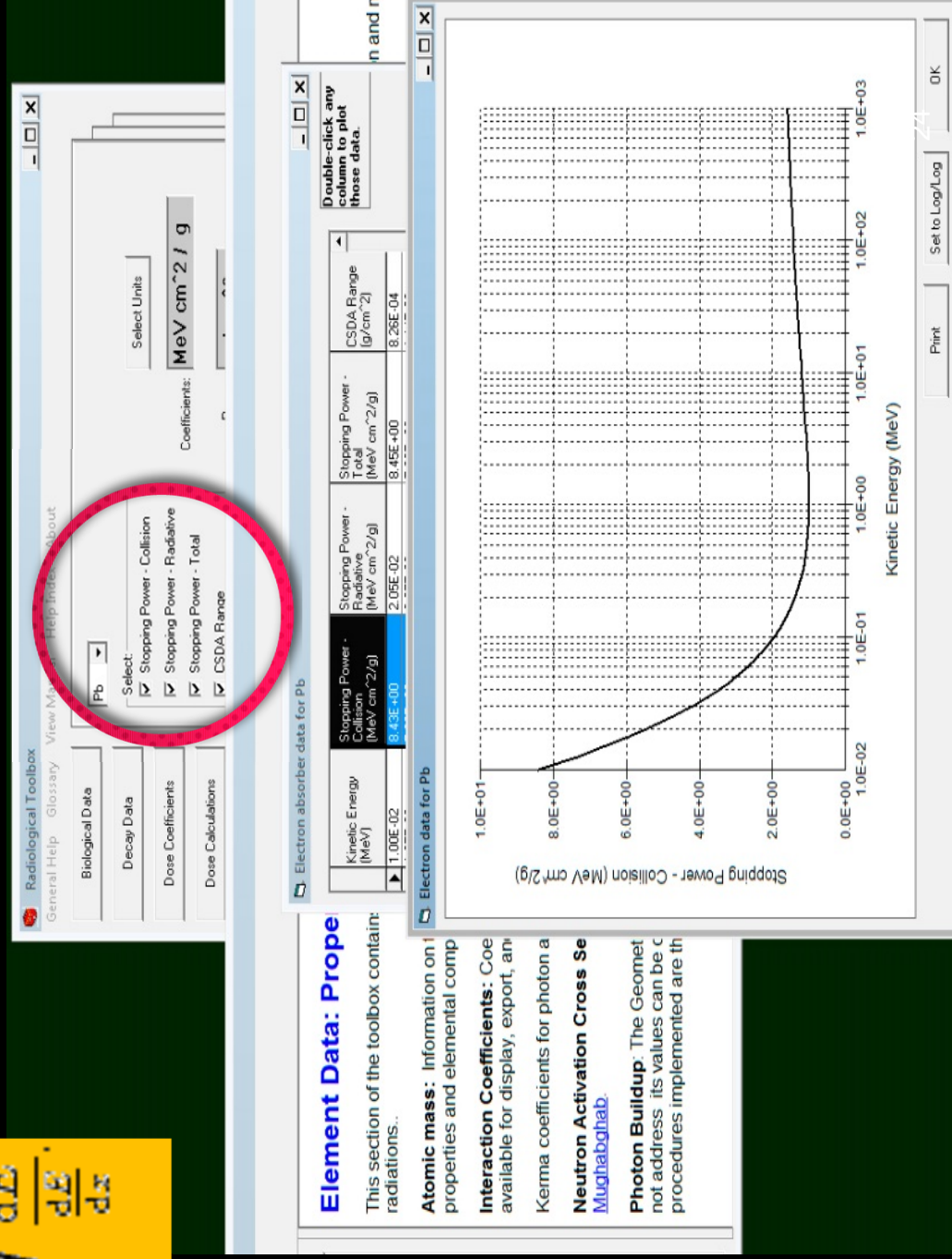


Element Data (AI)

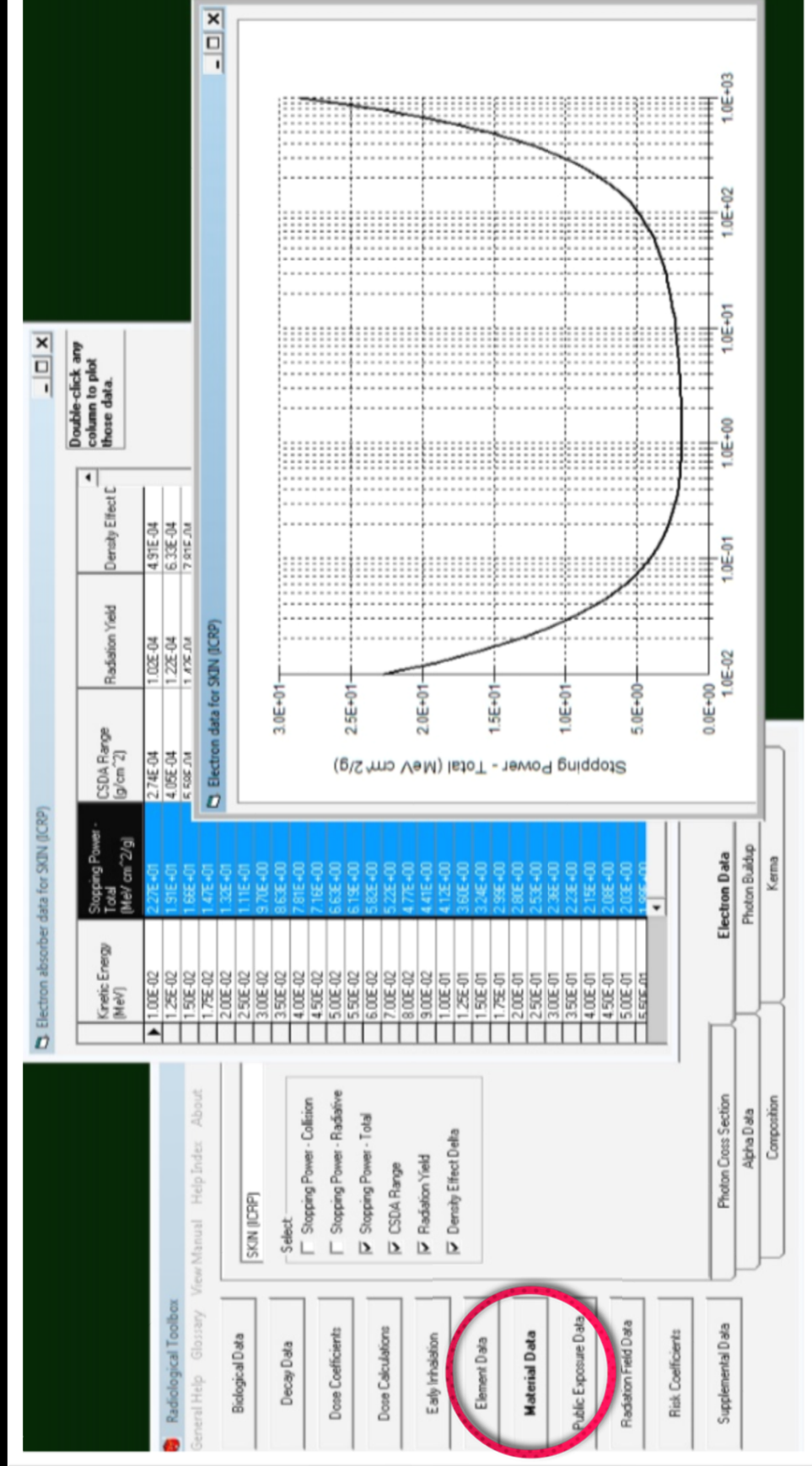


Element Data (Pb)

$$R_{\text{CSDA}}(E_0) = \int_0^{E_0} \frac{dE}{dx}$$



(db7) Material Data (Skin)



(db8) Public Exposure Data

Radiological Toolbox
General Help
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View Manual
Help Index
About

Biological Data
Decay Data
Dose Coefficients
Dose Calculations
Early Inhalation
Element Data
Material Data
Public Exposure Data
Radiation Field Data
Risk Coefficients
Supplemental Data

Natural Background Radiation
Background Radiation in the Body
Radionuclides in Materials
Radionuclides in Devices
Primordial Radionuclides
Typical Exposures during Medical Procedures
Typical Exposures during CT Examinations
DOE Ionizing Radiation Dose Graphic

Public Exposure Data

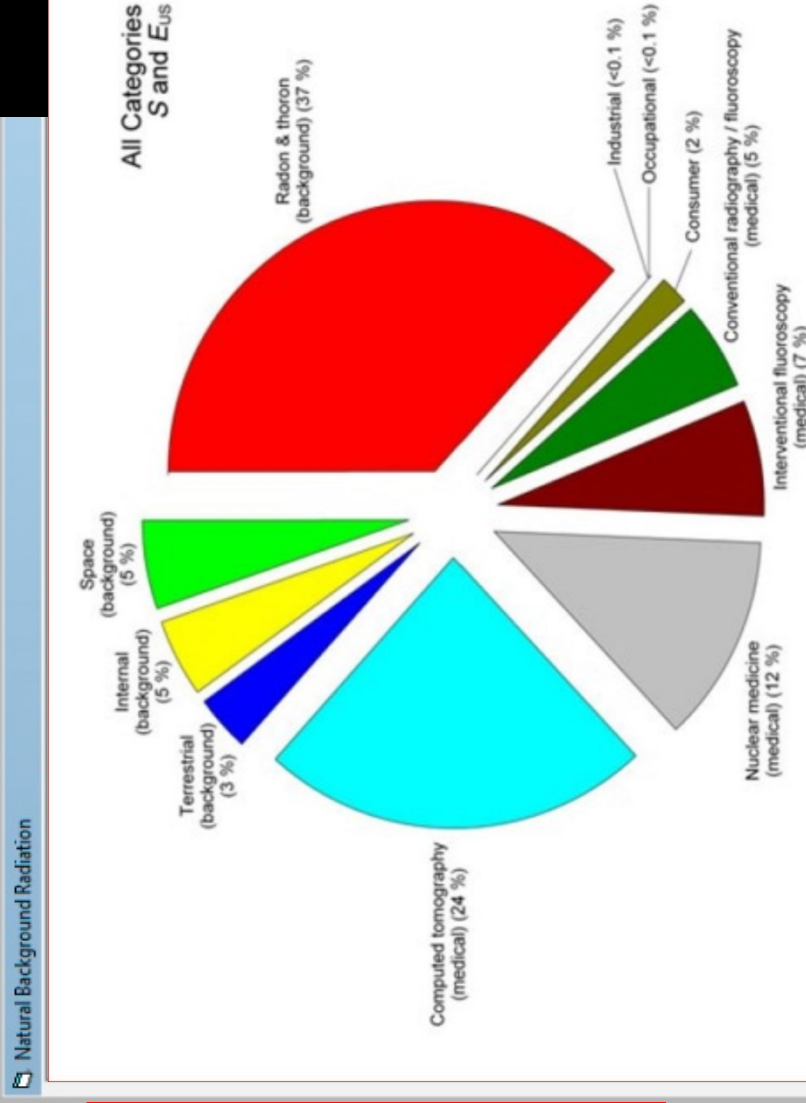
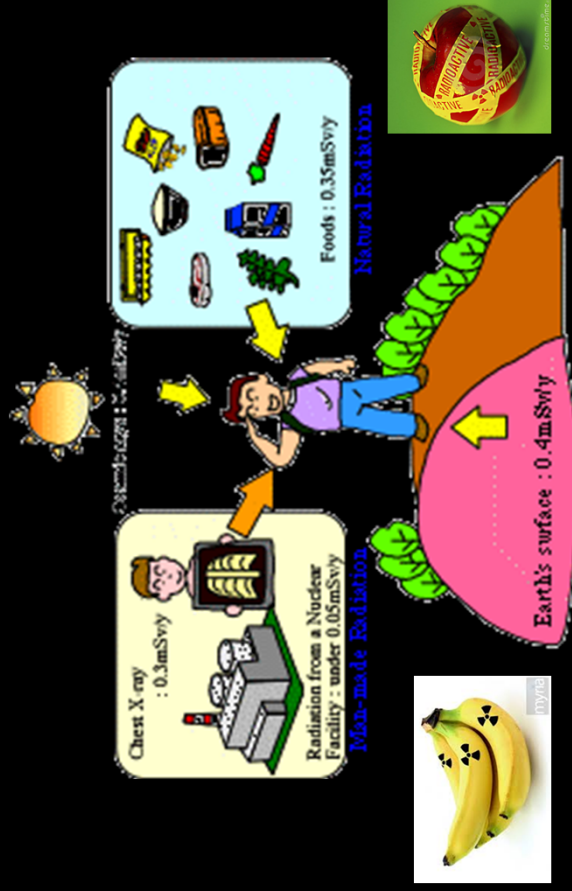


Fig. 1.1. Percent contribution of various sources of exposure to the total collective effective dose (1,870,000 person-Sv) and the total effective dose per individual in the U.S. population (6.2 mSv) for 2006. Percent values have been rounded to the nearest 1 %, except for those <1 % [see Table 1.1 for the values of S (person-sievert) and E_{US} (millisievert)].

Natural Radiation in Life



Radionuclides in Food			
Food	K-40 (pCi/kg)	Ra-226 (pCi/kg)	
Banana	3520	1	
Brazil nuts	5600	1000-7000	
Carrots	3400	0.6 - 2	
Potatoes	3400	1 - 2.5	
Beer	390	-	
Red meat	3000	0.5	
Lima beans	4640	2 - 5	
Drinking water	-	0 - 0.17	

Natural Occurring Radionuclides in Body		
Nuclide	Mass	Activity
Uranium	90 µg	1.1 Bq
Thorium	30 µg	0.11 Bq
Potassium 40	17 mg	4.4 kBq
Radium	31 pg	1.1 Bq
Carbon 14	22 ng	3.7 kBq
Tritium	0.06 pg	23 Bq
Polonium	0.2 pg	37 Bq

Radionuclides in Oceans	
Nuclide	Concentration
Uranium	33 mBq/L
Potassium 40	11 Bq/L
Tritium	0.6 mBq/L
Carbon 14	5 mBq/L
Rubidium 87	1.1 mBq/L

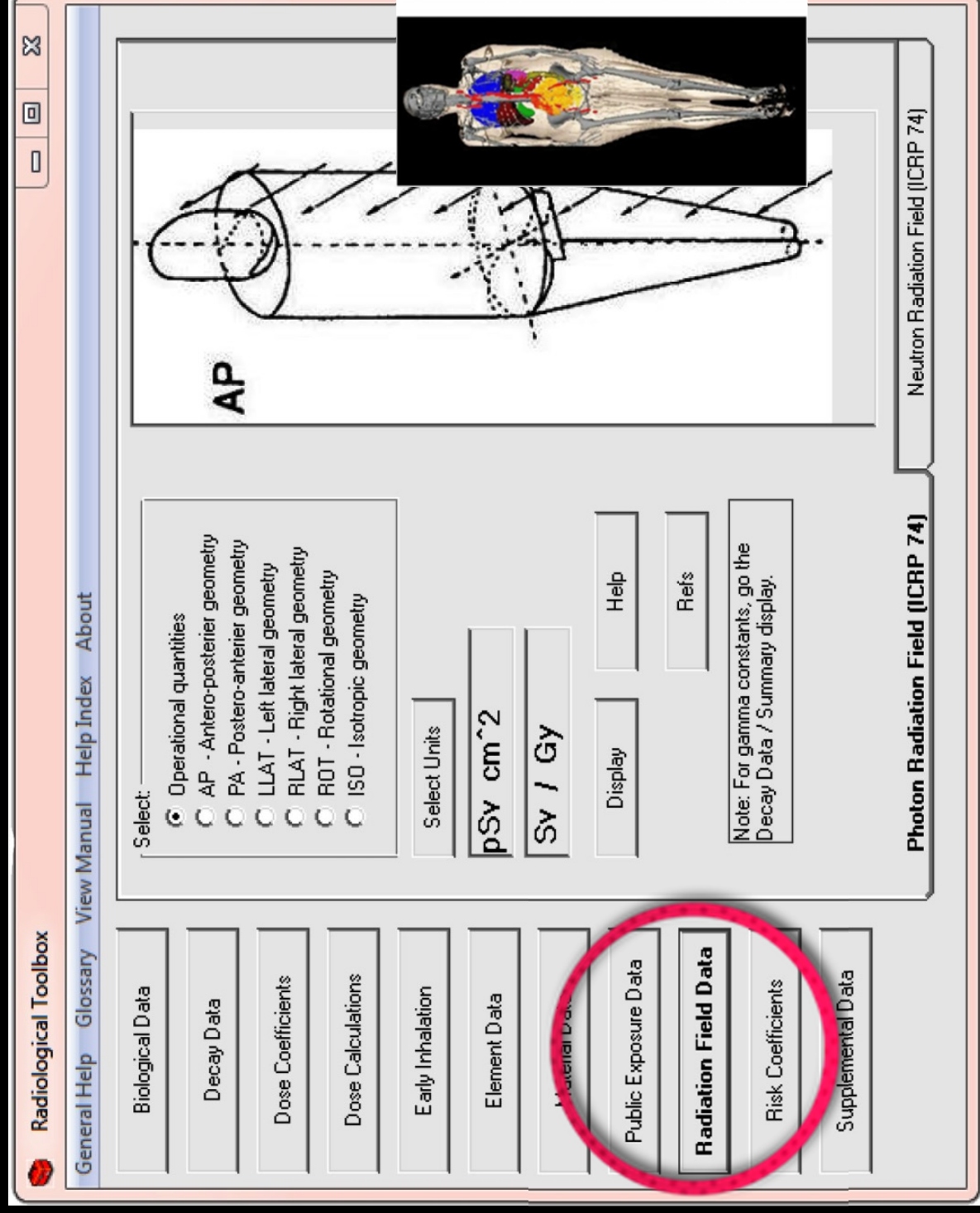
(db8) Medical Exposures



Dose from Medical Diagnostic Procedures		
Procedure	Dose (rem)	Dose (mSv)
Chest x-ray (1 film)	0.01	0.1
Dental x-ray	0.16	1.6
Mammogram	0.25	2.5
Lumbosacral spine	0.32	3.2
Bone scan (Tc-99m)	0.44	4.4
Cardiac (Tc-99m)	0.75	7.5
Cranial CT	5	50
GI fluoroscopy (barium)	8.5	85
Spiral CT	3-10	30 - 100

Computed tomography examinations

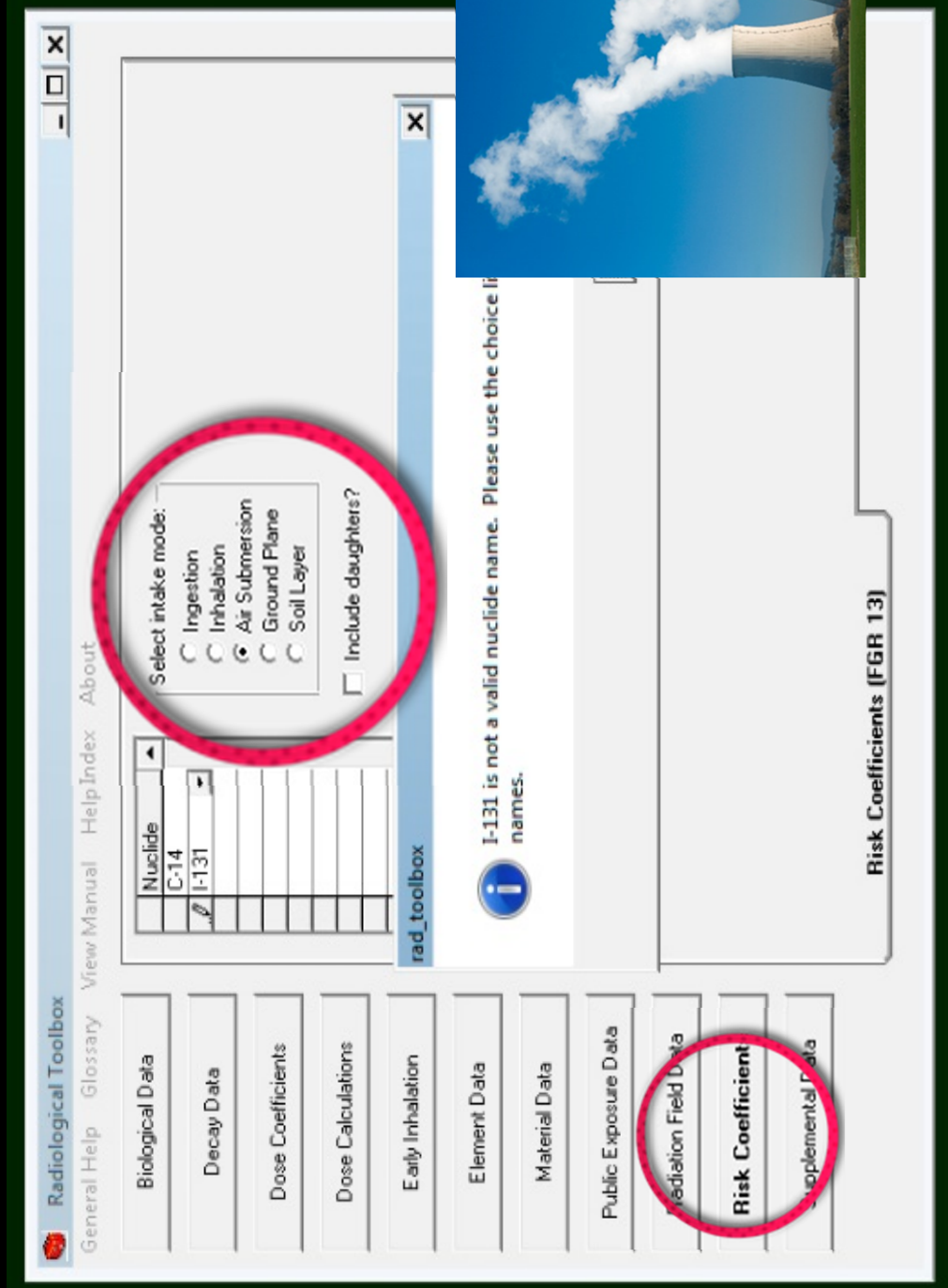
Effective dose per CT scans	
Examination	Dose (mSv)
Head	2
Chest	7
Abdomen/pelvis	10
Extremity	0.1
CT angiography: heart	20
CT angiography: head	5
Spine	10
Interventional	0.1
Whole-body screening	10
Calcium scoring	2
Cardiac	20
Virtual colonography	10
Miscellaneous	5



(db10) Radiological Risk Coefficients for Cancers

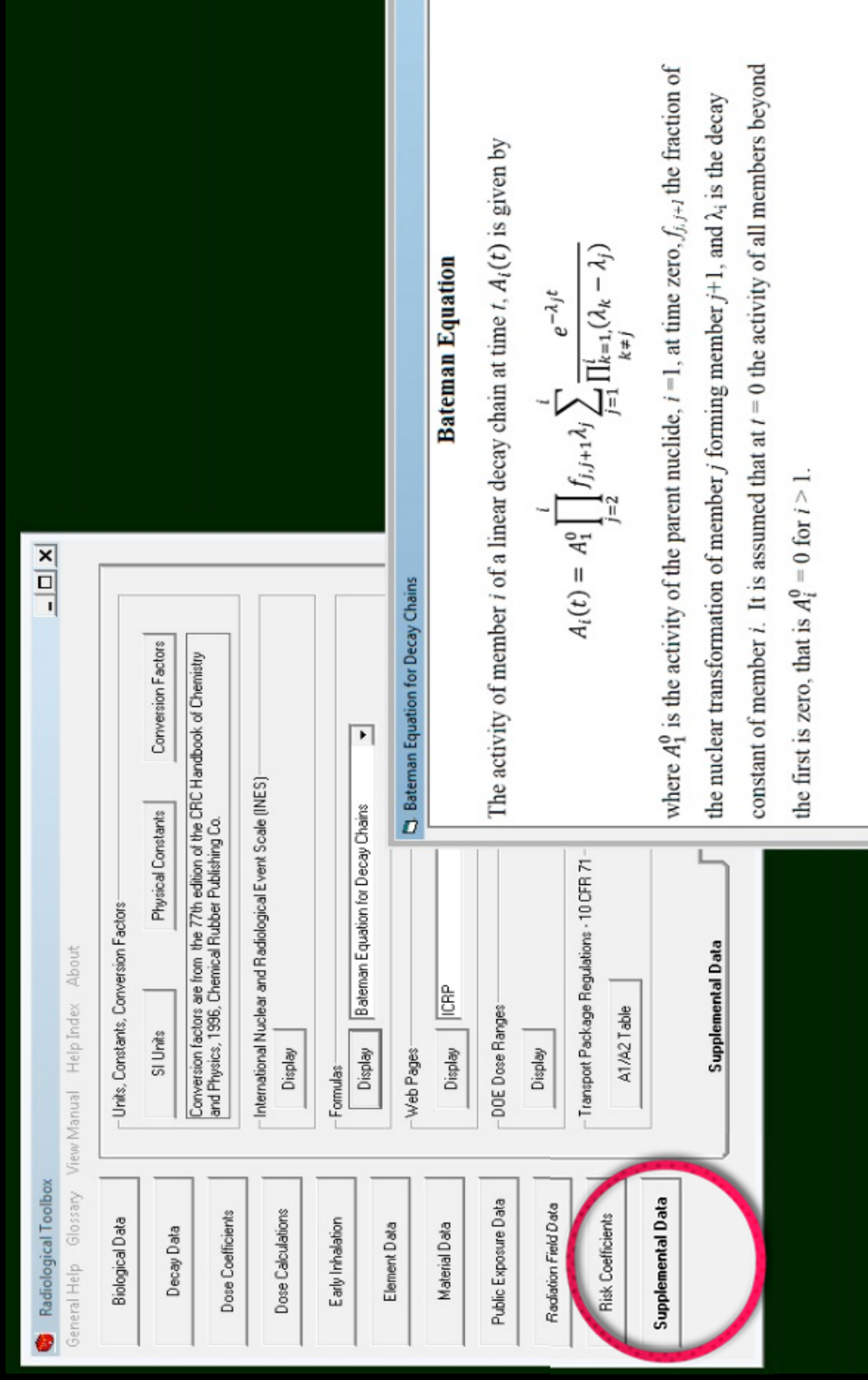
- Federal Guidance Reports 13
- Data presented for 14 cancer sites
- **Average member of the US public**
 - **Mortality risk** coefficient per unit activity inhaled or ingested for internal exposures or per unit time-integrated activity concentration in air or soil for external exposure
 - **Morbidity risk** coefficient is a comparable estimate of the average total risk of experiencing a radiogenic cancer, whether or not the cancer is fatal

(db10) Radiological Risk Coefficients for Cancers



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(db11) Supplemental Data



The screenshot displays the 'Radiological Toolbox' application window. The 'Supplemental Data' section is highlighted with a red circle. The interface includes a menu bar (General Help, Glossary, View Manual, Help Index, About) and a sidebar with various tool categories. The main content area is divided into several tabs: Units, Constants, Conversion Factors, Physical Constants, and Conversion Factors. The 'Conversion Factors' tab is active, showing conversion factors from the 77th edition of the CRC Handbook of Chemistry and Physics, 1996. Below this, there are sections for International Nuclear and Radiological Event Scale (INES), Formulas, Web Pages, DOE Dose Ranges, and Transport Package Regulations. The 'Supplemental Data' section is currently selected, displaying the Bateman Equation for Decay Chains.

Bateman Equation

The activity of member i of a linear decay chain at time t , $A_i(t)$ is given by

$$A_i(t) = A_1^0 \prod_{j=2}^i f_{j,j+1} \lambda_j \sum_{k=1}^i \frac{e^{-\lambda_j t}}{\prod_{k \neq j} (\lambda_k - \lambda_j)}$$

where A_1^0 is the activity of the parent nuclide, $i=1$, at time zero, $f_{j,j+1}$ the fraction of the nuclear transformation of member j forming member $j+1$, and λ_i is the decay constant of member i . It is assumed that at $t=0$ the activity of all members beyond the first is zero, that is $A_i^0 = 0$ for $i > 1$.

(db111) DOE: Office of Science

Ionizing Radiation Dose Ranges (Rem)



U.S. DEPARTMENT OF ENERGY

Evidence for small increases in human cancer above 10 rem acute exposure or 20 rem chronic exposure

Typical mission doses on International Space Station (ISS)

Kerala coast, India
high natural bkg/yr

Typical added annual dose for commercial airline flight crews

Airport x-ray scanner:
0.007 mrem/scan
(Limit = 25 mrem/yr
≈ 4000 scans/yr)

Round-trip New York - Los Angeles
(≈ 3.7 mrem)

EPA dose limit from release in air: public drinking water systems: 4 mrem/yr

EPA cleanup criteria for site decommissioning / unrestricted use: 25 mrem/yr

DOE facility releases average ≈ 310 mrem/yr (includes radon)

Natural background, USA (includes radon)

Yangjiang, China (1 rem)

Medical Diagnostics (A-O) see chart >>

DOE Low Dose Program

DOE, NRC dose limit for workers: 5 rem/yr (50 mSv/yr)

DHS emergency guideline for public relocation: high natural bkg/yr

DHS emergency guideline to save a life: 25 rem

Interplanetary Space natural bkg/yr

Human LD₅₀ range acute exposure with medical intervention*

Human LD₅₀ range acute exposure with medical intervention*

Whole body, acute: lung damage; cognitive dysfunction (death certain in 5 to 12 days)*

Life Span Study (A-bomb survivor epidemiology)

Charged particle event (Solar flare) dose on moon, no shielding

Estimated dose for 3-yr Mars mission (current shielding)

Ramsar, Iran high natural bkg/yr

Typical mission doses on International Space Station (ISS)

Kerala coast, India high natural bkg/yr

Typical added annual dose for commercial airline flight crews

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Human LD₅₀ range acute exposure with medical intervention*

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Whole body, acute: circulating blood cell death; moderate G-I damage (death probable 2-3 wks)*

Temporary epilation (3 wk onset)

Main erythema reaction [10 day onset]

Whole body, acute: cerebral/vascular breakdown (death in 0-5 days)*

Whole body, acute: marked G-I and bone marrow damage (death probable in 1-2 wks)*

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Medical Diagnostics (Estimated maximum organ dose)

A - Chest (PA & Lat) 0.014

B - Dental Panoramic 0.07

C - Lumbar-Sacral Spine 0.2 - 0.3

D - Mammogram 0.2 - 0.4

E - Heart Stress (Tc-99m) 0.6 - 1.2

F - Bone (Tc-99m) 0.4 - 1.5

G - Dual Isotope Stress Test 4.0 - 4.5

H - PET: F-18 FDG (bladder) 5.5 - 8

I - Chest (multiple scan average dose) 2 - 3

J - Head 3 - 5

K - Abdominal 2.2 - 6

L - Full Body 5 - 10

M - Barium Contrast G.I. 1 - 2.2

N - Cardiac Catheterization 1.2 - 4

O - TIPS Procedure 40 - 140

Fluoroscopy/Procedures

LD₅₀ = Lethal Dose to 50% (whole body dose that results in lethality to 50% of exposed individuals in 30-60 days)

Dose Equivalent: 100 rem = 1 Sievert = (absorbed dose x radiation quality)

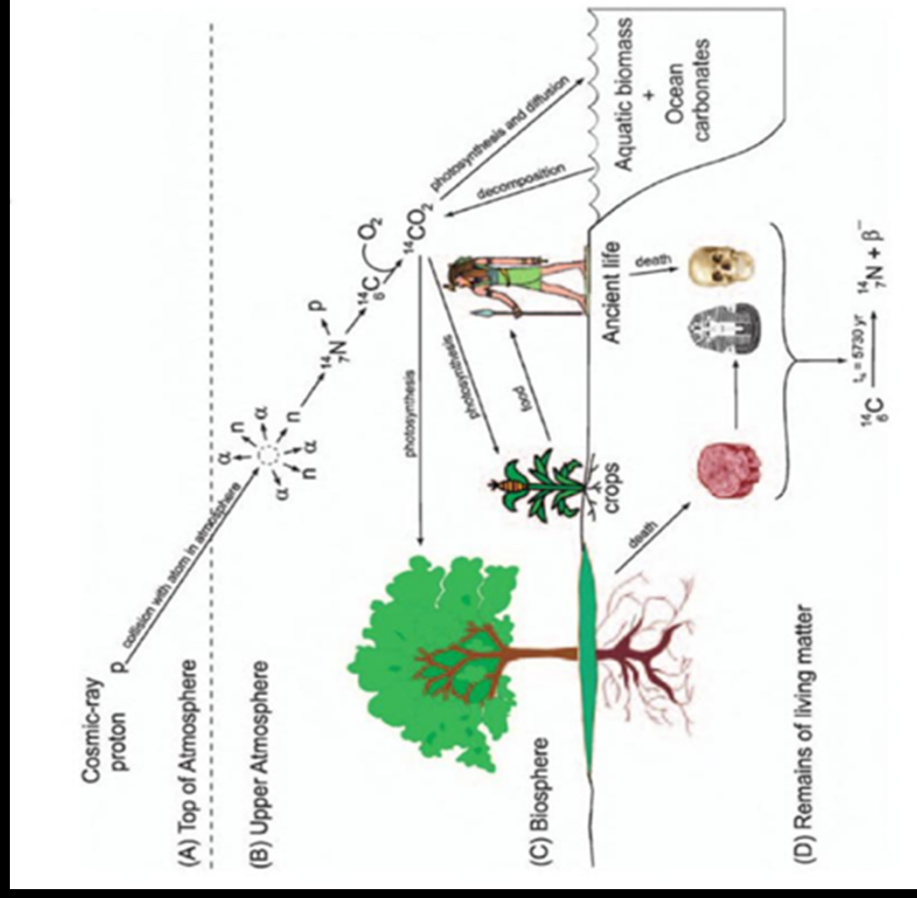
Absorbed Dose: 100 rad = 1 Gray

NOTE: This chart was constructed with the intention of providing a simple, use-friendly, "order-of-magnitude" reference for radiation exposures of interest to scientists, managers, and the general public. In that spirit, most quantities are expressed as "dose equivalent" in the more commonly used radiation protection units, the rem and Sievert. Medical diagnostics are expressed as estimated maximum organ dose, as they are not in "effective dose" units. The purpose of this chart is to provide a visual reference for the relative magnitudes of various radiation doses and to illustrate the wide range of exposure levels encountered in our society. It is not intended to be used for regulatory or legal purposes, and does not address everyone's needs. (NRC = Nuclear Regulatory Commission; EPA = Environmental Protection Agency; DHS = Department of Homeland Security) Disclaimer: Neither the United States Government nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information disclosed.

Chart compiled by NF Meeting, Office of Science, DOE/BER, "Orders of Magnitude" revised June 2010 <http://www.lowdose.energy.gov>

Source: Office of Biological and Environmental Research (BER), Office of Science, U.S. Department of Energy <http://www.science.doe.gov/ober>

Do We Need More Database?



$$C(x, y, z, t) = \frac{2\pi n_0 \sigma_0}{Q} \cdot \exp\left(-\frac{y^2}{2\sigma_y^2}\right) \cdot \exp\left(-\frac{(z - H_0)^2}{2\sigma_z^2}\right) + \exp\left(-\frac{(z + H_0)^2}{2\sigma_z^2}\right)$$

Oranges & Apples



A first peek at Cuyama Valley solar project

Plant would generate power for 13,000 homes, company says

By Brian Bullock / Staff Writer /
 bbullock@santamariatimes.com
 Jan 29, 2013





A word cloud featuring the phrase "Thank You" in numerous languages and scripts, including English, Spanish, French, German, Italian, Japanese, Korean, Chinese, Hindi, and others. The words are arranged in a circular pattern, with "Thank You" in the center. At the bottom of the word cloud, there is a cartoon illustration of a smiling, light blue dinosaur with its arms raised in a gesture of gratitude.

