IAEA
International Atomic Energy Agency
Atoms for Peace and Development

ASSESSMENT OF OCCUPATIONAL EXPOSURE DUE TO INTERNAL RADIATION SOURCES

UNIT 10

ICRP/OIR DATA VIEWER.

SOFTWARE FOR INTERNAL DOSIMETRY

ICRP/OIR DATA VIEWER. SOFTWARE FOR INTERNAL DOSIMETRY

LECTURE CONTENT

- **ICRP/OIR DATA VIEWER. Electronic Annex of OIR Publications Parts 1-5.**
- **TAURUS – Sofware using ICRP/OIR Models** (ICRP Publication 103)
- **IDEA PLUS – Sofware using ICRP/OIR Models** (ICRP Publication 103)
- **CADOR MED – Sofware using ICRP/OIR Models** (ICRP Publication 103)
- **Software for internal dosimetry based on ICRP Publications 60/78/119**

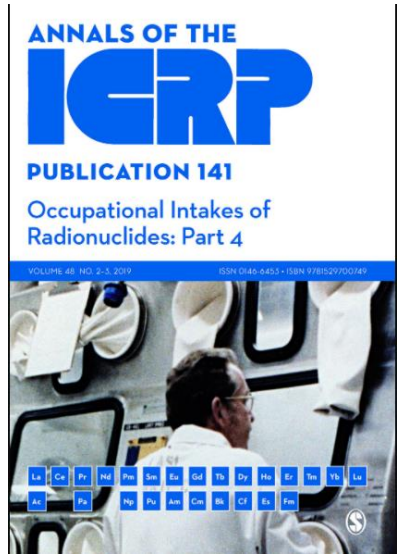
ICRP/OIR DATA VIEWER. SOFTWARE FOR INTERNAL DOSIMETRY

- **ICRP/OIR DATA VIEWER. Electronic Annex of OIR Publications Parts 1-5**

  ✓ The **ICRP/OIR (Occupational Intakes of Radionuclides) Data Viewer** is a freely downloadable electronic supplement which includes all radionuclides from the OIR Parts 2, 3, and 4 combined (when published, the electronic supplement to OIR Part 5 will supersede it).

  ✓Last version of OIR Data Viewer for ICRP Publications 134 (OIR Part 2), 137 (OIR Part 3) and 141 (OIR Part 4): v4010419 2019 July 30:
  https://journals.sagepub.com/doi/suppl/10.1177/ANIB_48_2-3

  ✓ The OIR **Data Viewer** can display:
  - Dose per intake (dose coefficients)
  - Dose per content functions,
  - Content for specified doses,
  - Content per intake - Reference Bioassay (retention/excretion) functions.



ICRP/OIR DATA VIEWER. SOFTWARE FOR INTERNAL DOSIMETRY

- **ICRP/OIR DATA VIEWER. Electronic Annex of OIR Publications Parts 1-5.**

✓**Using the Latest ICRP Dose Coefficients: ICRP's Data Viewer, IDEAplus, and TAURUS**
https://www.icrp.org/page.asp?id=483

✓ The Occupational Intakes of Radionuclides (OIR) series of publications is (almost) complete, the full set of internal dose coefficients for occupational exposures is (nearly) finished.

✓ ICRP Publication 130 Occupational Intakes of Radionuclides Part 1 lays out the methodology.

✓ OIR Part 2, Part 3, Part 4 and Part 5 provide coefficients for different sets of radionuclides.
  - Part 5, focuses on radionuclides less often encountered, and will complete this series.

✓ Third-party software that uses ICRP's latest data is available.

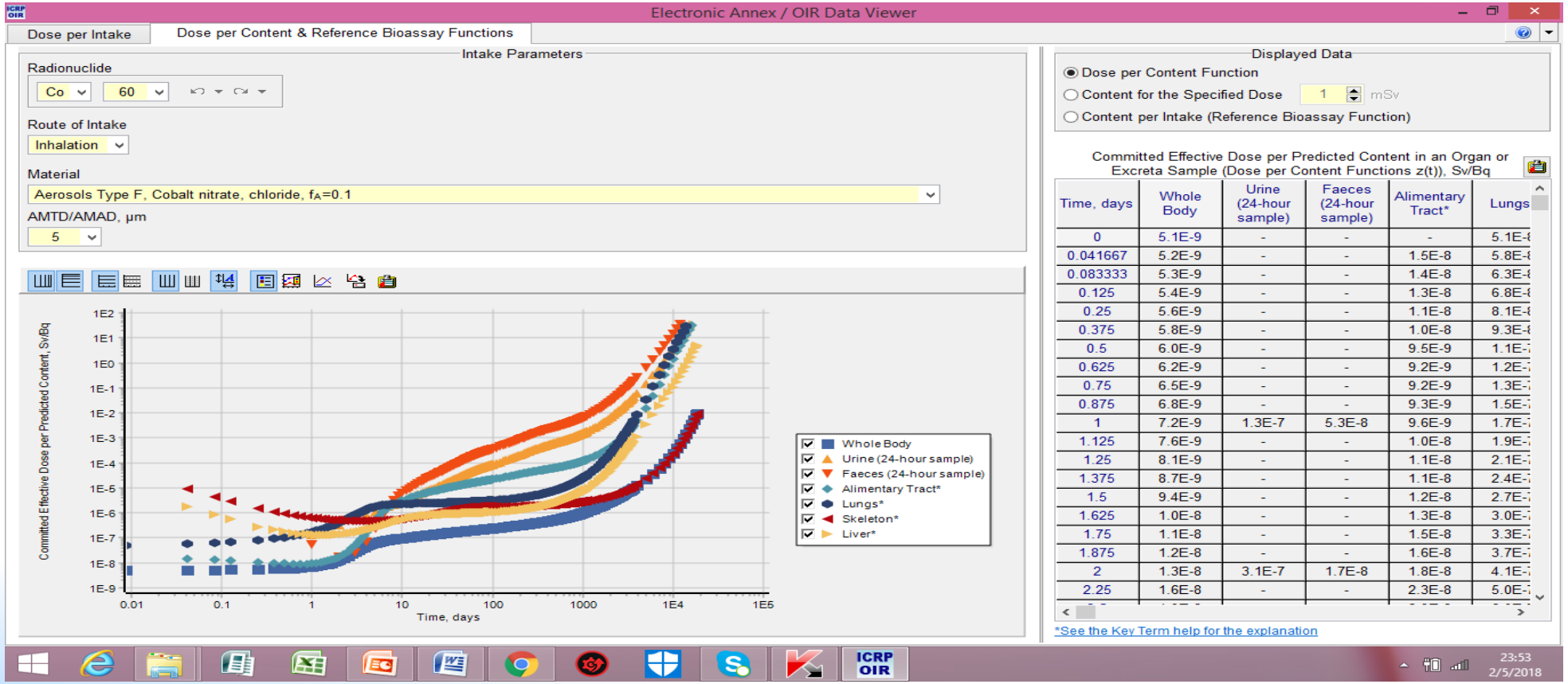
ICRP/OIR DATA VIEWER. SOFTWARE FOR INTERNAL DOSIMETRY

- **ICRP/OIR DATA VIEWER. Electronic Annex of OIR Publications Parts 1-5.**
  - **Occupational Intakes of Radionuclides (OIR) – Parts 1-5**
    - **ICRP Publication 130** – OIR Part 1 (2015). Generic principles, monitoring + revised HRTM
    - **ICRP Publication 134** – OIR Part 2 (2017). H, C, P, S, Ca, Fe, Co, Zn, Sr, Y, Zr, Nb, Mo, Tc
    - **ICRP Publication 137** – OIR Part 3 (2017)
      Ru, Sb, Te, I, Cs, Ba, Ir, Pb, Bi, Po, Ra, Th, U and Rn (dose coefficients for radon derived using biokinetic and dosimetric models)
    - **ICRP Publication 141** – OIR Part 4 (2019)
      La, Ce, Pr, Nd, Pm, Sm, Eu, Gd, Tb, Dy, Ho, Er, Tm, Yb, Lu, Ac, Pa, Np, Pu, Am, Cm, Bk, Cf, Es, Fm
    - **ICRP Publication -** OIR Part 5 (in press): Be, F, Na, Mg, Al, Si, Cl, K, Sc, Ti, V, Cr, Mn, Ni, Cu, Ga, Ge, As, Br, Rb, Ag, Cd, In, Sn, Pt, Au, Hg, Tl, La, Hf, At, Fr, Se, Rh, Pd, W, Re, Os and noble gases Ne, Ar, Kr, Xe

ICRP/OIR DATA VIEWER. SOFTWARE FOR INTERNAL DOSIMETRY

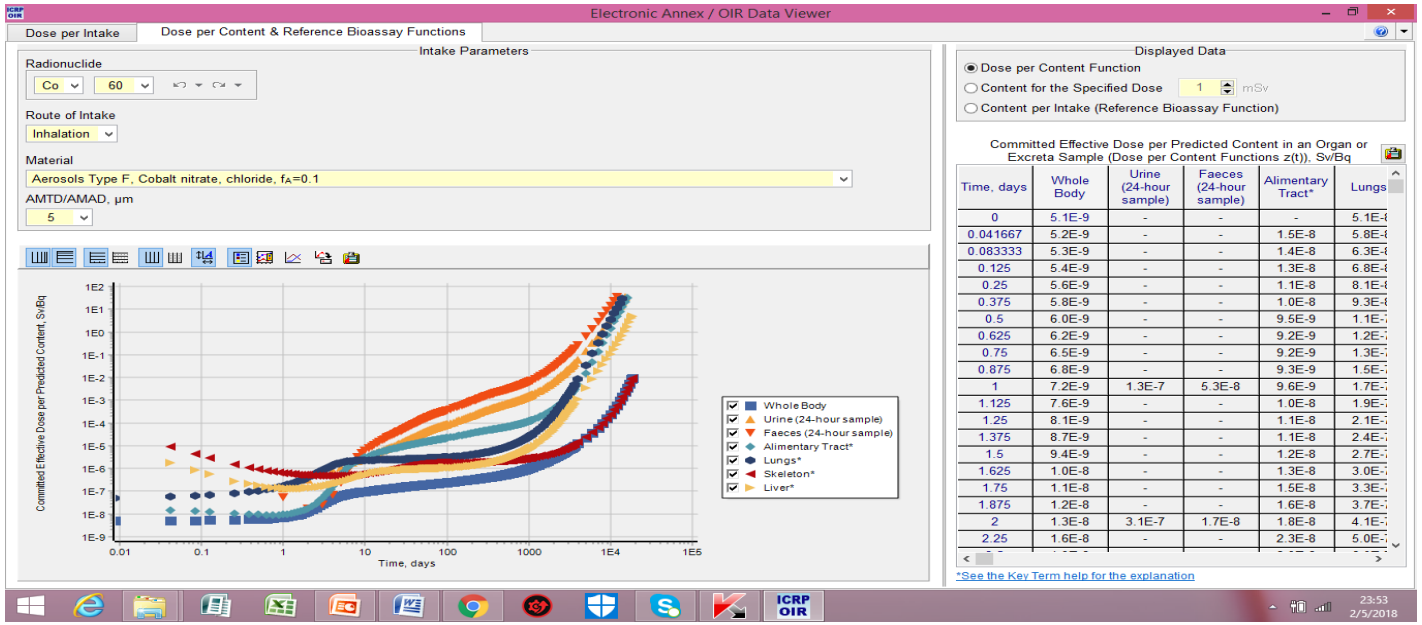
- **OCCUPATIONAL INTERNAL DOSIMETRY - OIR DATA VIEWER**

Last update: Electronic Annex ICRP Publication 141 https://journals.sagepub.com/doi/suppl/10.1177/ANIB_48_2-3



ICRP/OIR DATA VIEWER. SOFTWARE FOR INTERNAL DOSIMETRY

- **ICRP Electronic Annex /OIR DATA VIEWER**



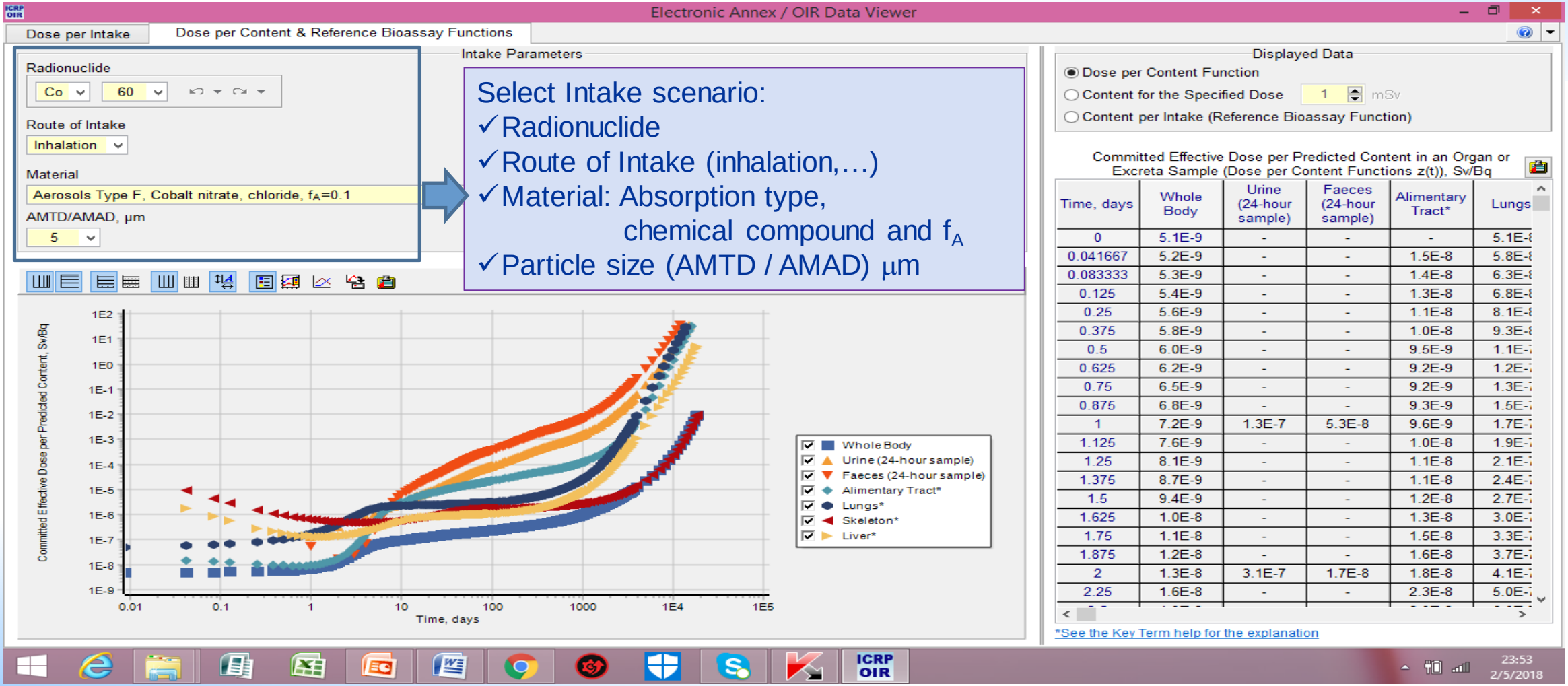
Select Intake scenario:
- ✓Radionuclide
- ✓Route of Intake (inhalation,…)
- ✓Material: Absorption type, chemical compound and f_A
- ✓Particle size (AMTD / AMAD) µm

Select type of data to be displayed:
- ✓Dose per Intake e(50) $SvBq^{-1}$

- ✓Dose per Content z(t) function
- ✓Content for the specific dose *(select the dose in mSv)*
- ✓Content per Intake m(t) Reference Bioassay (retention/excretion) functions

ICRP/OIR DATA VIEWER. SOFTWARE FOR INTERNAL DOSIMETRY

- **ICRP Electronic Annex /OIR DATA VIEWER**



Time, days	Whole Body	Urine (24-hour sample)	Faeces (24-hour sample)	Alimentary Tract*	Lungs
0	5.1E-9	-	-	-	5.1E-8
0.041667	5.2E-9	-	-	1.5E-8	5.8E-8
0.083333	5.3E-9	-	-	1.4E-8	6.3E-8
0.125	5.4E-9	-	-	1.3E-8	6.8E-8
0.25	5.6E-9	-	-	1.1E-8	8.1E-8
0.375	5.8E-9	-	-	1.0E-8	9.3E-8
0.5	6.0E-9	-	-	9.5E-9	1.1E-7
0.625	6.2E-9	-	-	9.2E-9	1.2E-7
0.75	6.5E-9	-	-	9.2E-9	1.3E-7
0.875	6.8E-9	-	-	9.3E-9	1.5E-7
1	7.2E-9	1.3E-7	5.3E-8	9.6E-9	1.7E-7
1.125	7.6E-9	-	-	1.0E-8	1.9E-7
1.25	8.1E-9	-	-	1.1E-8	2.1E-7
1.375	8.7E-9	-	-	1.1E-8	2.4E-7
1.5	9.4E-9	-	-	1.2E-8	2.7E-7
1.625	1.0E-8	-	-	1.3E-8	3.0E-7
1.75	1.1E-8	-	-	1.5E-8	3.3E-7
1.875	1.2E-8	-	-	1.6E-8	3.7E-7
2	1.3E-8	3.1E-7	1.7E-8	1.8E-8	4.1E-7
2.25	1.6E-8	-	-	2.3E-8	5.0E-7

ICRP/OIR DATA VIEWER. SOFTWARE FOR INTERNAL DOSIMETRY

- **ICRP Electronic Annex /OIR DATA VIEWER – DISPLAYED DATA**

Electronic Annex / OIR Data Viewer

Dose per Intake | Dose per Content & Reference Bioassay Functions

Intake Parameters

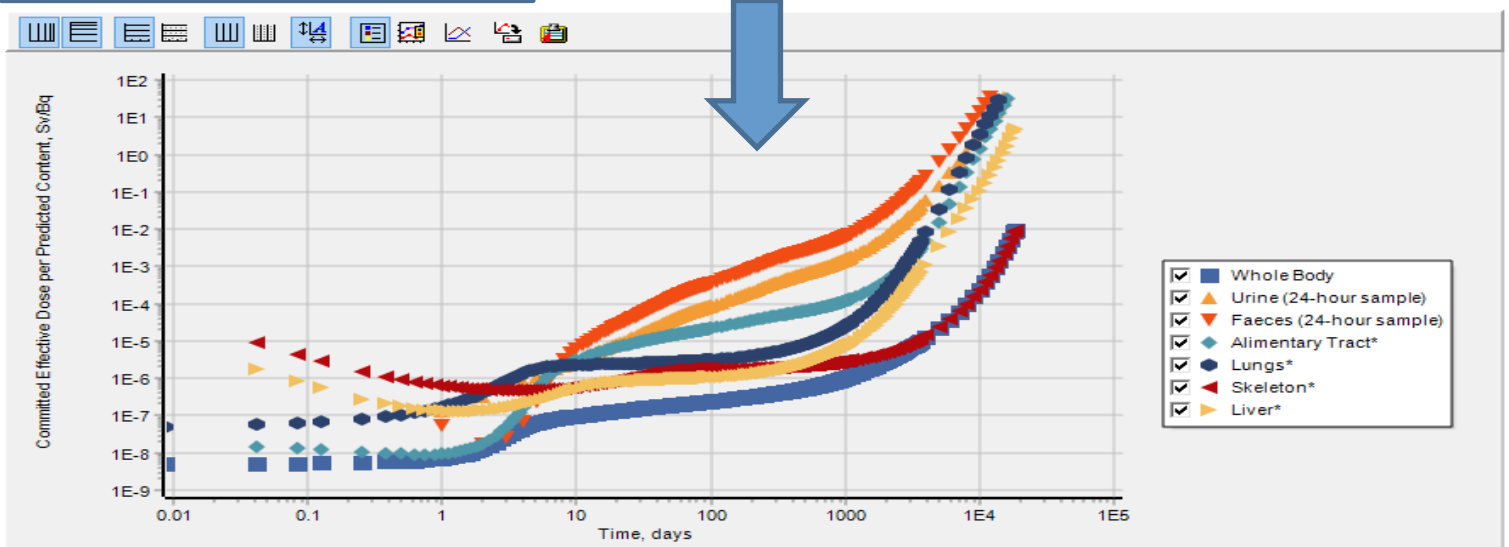
Radionuclide: Co 60

Route of Intake: Inhalation

Material: Aerosols Type F, Cobalt nitrate, chloride, f_A=0.1

AMTD/AMAD, μm: 5

Example 1: Radionuclide ^{60}Co
- ✓ Dose per content z(t) Sv/Bq displayed
- ✓ Intake scenario: Inhalation of aerosols Type F, cobalt nitrate, f_A =0.1, particle size AMAD= 5 μm



Displayed Data
- Dose per Content Function
- Content for the Specified Dose 1 mSv
- Content per Intake (Reference Bioassay Function)

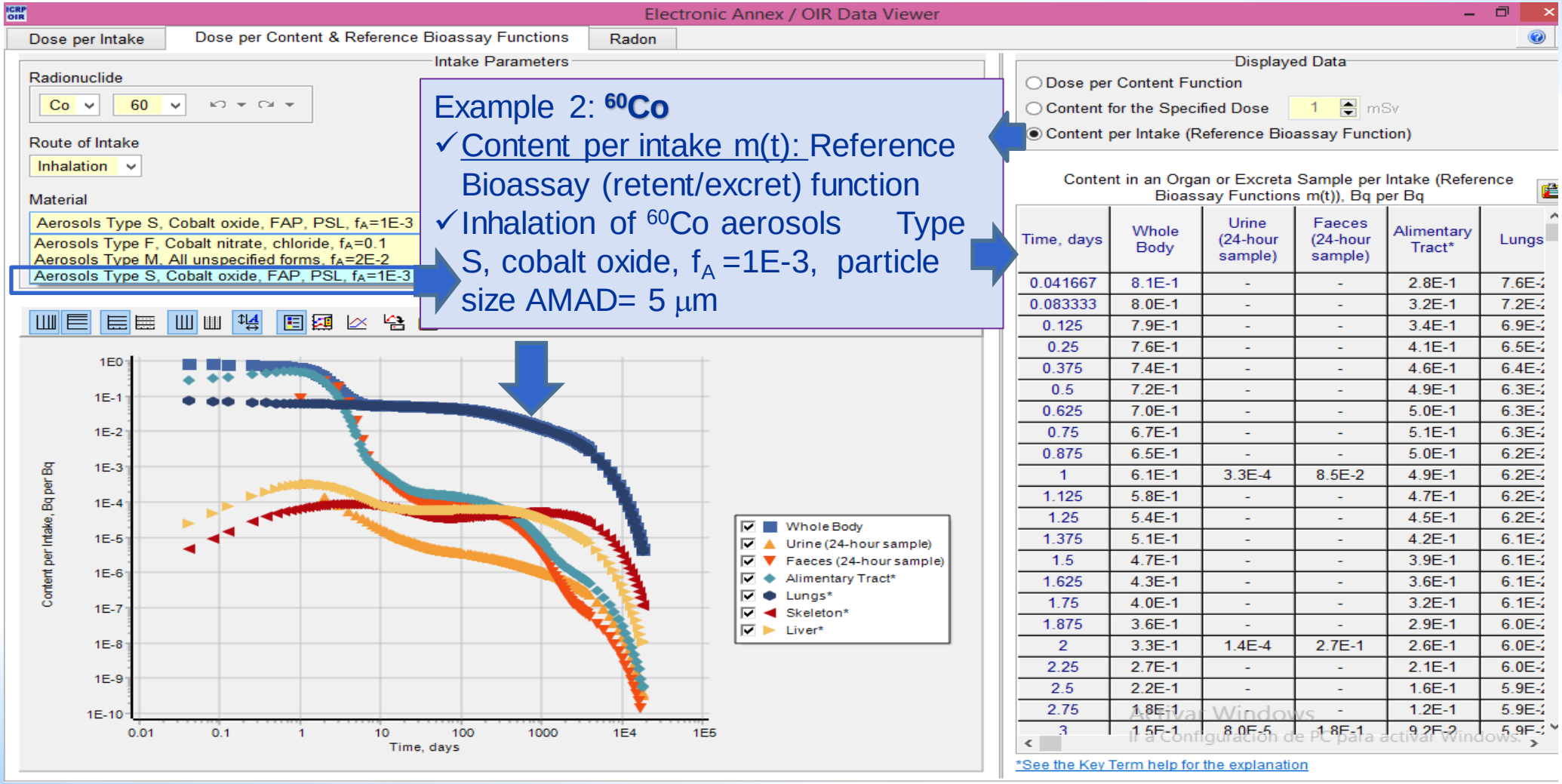
Committed Effective Dose per Predicted Content in an Organ or Excreta Sample (Dose per Content Functions z(t)), Sv/Bq

Time, days	Whole Body	Urine (24-hour sample)	Faeces (24-hour sample)	Alimentary Tract*	Lungs
0	5.1E-9	-	-	-	5.1E-9
0.041667	5.2E-9	-	-	1.5E-8	5.8E-9
0.083333	5.3E-9	-	-	1.4E-8	6.3E-9
0.125	5.4E-9	-	-	1.3E-8	6.8E-9
0.25	5.6E-9	-	-	1.1E-8	8.1E-9
0.375	5.8E-9	-	-	1.0E-8	9.3E-9
0.5	6.0E-9	-	-	9.5E-9	1.1E-8
0.625	6.2E-9	-	-	9.2E-9	1.2E-8
0.75	6.5E-9	-	-	9.2E-9	1.3E-8
0.875	6.8E-9	-	-	9.3E-9	1.5E-8
1	7.2E-9	1.3E-7	5.3E-8	9.6E-9	1.7E-8
1.125	7.6E-9	-	-	1.0E-8	1.9E-8
1.25	8.1E-9	-	-	1.1E-8	2.1E-8
1.375	8.7E-9	-	-	1.1E-8	2.4E-8
1.5	9.4E-9	-	-	1.2E-8	2.7E-8
1.625	1.0E-8	-	-	1.3E-8	3.0E-8
1.75	1.1E-8	-	-	1.5E-8	3.3E-8
1.875	1.2E-8	-	-	1.6E-8	3.7E-8
2	1.3E-8	3.1E-7	1.7E-8	1.8E-8	4.1E-8
2.25	1.6E-8	-	-	2.3E-8	5.0E-8

*See the Key Term help for the explanation

ICRP/OIR DATA VIEWER. SOFTWARE FOR INTERNAL DOSIMETRY

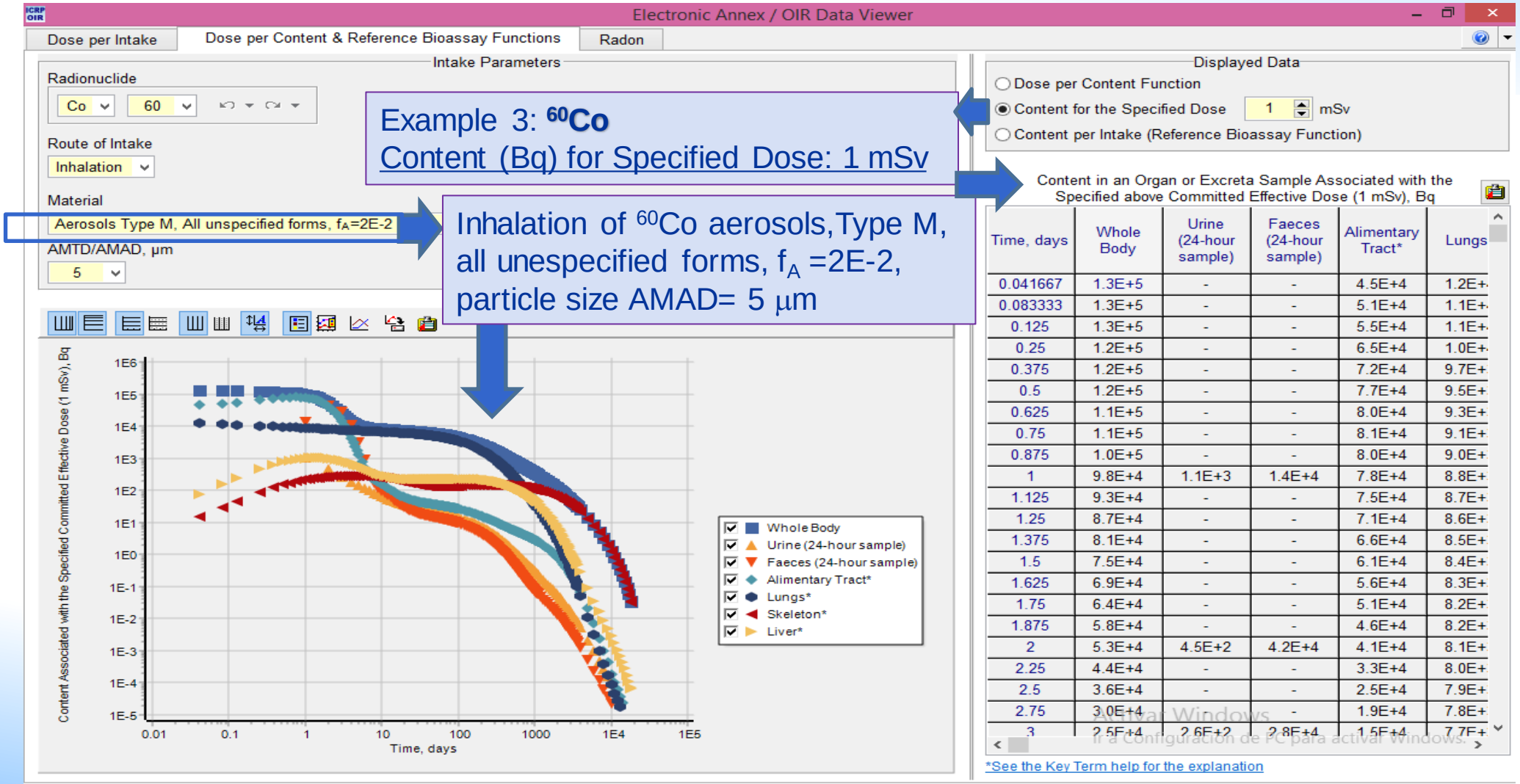
- **ICRP Electronic Annex /OIR DATA VIEWER - DISPLAYED DATA**



Time, days	Whole Body	Urine (24-hour sample)	Faeces (24-hour sample)	Alimentary Tract*	Lungs
0.041667	8.1E-1	-	-	2.8E-1	7.6E-
0.083333	8.0E-1	-	-	3.2E-1	7.2E-
0.125	7.9E-1	-	-	3.4E-1	6.9E-
0.25	7.6E-1	-	-	4.1E-1	6.5E-
0.375	7.4E-1	-	-	4.6E-1	6.4E-
0.5	7.2E-1	-	-	4.9E-1	6.3E-
0.625	7.0E-1	-	-	5.0E-1	6.3E-
0.75	6.7E-1	-	-	5.1E-1	6.3E-
0.875	6.5E-1	-	-	5.0E-1	6.2E-
1	6.1E-1	3.3E-4	8.5E-2	4.9E-1	6.2E-
1.125	5.8E-1	-	-	4.7E-1	6.2E-
1.25	5.4E-1	-	-	4.5E-1	6.2E-
1.375	5.1E-1	-	-	4.2E-1	6.1E-
1.5	4.7E-1	-	-	3.9E-1	6.1E-
1.625	4.3E-1	-	-	3.6E-1	6.1E-
1.75	4.0E-1	-	-	3.2E-1	6.1E-
1.875	3.6E-1	-	-	2.9E-1	6.0E-
2	3.3E-1	1.4E-4	2.7E-1	2.6E-1	6.0E-
2.25	2.7E-1	-	-	2.1E-1	6.0E-
2.5	2.2E-1	-	-	1.6E-1	5.9E-
2.75	1.8E-1	-	-	1.2E-1	5.9E-
3	1.5E-1	8.0E-5	1.8E-1	9.2E-2	5.9E-

ICRP/OIR DATA VIEWER. SOFTWARE FOR INTERNAL DOSIMETRY

- **ICRP Electronic Annex /OIR DATA VIEWER - DISPLAYED DATA**

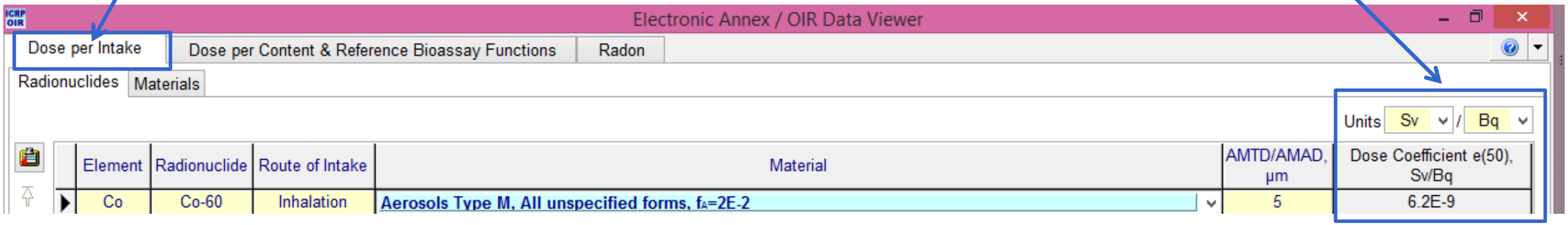


Time, days	Whole Body	Urine (24-hour sample)	Faeces (24-hour sample)	Alimentary Tract*	Lungs
0.041667	1.3E+5	-	-	4.5E+4	1.2E+
0.083333	1.3E+5	-	-	5.1E+4	1.1E+
0.125	1.3E+5	-	-	5.5E+4	1.1E+
0.25	1.2E+5	-	-	6.5E+4	1.0E+
0.375	1.2E+5	-	-	7.2E+4	9.7E+
0.5	1.2E+5	-	-	7.7E+4	9.5E+
0.625	1.1E+5	-	-	8.0E+4	9.3E+
0.75	1.1E+5	-	-	8.1E+4	9.1E+
0.875	1.0E+5	-	-	8.0E+4	9.0E+
1	9.8E+4	1.1E+3	1.4E+4	7.8E+4	8.8E+
1.125	9.3E+4	-	-	7.5E+4	8.7E+
1.25	8.7E+4	-	-	7.1E+4	8.6E+
1.375	8.1E+4	-	-	6.6E+4	8.5E+
1.5	7.5E+4	-	-	6.1E+4	8.4E+
1.625	6.9E+4	-	-	5.6E+4	8.3E+
1.75	6.4E+4	-	-	5.1E+4	8.2E+
1.875	5.8E+4	-	-	4.6E+4	8.2E+
2	5.3E+4	4.5E+2	4.2E+4	4.1E+4	8.1E+
2.25	4.4E+4	-	-	3.3E+4	8.0E+
2.5	3.6E+4	-	-	2.5E+4	7.9E+
2.75	3.0E+4	-	-	1.9E+4	7.8E+
3	2.5E+4	2.6E+2	2.8E+4	1.5E+4	7.7E+

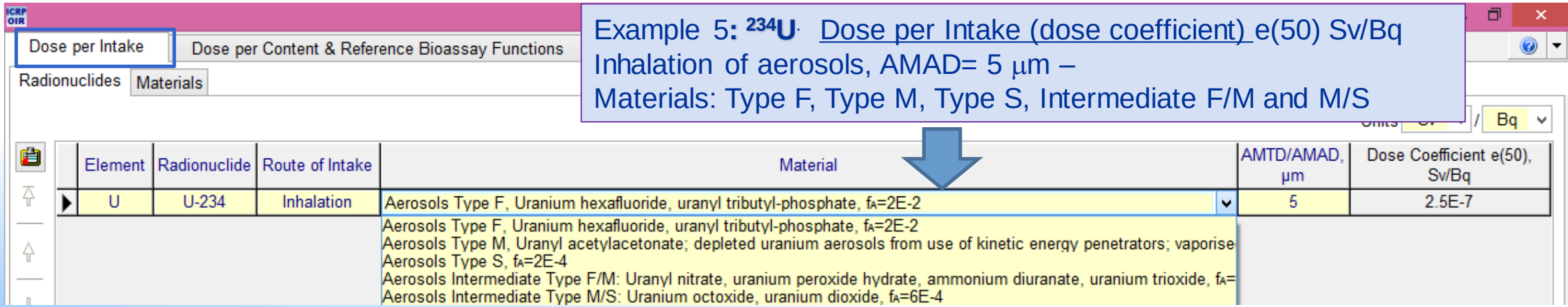
ICRP/OIR DATA VIEWER. SOFTWARE FOR INTERNAL DOSIMETRY

- **ICRP Electronic Annex /OIR DATA VIEWER - DISPLAYED DATA**

Example 4: ^{60}Co
✓ Dose per Intake (dose coefficient) e(50) Sv/Bq
✓ Inhalation of ^{60}Co aerosols, Type M, all unespecified forms, f_A =2E-2, AMAD= 5 μm

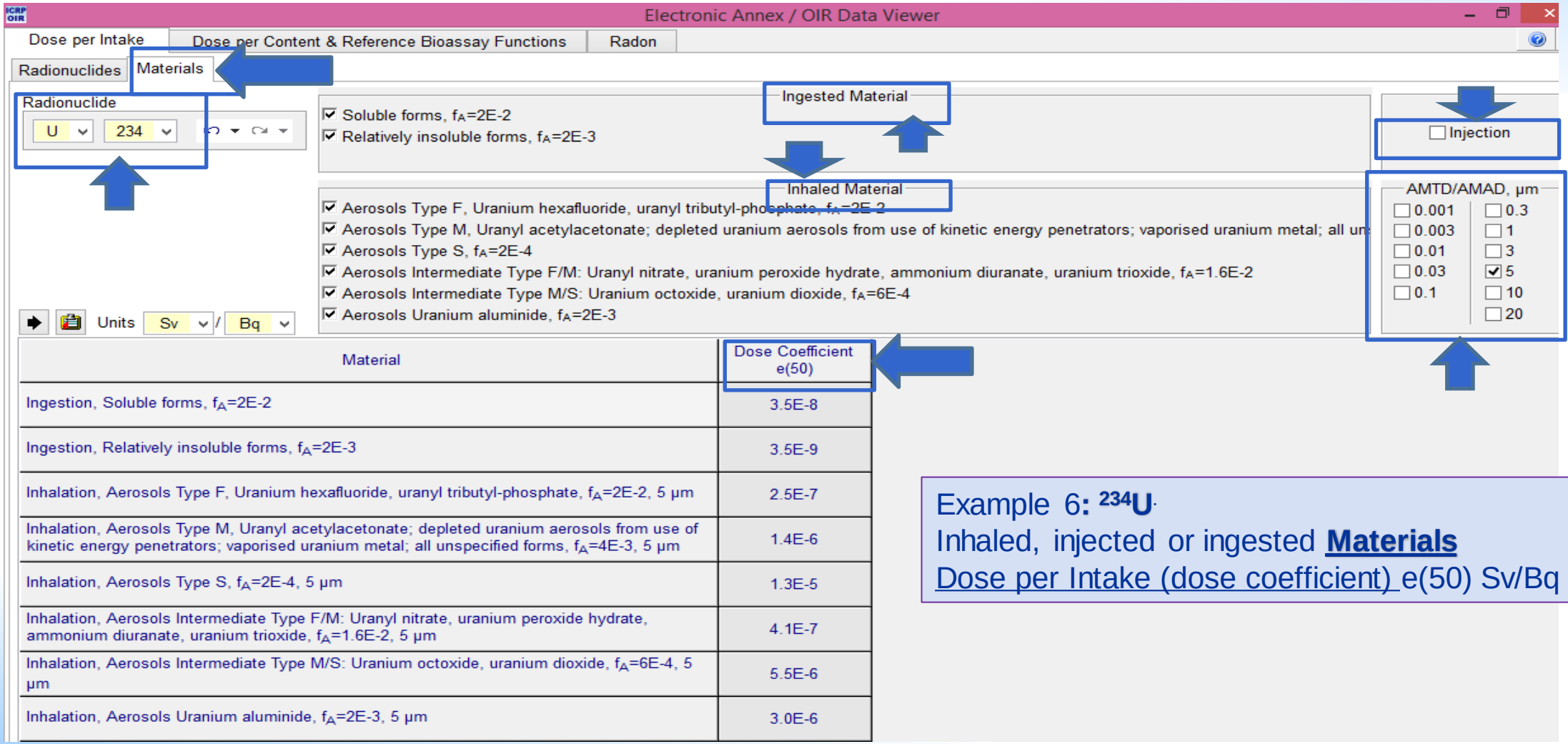


Example 5: ^{234}U. Dose per Intake (dose coefficient) e(50) Sv/Bq
Inhalation of aerosols, AMAD= 5 μm –
Materials: Type F, Type M, Type S, Intermediate F/M and M/S



ICRP/OIR DATA VIEWER. SOFTWARE FOR INTERNAL DOSIMETRY

- **ICRP Electronic Annex /OIR DATA VIEWER - DISPLAYED DATA**

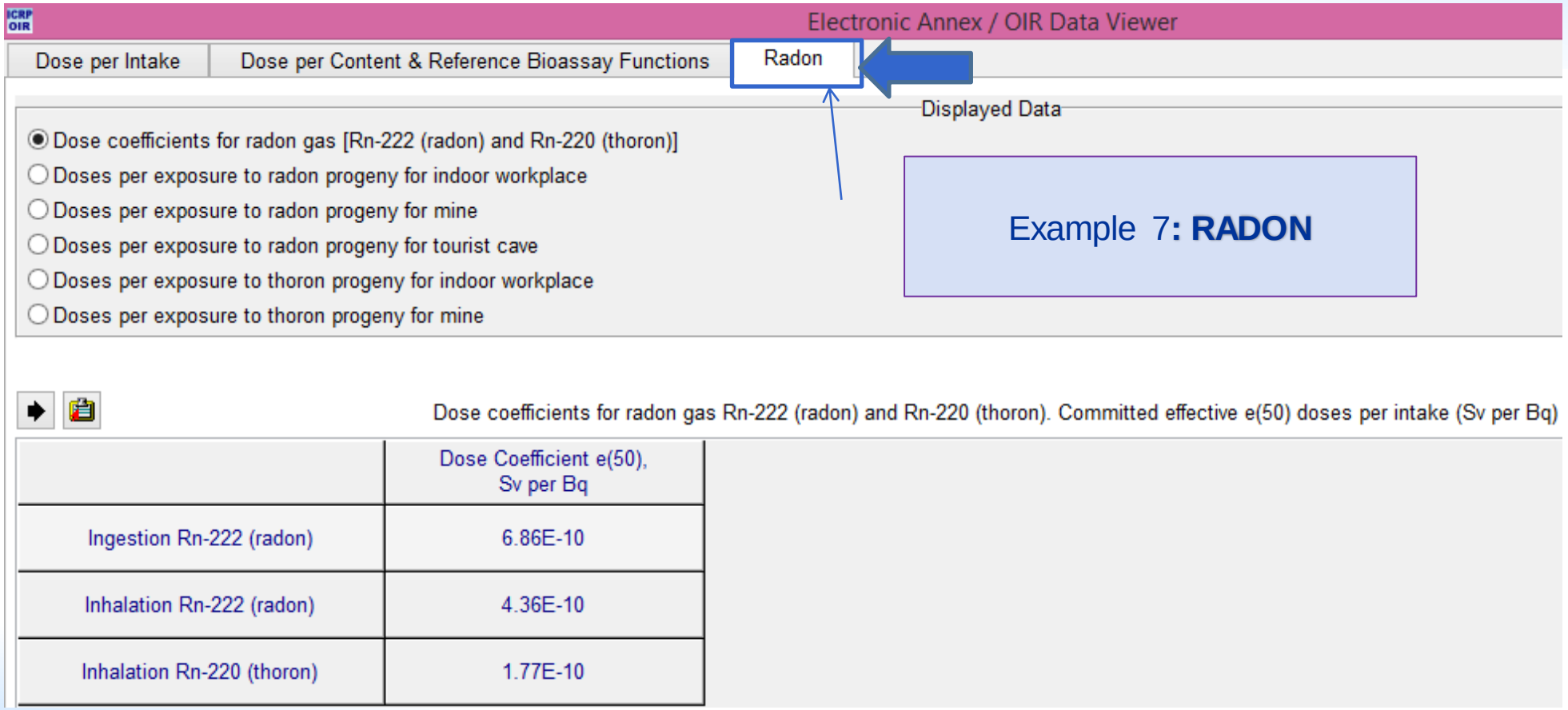


Material	Dose Coefficient e(50)
Ingestion, Soluble forms, f_A=2E-2	3.5E-8
Ingestion, Relatively insoluble forms, f_A=2E-3	3.5E-9
Inhalation, Aerosols Type F, Uranium hexafluoride, uranyl tributyl-phosphate, f_A=2E-2, 5 µm	2.5E-7
Inhalation, Aerosols Type M, Uranyl acetylacetonate; depleted uranium aerosols from use of kinetic energy penetrators; vaporised uranium metal; all unspecified forms, f_A=4E-3, 5 µm	1.4E-6
Inhalation, Aerosols Type S, f_A=2E-4, 5 µm	1.3E-5
Inhalation, Aerosols Intermediate Type F/M: Uranyl nitrate, uranium peroxide hydrate, ammonium diuranate, uranium trioxide, f_A=1.6E-2, 5 µm	4.1E-7
Inhalation, Aerosols Intermediate Type M/S: Uranium octoxide, uranium dioxide, f_A=6E-4, 5 µm	5.5E-6
Inhalation, Aerosols Uranium aluminide, f_A=2E-3, 5 µm	3.0E-6

Example 6: ^{234}U.
Inhaled, injected or ingested **Materials**
Dose per Intake (dose coefficient) e(50) Sv/Bq

ICRP/OIR DATA VIEWER. SOFTWARE FOR INTERNAL DOSIMETRY

- **ICRP Electronic Annex /OIR DATA VIEWER - DISPLAYED DATA**



	Dose Coefficient e(50), Sv per Bq
Ingestion Rn-222 (radon)	6.86E-10
Inhalation Rn-222 (radon)	4.36E-10
Inhalation Rn-220 (thoron)	1.77E-10

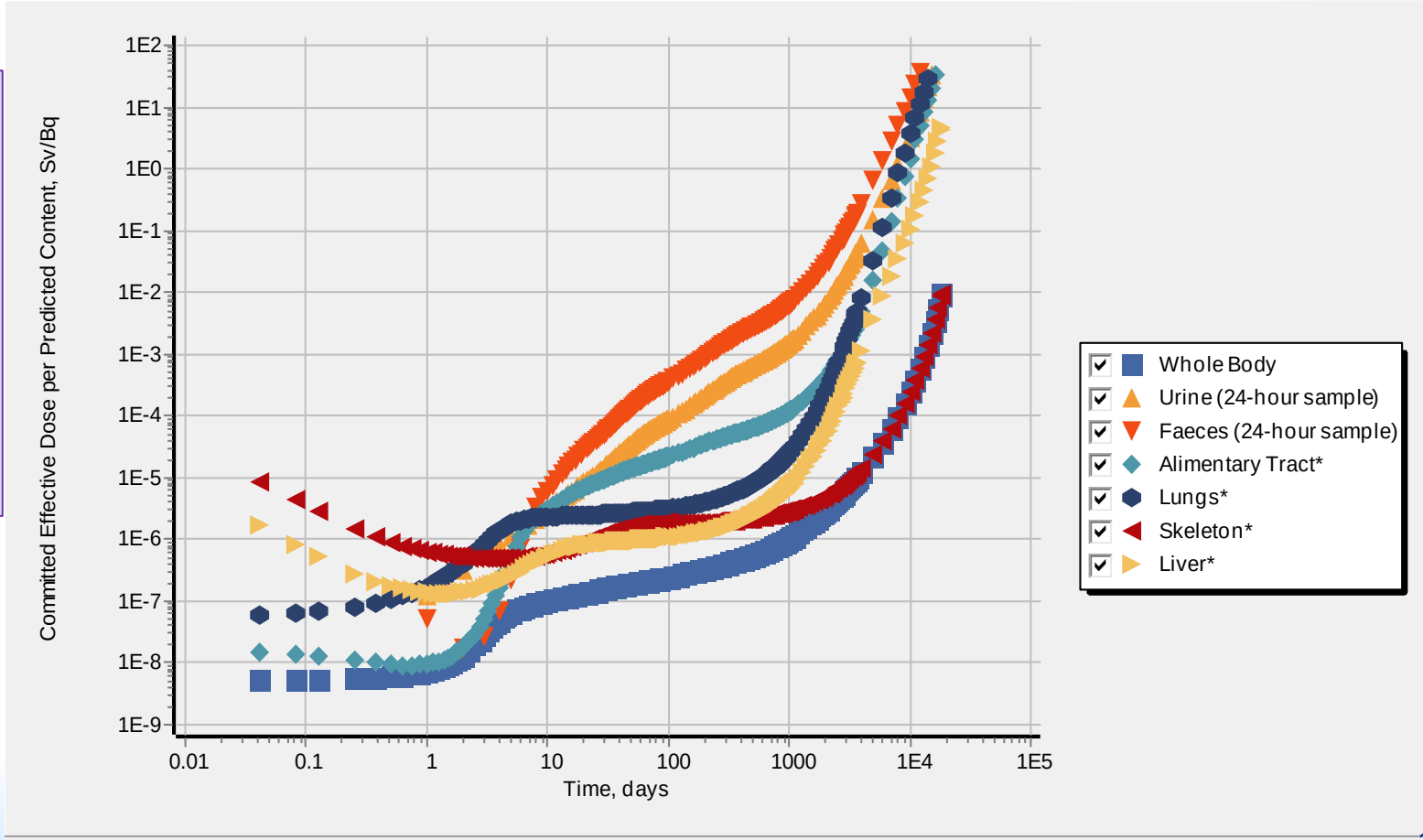
ICRP/OIR DATA VIEWER. SOFTWARE FOR INTERNAL DOSIMETRY

- **ICRP Electronic Annex /OIR DATA VIEWER – EXPORT GRAPH:**

Radionuclide ^{60}Co

✓**Dose per content z(t) Sv/Bq**

✓Inhalation
✓aerosols Type F,
✓cobalt nitrate,
✓f_A =0.1,
✓particle size AMAD= 5 μm



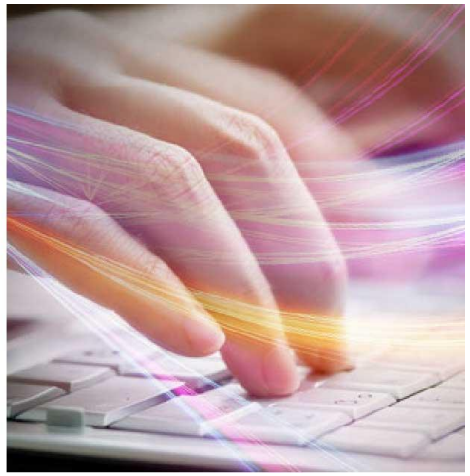
ICRP/OIR DATA VIEWER. SOFTWARE FOR INTERNAL DOSIMETRY

- **TAURUS – Software using ICRP/OIR Models** (ICRP Publication 103)
  https://www.icrp.org/page.asp?id=483

TAURUS
for IMBA

Developed by Public Health England's Radiation Hazards and Emergencies Department

phe-protectionservices.org.uk/imba



- ✓ TAURUS supersedes the earlier IMBA (Integrated Modules for Bioassay Analysis) suite of software modules.
- ✓ Taurus is designed to be an easy-to-use tool for standard internal dose assessments, both prospective and retrospective.
- ✓ Taurus can handle assessments involving up to 20 different intakes by either inhalation (particulate or gas/vapour), ingestion or direct injection; and up to 2000 measurements for a variety of bioassay quantities. **TAURUS uses ICRP's latest data with ICRP`s permission**

ICRP does not endorse, recommend, or guarantee any third-party software, and shall not be liable for any loss or damage arising from its use.

ICRP/OIR DATA VIEWER. SOFTWARE FOR INTERNAL DOSIMETRY

- **TAURUS – Software using ICRP/OIR Models** (ICRP Publication 103)
  https://www.phe-protectionservices.org.uk/imba

  ✓ **Taurus** is the new internal dosimetry software developed by PHE's Centre for Radiation, Chemical and Environmental Hazards in UK.

  - **Taurus** implements the most recent recommendations of the International Commission on Radiological Protection (ICRP Publication 103) and all the biokinetic and dosimetric models used for the calculation of the effective dose coefficients in the "Occupational Intakes of Radionuclides (OIR)" series of ICRP Publications.

  - Users can use ICRP default parameter values or specify the parameter values for prospective and retrospective internal dosimetry calculations.

  ✓ **Taurus** is available since September 2020 – **Email: Taurus@ phe.gov.uk**

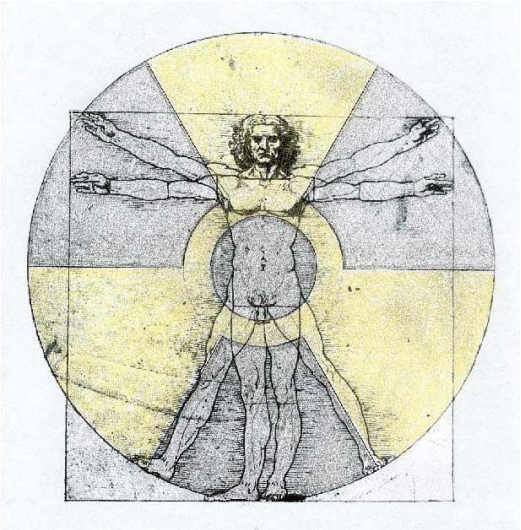
  (*Contact : PHE (Public Helath England, Chilton office. Internal Dosimetry Group. Chilton, Didcot, Oxon OX11 0RQ, UK. Telephone +44 (0) 01235 822660)*

ICRP/OIR DATA VIEWER. SOFTWARE FOR INTERNAL DOSIMETRY

- **IDEA PLUS – Software using ICRP/OIR Models** (ICRP Publication 103)
  https://www.icrp.org/page.asp?id=483

IDEAplus
Expert System for
Internal Dosimetry
Developed by IDEA System GmbH

idea-system.com

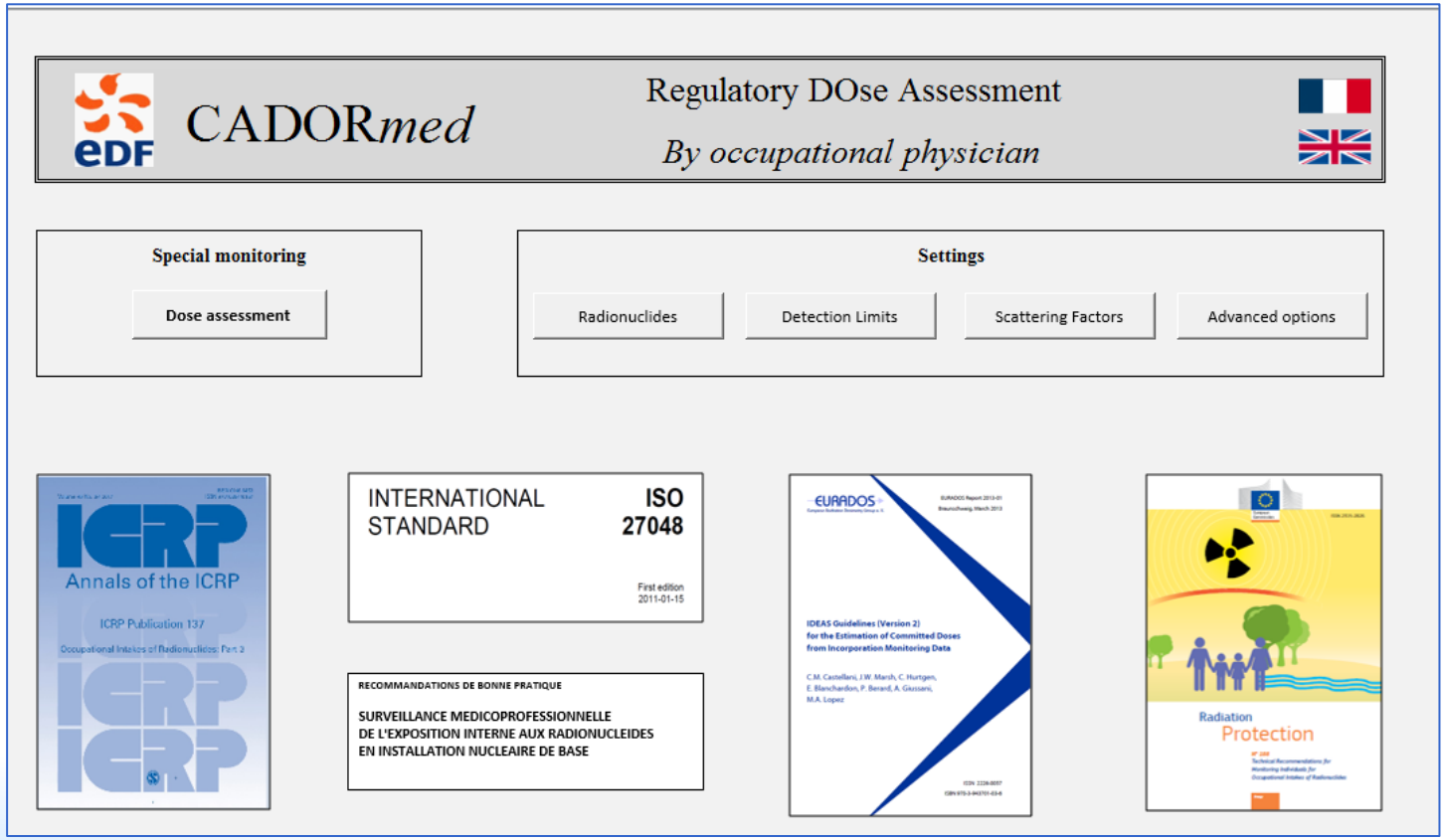


- ✓ ICRP has permitted IDEA System GmbH to use ICRP data in their commercial IDEAplus Expert System for Internal Dosimerty.
- ✓ IDEA has developed the expert system to help users perform all phases of incorporation monitoring and internal dosimetry in exact agreement with ICRP recommendations.

ICRP does not endorse, recommend, or guarantee any third-party software, and shall not be liable for any loss or damage arising from its use.

ICRP/OIR DATA VIEWER. SOFTWARE FOR INTERNAL DOSIMETRY

- **CADORmed – Software using ICRP/OIR Models** (ICRP Publication 103)



Contact person
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EDF, France

ICRP does not endorse, recommend, or guarantee any third-party software, and shall not be liable for any loss or damage arising from its use.

ICRP/OIR DATA VIEWER. SOFTWARE FOR INTERNAL DOSIMETRY

- **Software for internal dosimetry based on ICRP Publications 78/119 (ICRP 60 recommendations)**
  - ✓ **IMBA – commercial software developed by PHE, UK**
  - ✓ **AIDE - commercial software developed by Luiz Bertelli, LANL, US**
  - ✓ **MONDAL 3 – free software developed by NIRS, Japan**
  - ✓ **IDEA System - commercial software developed by Hasn Dorfel, Germany**

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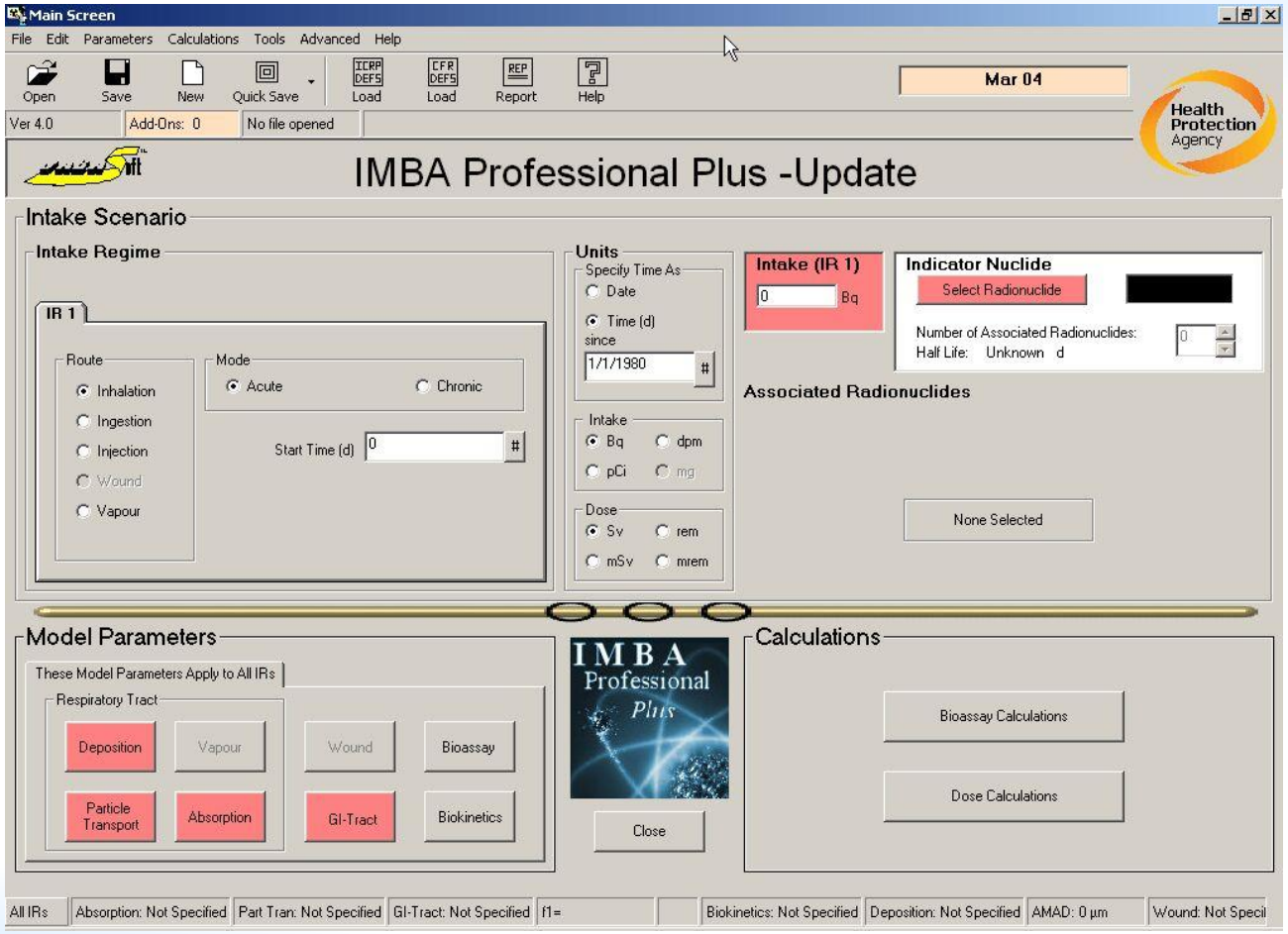
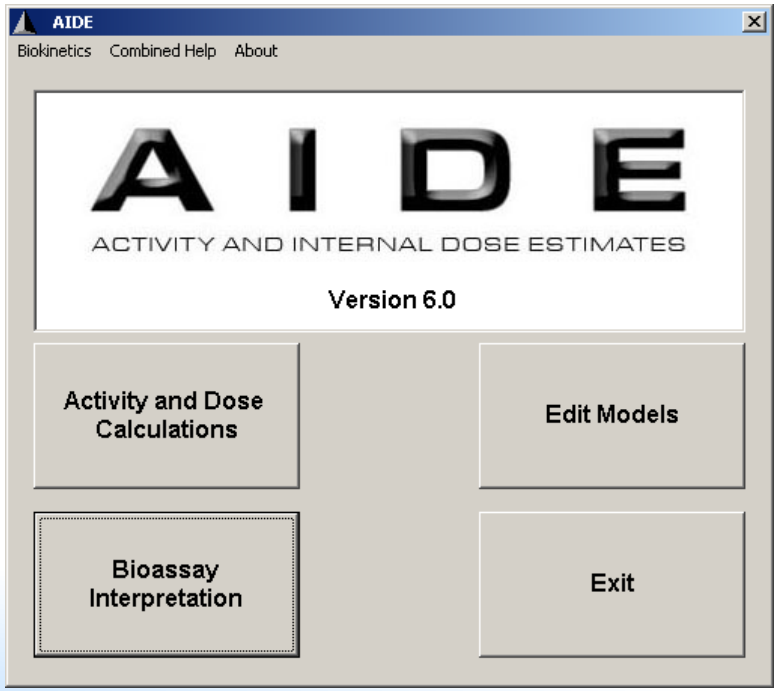


https://www.phe-protectionservices.org.uk/imba

ICRP/OIR DATA VIEWER. SOFTWARE FOR INTERNAL DOSIMETRY

- **Software for internal dosimetry based on ICRP Publications 78/119 (ICRP 60 recommendations)**

  ✓ **AIDE - Activity and Internal Dose Estimates -** commercial software developed by Luiz Bertelli, LANL, US



- Activity and Internal Dose Calculations:

  Calculations of activities in bioassay compartments and effective doses for inhalation, ingestion and injection of radionuclides, for single, several continuous and worker's intake patterns, for infinite or limited time under intake.

- Bioassay interpretation:

  Intake and internal dose estimates can be carried out through the use of single or multiple bioassay measurements. All estimate procedures are in concordance with ICRP78 and IDEAS Guidelines

- Edit Models

lbertelli@xmission.com;
lbertelli@lanl.gov

ICRP/OIR DATA VIEWER. SOFTWARE FOR INTERNAL DOSIMETRY

- **Software for internal dosimetry based on ICRP Publications 78/119 (ICRP 60 recommendations)**

MONDAL 3

http://www.nirs.qst.go.jp/db/anzendb/RPD/mondal3.php

e-mail: mondal@qst.go.jp

MONDAL 3 was developed by National Institute of Radiological Sciences (NIRS) in Japan

MONITORING TO DOSE CALCULATION (MONDAL)

"MONDAL3" is a free, PC based software that will help users to estimate intake of radionuclides inhaled or ingested by workers or by members of the public and resulting committed effective dose based on measurement results of individual monitoring such as in vivo counting or bioassay measurement.

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