

Taurus

The Taurus software package performs intake and dose calculations for internal radiological contamination in occupational exposures. It was developed by the UK Health Security Agency's Internal Dosimetry Group, UK.

Taurus provides a simple graphical user interface (GUI) to UKHSA's internal dosimetry computer code Pleiades (Fell T.P. et al, 2007). Pleiades is written in Fortran and has been used for the calculation of reference dose coefficients and bioassay quantities published in the International Commission on Radiological Protection (ICRP) Occupational Intakes of Radionuclides series of publications (ICRP 2016b, 2017, 2019). Taurus thus implements the most recent ICRP recommendations (ICRP 2007) and the accompanying biokinetic, dosimetric models (ICRP 2009, 2015, 2016a, 2016b, 2017, 2019, 2022) and radiological decay data (ICRP 2008).

In addition to calculating radionuclide activity in organs and excreta and committed doses due to occupational exposures, Taurus also estimates radionuclide intakes from bioassay data using the well proven maximum-likelihood fitting module previously used in UKHSA's IMBA software (Birchall et al, 2003) which can produce robust estimates of multiple intakes using several types of bioassay data, including censored observations (e.g. less than the limit of detection results). IMBA is the predecessor of Taurus and only implements previous ICRP recommendations (ICRP 1994).

Plotting of measurements and bioassay predictions is through Dynamic Data Exchange with Dplot Graph software for scientists and engineers, by Hydesoft computing LLC, a freely distributable restricted functionality version of which (DPlot Jr) is included in the Taurus installation package. If a full version of DPlot is installed Taurus will benefit from the increased functionality which this provides.

The Taurus GUI was built using the Winteracter Portable Fortran user interface and graphics toolset by Interactive Software Services Ltd.

Taurus enables the user to:

- calculate equivalent organ doses and effective doses and bioassay quantities from one or more specified intakes and at pre-defined time-points
- calculate doses and bioassay quantities from one or more specified intakes and at user-specified time points
- estimate single or multiple intakes from measurements of activity in the body and/or excreta and to calculate the resulting doses.

Activity and doses are given in S.I. units of bequerel (Bq) and sievert (Sv).

Main screen

Taurus

File Preferences User guide Notebook Refresh screen About

Input

Reference
Case_1_Co-60

Nuclide
Co-60 5.2713y

Deposition parameters
ICRP OIR series defaults Lightwork
5.0 microns AMAD (for aerosols only)

Absorption parameters
ICRP OIR series defaults
User-defined form Add

Systemic biokinetics
ICRP OIR series defaults

Alimentary tract
ICRP OIR series defaults

Respiratory tract
ICRP OIR series defaults

Intake regimes
Number of intake regimes (max. 20) 2 Retrieve forms Help: Forms Help

	Form	Route	Mode	Start	End	Intake	tA	fr	sr	ss	fb	sb
1	M	INH	Acute	0		2.2773E+03	2.00E-02	0.20000	1.0000	5.00000E-03	3.00000E-02	2.00000E-0
2	S	INH	Acute	0		1.0230E+02	1.00E-03	1.00000E-0	1.0000	1.00000E-04	3.00000E-02	2.00000E-0

Bioassay quantities

Whole body + Urine + Blood Kidneys
Lungs Faeces GI tract Liver
Thyroid Skeleton Help

Calculations
Quick dose and bioassay Help
Prospective calculation
Retrospective calculation (data fitting)
Start calculations
Progress

Results
Total effective dose, Sv 1.73E-05
View doses
Goodness of fit
Plot bioassay

Report
short long
Save report
View report

Licence information
This copy of Taurus is registered to IDG for 5 users. It will expire on 19/10/2022.

Bioassay screens

Urine bioassay measurements and predictions

Help

Parameters for bioassay predictions

Create time series
Linear Log
Start time (d) 0.50000
Stop time (d) 250.00
Send ->

Specify collection periods
1.0000 Send ->

Parameters for measurement data
u distn L Send ->
Uncertainty 1.5000 Send ->

Monitoring nuclide
CO-60 Help

Bioassay predictions
Number of rows (max. 2000) 50 OK

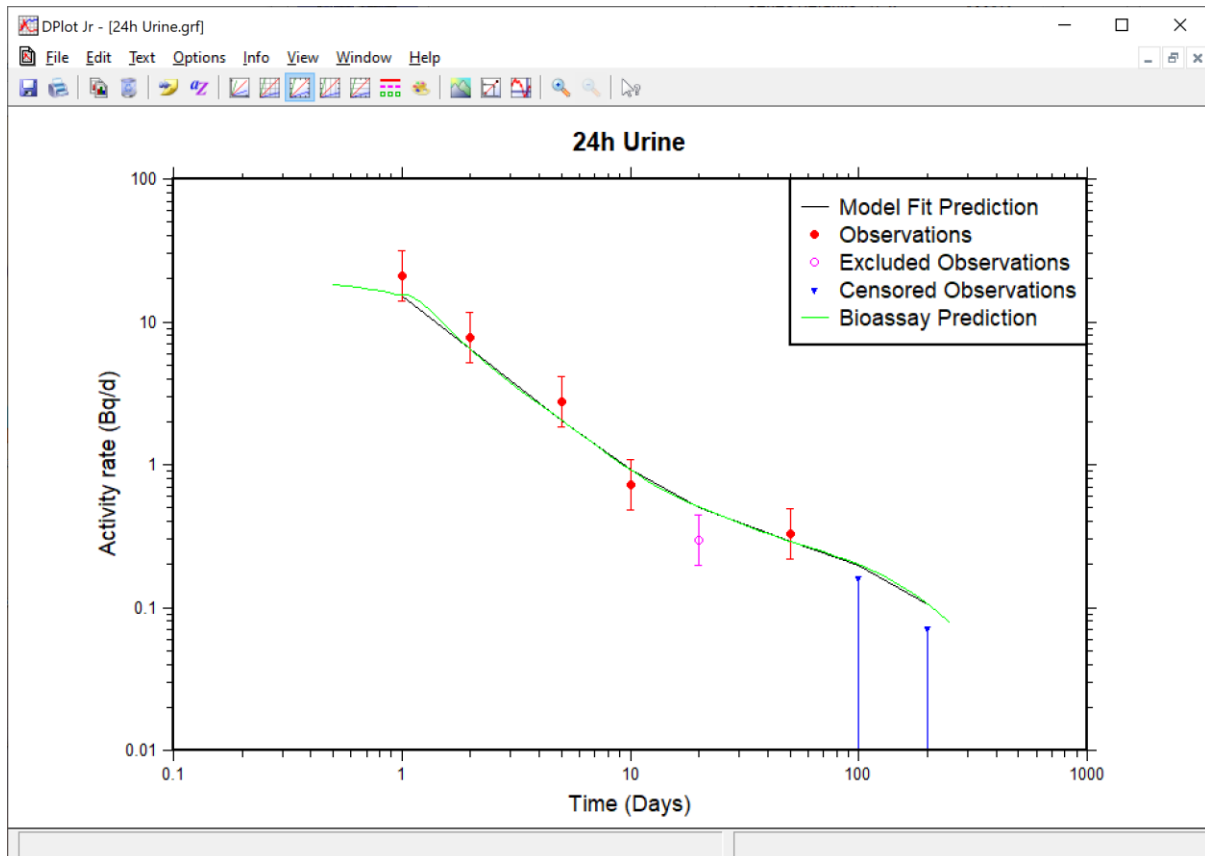
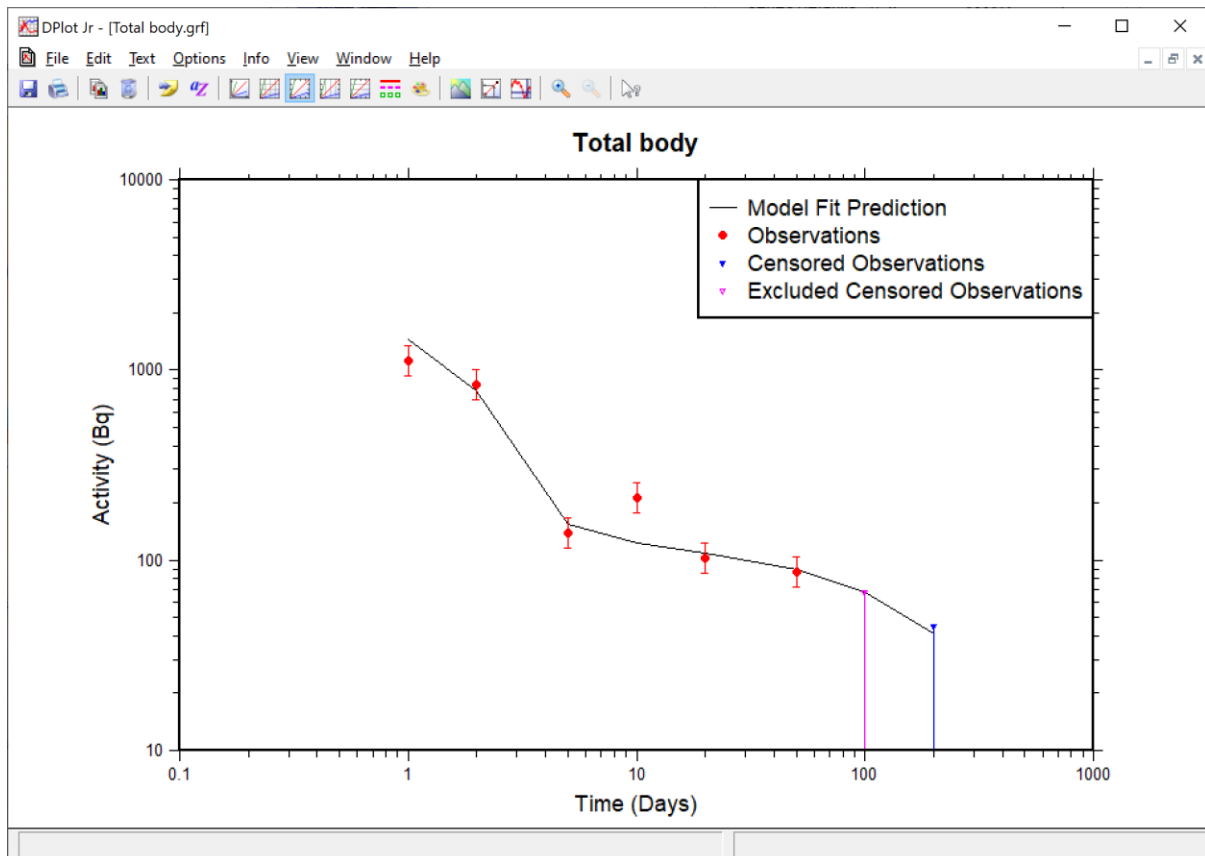
Measurement data
Number of rows (max. 2000) 8 OK

Measurement fit output

	Specified time (d)	Collection period (d)	Activity (Bq)	Time (d)	Collection period (d)	Activity (Bq)	LOD	Uncert- ainty, u	u distn	Excl.	Predicted activity (Bq)	Chi-square
1	0.50000	0.50000	1.810E+01	1.0000	1.0000	2.110E+01	1.5000	L			1.522E+01	6.480E-01
2	0.56761	0.56761	1.784E+01	2.0000	1.0000	7.810E+00	1.5000	L			6.412E+00	2.370E-01
3	0.64437	0.64437	1.744E+01	5.0000	1.0000	2.750E+00	1.5000	L			2.055E+00	5.170E-01
4	0.73150	0.73150	1.691E+01	10.0000	1.0000	7.240E-01	1.5000	L			9.231E-01	3.590E-01
5	0.83041	0.83041	1.628E+01	20.0000	1.0000	2.970E-01	1.5000	L	E		5.068E-01	0.000E+00
6	0.94270	0.94270	1.557E+01	50.0000	1.0000	3.290E-01	1.5000	L			2.925E-01	8.430E-02
7	1.0702	1.0000	1.535E+01	100.00	1.0000	1.600E-01	<	1.5000	L		1.992E-01	0.000E+00
8	1.2149	1.0000	1.373E+01	200.00	1.0000	7.120E-02	<	1.5000	L		1.051E-01	0.000E+00
9	1.3792	1.0000	1.136E+01									
10	1.5657	1.0000	9.275E+00									
11	1.7774	1.0000	7.627E+00									
12	2.0177	1.0000	6.331E+00									
13	2.2906	1.0000	5.302E+00									
14	2.6003	1.0000	4.481E+00									
15	2.9519	1.0000	3.818E+00									
16	3.3511	1.0000	3.274E+00									
17	3.8042	1.0000	2.821E+00									
18	4.3186	1.0000	2.435E+00									
19	4.9026	1.0000	2.102E+00									
20	5.5656	1.0000	1.813E+00									
21	6.3182	1.0000	1.563E+00									
22	7.1725	1.0000	1.347E+00									
23	8.1424	1.0000	1.162E+00									
24	9.2434	1.0000	1.006E+00									
25	10.493	1.0000	8.771E-01									

Return to main screen

Plot of bioassay data



Comprehensive User Guide

The screenshot shows a web browser window titled "User guide". The browser's address bar and navigation buttons (Hide, Back, Forward, Print, Options) are visible at the top. On the left side, there is a "Contents" panel with a search and favourites bar. The table of contents lists various sections, with "Methodology and computations" highlighted in blue. The main content area on the right displays the text for this section, including sub-sections for "Biokinetic and dosimetric calculations: PLEIADES", "Biokinetic calculations", and "Dosimetric calculations".

Methodology and computations

The Taurus software package performs intake and dose calculations for internal radiological contamination from occupational exposures, for acute or chronic intakes by inhalation, ingestion, or injection into blood.

Taurus implements the 2007 Recommendations issued in ICRP Publication 103 (ICRP, 2007) and applies the methodologies for dose calculation described in ICRP Publication 130 (ICRP, 2015) and 133 (ICRP, 2016). The new methodology and new biokinetic and dosimetric models used in the Occupational Intakes of Radionuclides (OIR) series of reports, ICRP 130, 134, 137, 141 and 151 (ICRP 2015, 2016b, 2017, 2019, 2022), supersede those used for the calculation of doses to Workers published in ICRP 68 (ICRP, 1994).

Biokinetic and dosimetric calculations: PLEIADES

The biokinetic and dosimetric calculations in Taurus are performed by the internal dosimetry computer code PLEIADES - Program for LinEar Internal Age-dependent DosES (Fell et al, 2007), written in Fortran 90 and developed at UK Health Security Agency's Radiation, Chemical and Environmental Hazards Directorate, UK.

Biokinetic calculations

Biokinetic compartment models are used to calculate the distribution of radioactivity within body tissue as a function of time following internal contamination, via inhalation, ingestion or injection into blood. The mathematical problem is defined by a set of ordinary differential equations, which are determined by an input function describing the exposure (route and duration of the intake) and by the 'biokinetic matrix' constructed with all the relevant biokinetic transfer rates and the nuclear decay data for the contaminant. The structure and the transfer rates of the biokinetic models (respiratory, alimentary and systemic models) are published in the OIR series of reports and the radioactive decay data in ICRP Publication 107 (ICRP, 2008).

The solutions to the biokinetic equations are computed by PLEIADES in terms of the eigenvalues and eigenvectors of the biokinetic matrix and by exploiting the particular block structure of the matrix (Fell et al., 2007). PLEIADES solves the eigenvalue problems and related computations by using the LAPACK (Linear Algebra PACKage) library (Anderson et al., 1999) and its associated BLAS (Basic Linear Algebra Subroutines) library.

The 'eigenvalue-eigenvector' solutions to the biokinetic equations take then the familiar form of a sum of exponentials and are used to calculate the activity and the number of transformations (time-integrated activity) over any period of time in body tissues and organs.

Dosimetric calculations

Dosimetric models are used to calculate the deposition of energy in 'target' organs/tissues for transformations occurring in the 'source' organ/tissues as determined from the biokinetic calculations. The information and values for energies and emissions yields of radionuclides and for the specific absorbed fractions (SAFs) used by PLEIADES are published in ICRP 107 and ICRP 133 respectively. The radiation weighted 'S coefficients' or equivalently the Specific Effective Energies (SEEs) are calculated

References

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