RAMP
Introduction to IMBA 2020

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What is Fundamentally Necessary

- The Number of Transformations that will occur in a Source Organ – information that arises from an appropriate Biokinetic model and radioactive decay kinetics.

- The energy deposited per transformation in any target organ – information that arises from an appropriate dosimetric model

We have approximately 50 years of experience in this set of problems

- ICRP 2
- ICRP 26/30
- ICRP 66 through 100
- Beyond ICRP 100
- MIRD

IMBA

- The initial aim of the project which lead to the development of IMBA (circa 1995-2000) according to Alan Birchall was to develop a systematic way to implement the latest ICRP biokinetic models that was:
  - Easily applied to bioassay and dosimetry problems
  - Readily incorporated into existing systems

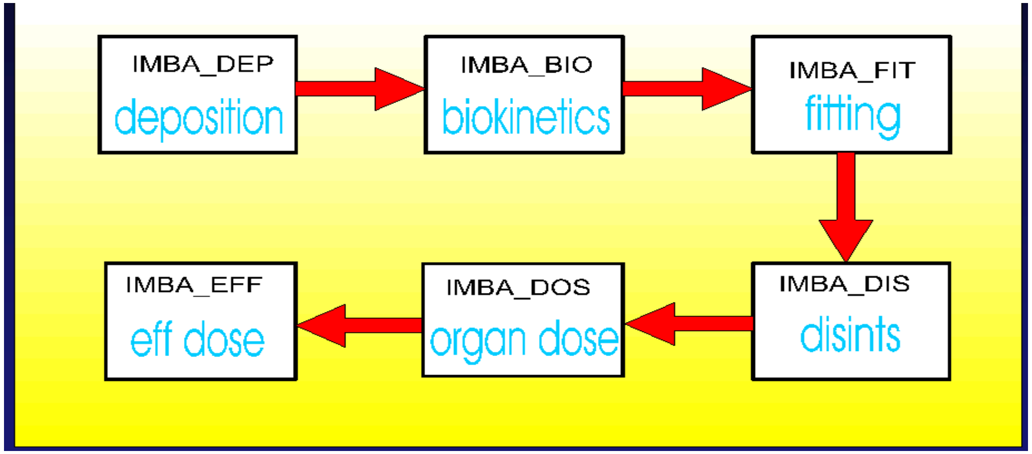
IMBA

- According this sequentially lead to the development of:

1. The IMBA modules
2. IMBA Expert
3. IMBA Professional
4. IMBA Professional Plus

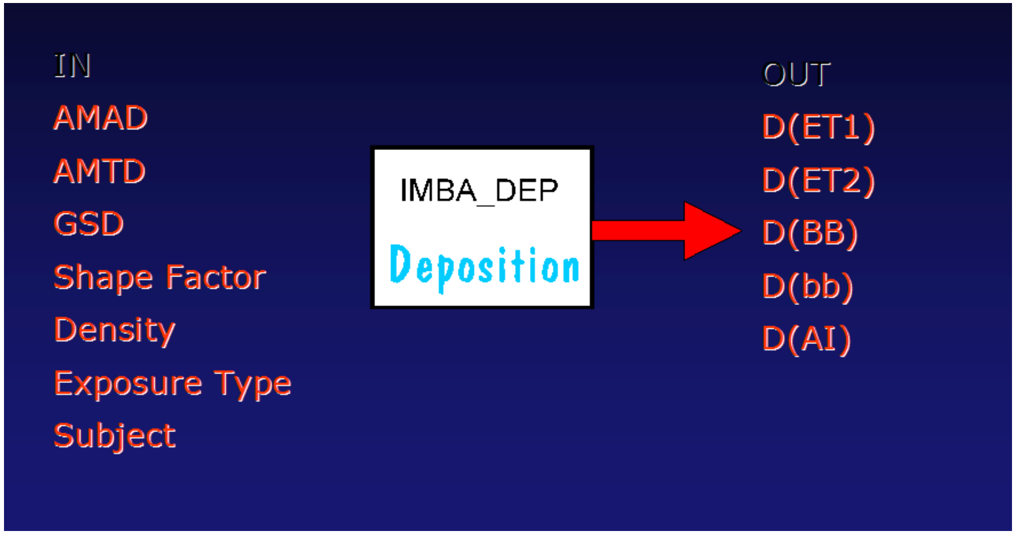
IMBA

- The foundation of the code was the development of the IMBA modules whose stand alone structure addressed each major issue associated with internal dosimetry:



IMBA

- One of the first modules was associated with the code LUDEP which as a central feature determined deposition given various aerosol characteristics:



IMBA

- The design base was finalized after substantial marketing efforts:

Calculations

- *Doses from known intakes*
- *Bioassay quantities from intakes*
- *Intakes from bioassay measurements*

Intakes

- *Inhalation, Ingestion, Injection*
- *Acute and chronic intakes*
- *Up to 10 simultaneous intakes (mixed)*

Ability to change parameters

- *Aerosol*
- *Particle transport rates*
- *Absorption rates*
- *GI-tract parameters, f_1*
- *Dosimetric parameters W_R, w_T,*
- *Enter own bioassay functions*

Built in data bases

- *All ICRP default parameters (lung, GIT)*
- *All element specific defaults (type, f_1)*
- *All bioassay and biokinetic models*
- *All ICRP dosimetric parameters*
- *Nuclear decay data*

Other requirements

- *To simultaneously fit up to 10 intakes*
- *To fit to multiple bioassay types (eg urine, faeces and lung)*
- *Multiple units: Bq/pCi, rem/Sv,*
- *Ability to enter times since intake or dates*
- *To calculate doses from mixtures of up to 30 radionuclides*
- *To save/restore all parameter values, generate reports*
- *On screen help facilities, user manuals etc.*
- *On screen graphical and tabular outputs*
- *Inport/export data from spreadsheets, files and data bases etc.*

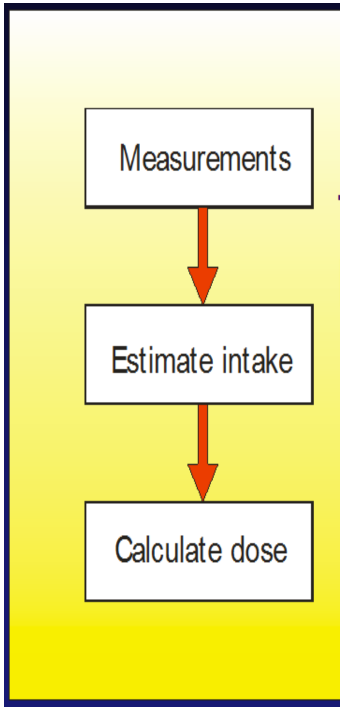
Simple and Easy to Use

IMBA

How to Calculate Bioassay Quantities using IMBA

A fly by look at IMBA!

IMBA



When considering the Bottom-Up problem in internal dosimetry there is a simply sequence of events: one considers various types of measurements, one estimates the intake, and then one calculates the dose associated with the intake.

IMBA

- Many types of measurements are relevant to internal dosimetry including:
  - Environmental Measurements
    - Air Sampling
      - Continuous air samples (CAM, PING, SPING etc.)
      - Grab Samples
      - Lapel air samples
  - In vivo Monitoring
    - Whole body and Lung counts
  - In vitro Monitoring
    - Nose blows
    - Blood sampling
    - Biopsy/autopsy
    - Chromosome aberrations and other exotic techniques
    - Urine Monitoring
    - Fecal Monitoring

IMBA

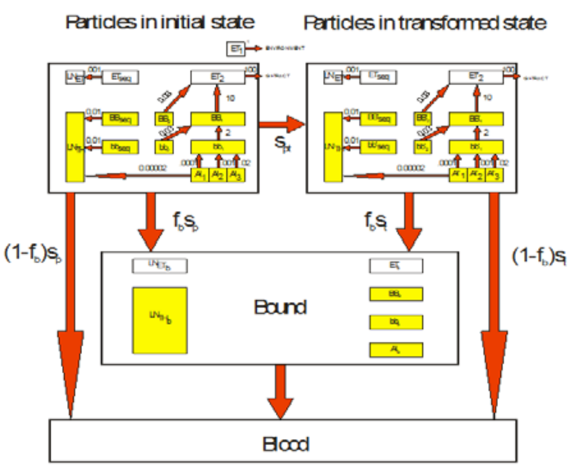
- The aim is to employ our information about reality which was obtained from measurements in order to understand the 4-main bioassay quantities:
  - Lung Retention
  - Whole Body retention
  - Urinary excretion
  - Fecal excretion

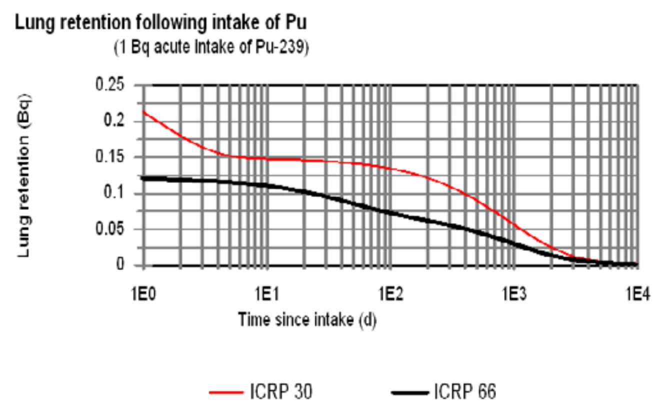
IMBA

- Our understanding of the Bioassay Quantities and physiological behavior relative to these quantities is summarized in a bioassay function:
  - the bioassay function is:
    - The value of the (bioassay) quantity at time t from a 1 Bq intake.

IMBA

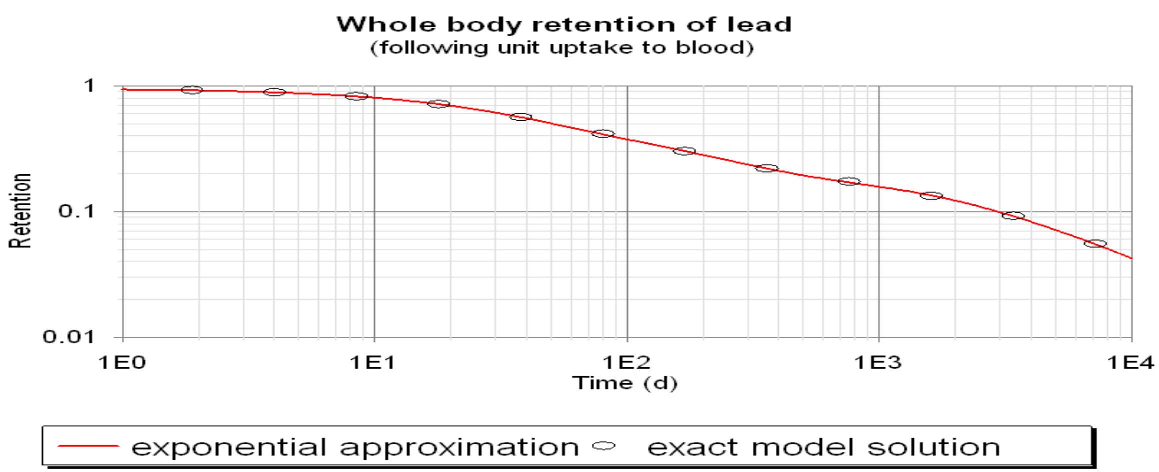
- So as an example: We have a lung retention models which lead to mathematical functions that can be used for instance to predict retention of Pu in the lung.





IMBA

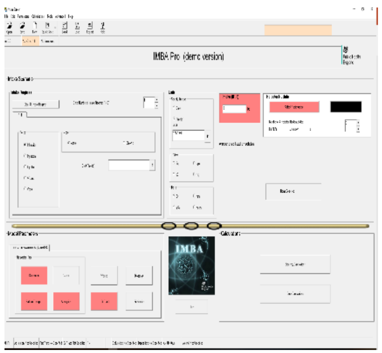
- These efforts are not necessarily trivial, consider the bioassay quantity whole body retention:
  - The first step would be to estimate the intake to blood, followed by the translocation from blood to organs:
- This complexity may be simplified by approximating the whole body retention after the uptake into blood with a polynomial function



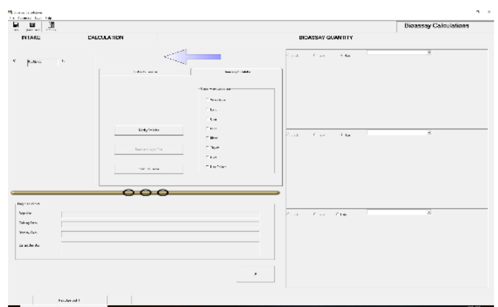
IMBA

- This approach of employing normalized exponential retention and excretion functions is frequently used by IMBA which contains an extensive data base of such functions for each element.

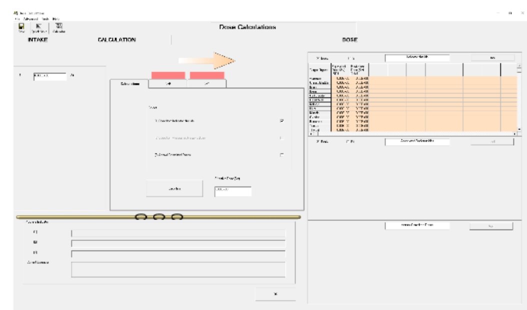
- IMBA has three main screens



The Opening Main Screen.



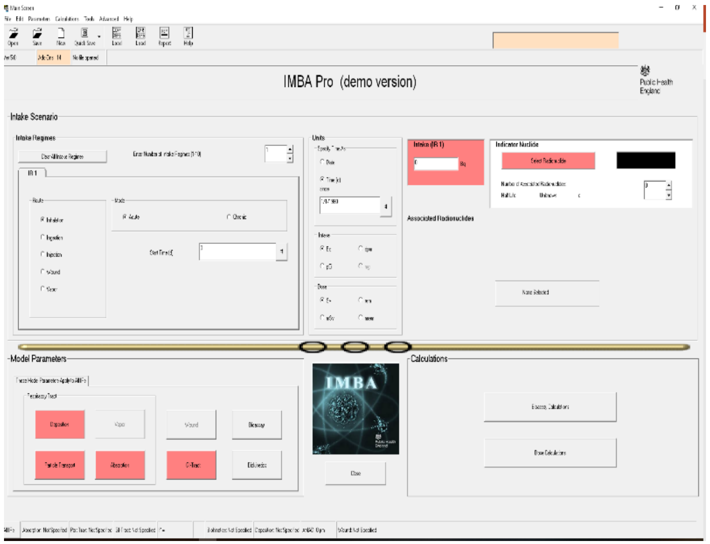
The Bioassay Screen



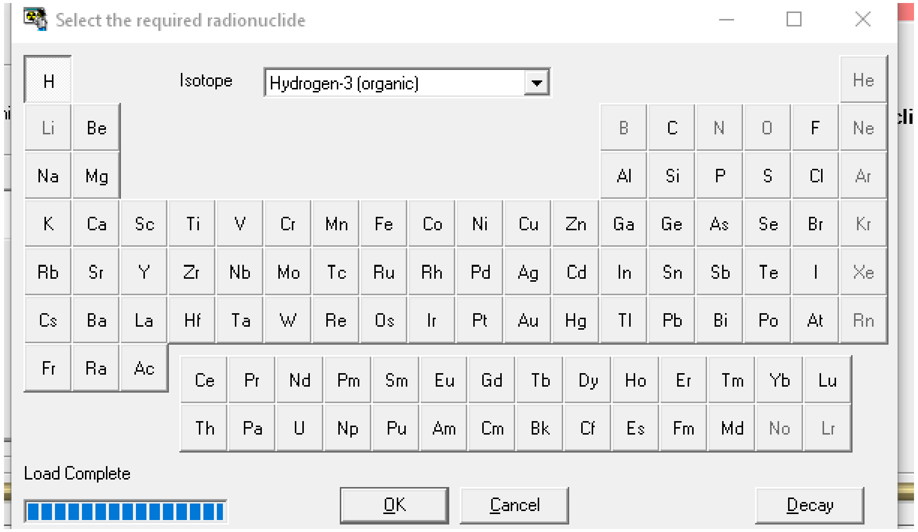
Calculation Screens

Features of the Main Screen

- The main screen has three Sections
  - The Intake Scenario
  - The Model Parameters
  - The Calculations Section

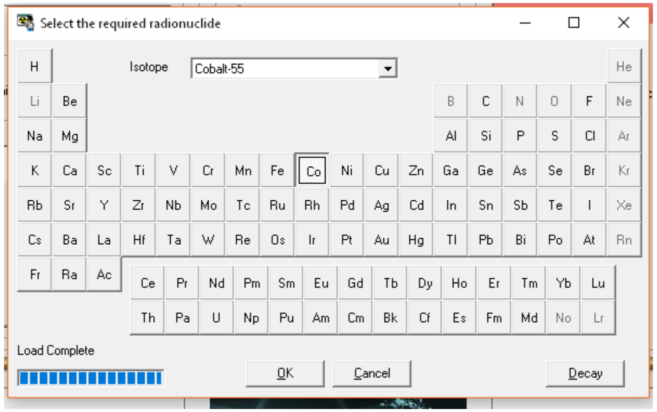


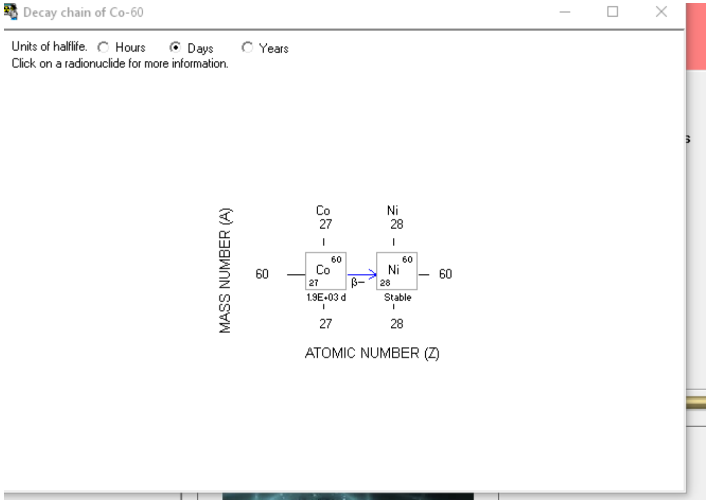
- Selecting the Radionuclide tab produces an image of the periodic table of the elements.



The Intake Section

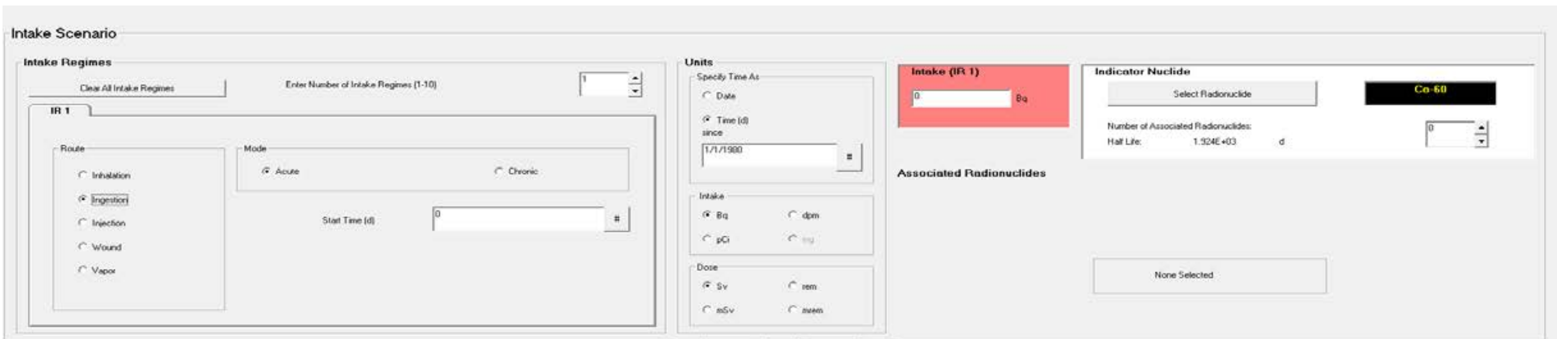
If one selected (Cobalt) from the drop down menu Associated with Cobalt and then the decay Tab, information on the decay would be provided.





The Intake Section

As an example, after selecting a pathway of intake - by selection of the ingestion button and leaving the intake mode at the default value of "acute" one input the intake at the tab (Intake IR 1).



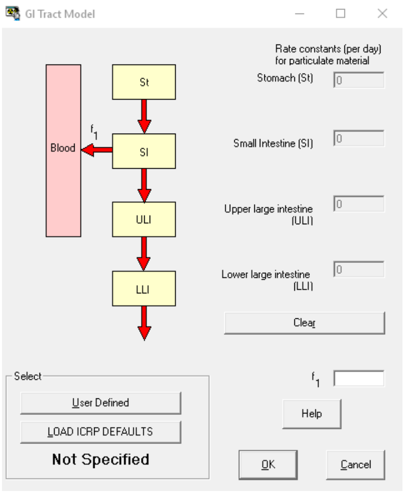
IMBA will allow up to 10 intakes (1 – 10).

The Intake Section

- Again, as an example one could input a 1.0 Bq intake by typing 1 into the red box.
- This is followed by moving the computer curser pointer to the Model Parameters Section of the Main Screen and hovering over the GI-Tract Button.
  - A left Click will select the GI-Tract as the item of interest. A diagram of the

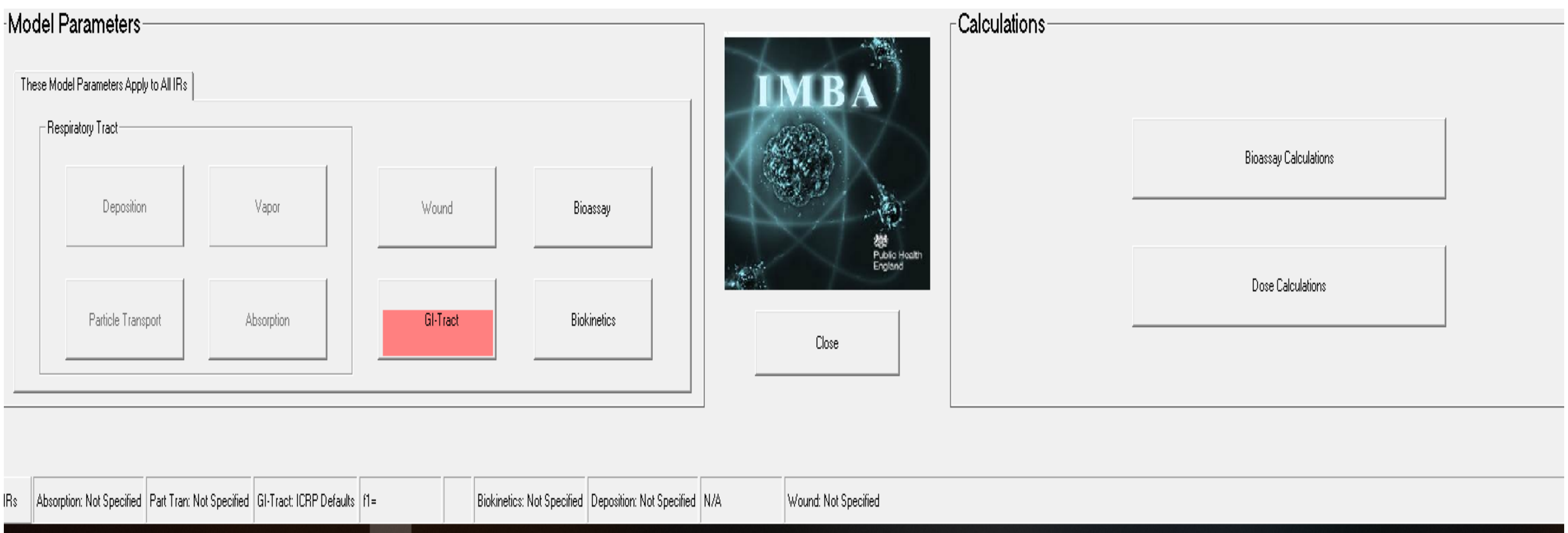
GI-tract will pop-up.

Selecting the “load ICRP defaults” simplifies a generic problem.
However, one could select their own
Inputs for the model if so desired.
The “Not Specified” just indicates that no
Selection has been input.
Notice that the F_1 box has been left
Blank in this case.

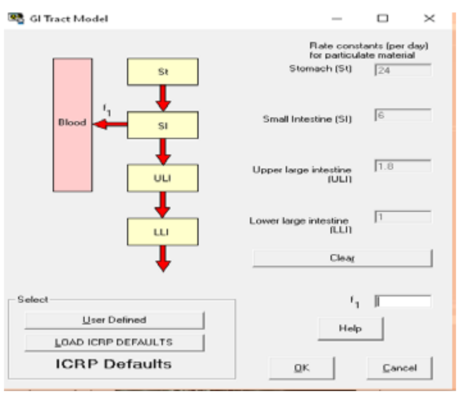


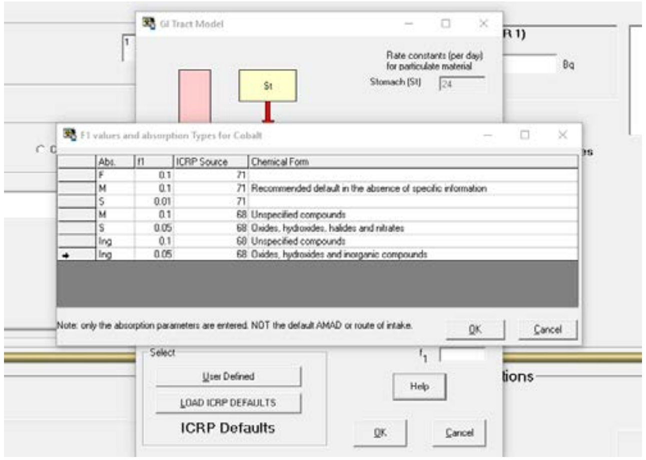
The Intake Section

- Notice in the Model Parameters Section that only half of the GI-Tract button is highlighted in red. This means that the Model parameters are only partially defined…it is related in this case to not defining the F_1 value.



- As an example, to complete a dose calculation one would return to the Model Parameters Section again and select the GI-Tract button which at this time is half-highlighted in red.
- By moving the Cursor pointer to the F_1 box.
  - One can either input the value if known, or select help to observe the ICRP Recommendations.
  - One could also select help in this case…. and select the “ing” for ingestion of oxides ICRP 68 row.



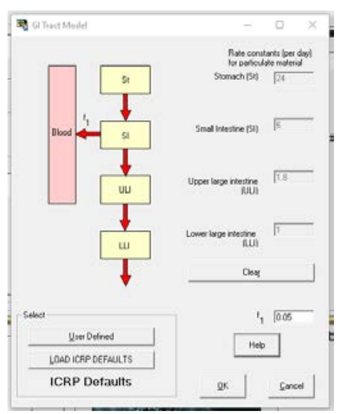


The Intake Section

After selection of the "ing" row for ICRP 68 oxides a little black arrow appeared in the gray box on the left of the row.

Selecting the "okay" box in that drop down pulls in those ICRP default values into the F1 box and defines them in IMBA for this bioassay calculation.

Notice how the value of 0.05 now populates the F_1 box.

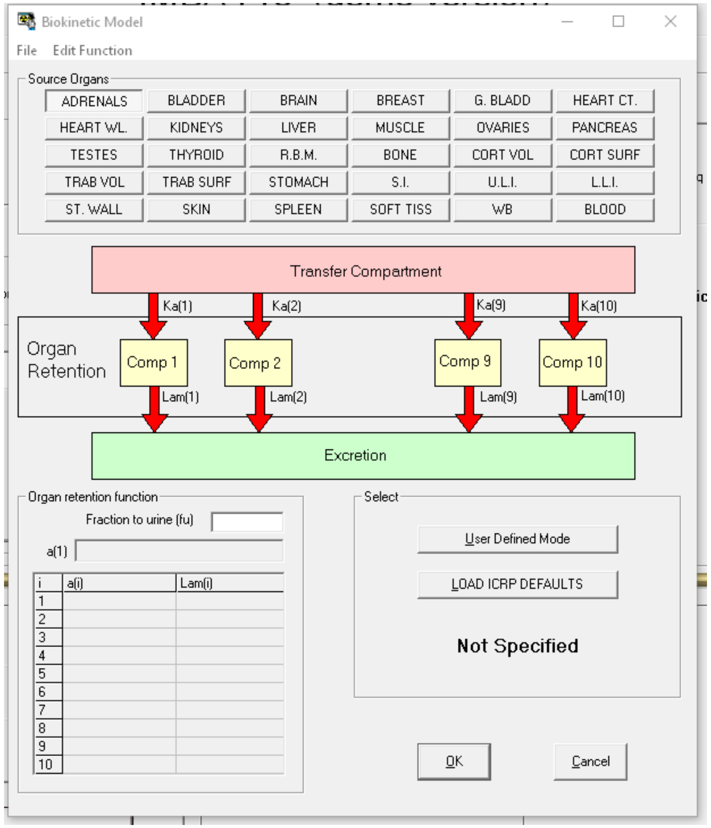


- One needs to select the "OK" tab of the Model Parameters - GI-Track drop down box.

- Notice – WOW! There are no more red highlighted boxes.
- Now we can use IMBA to do a calculation.
- This is done by moving the pointer cursor to the **MODEL PARAMETERS** biokinetics tab.
- While hovering over the biokinetics tab, in this example I have clicked the left mouse button and selected the biokinetics tab option.
  - A biokinetics model pop-up screen appeared.

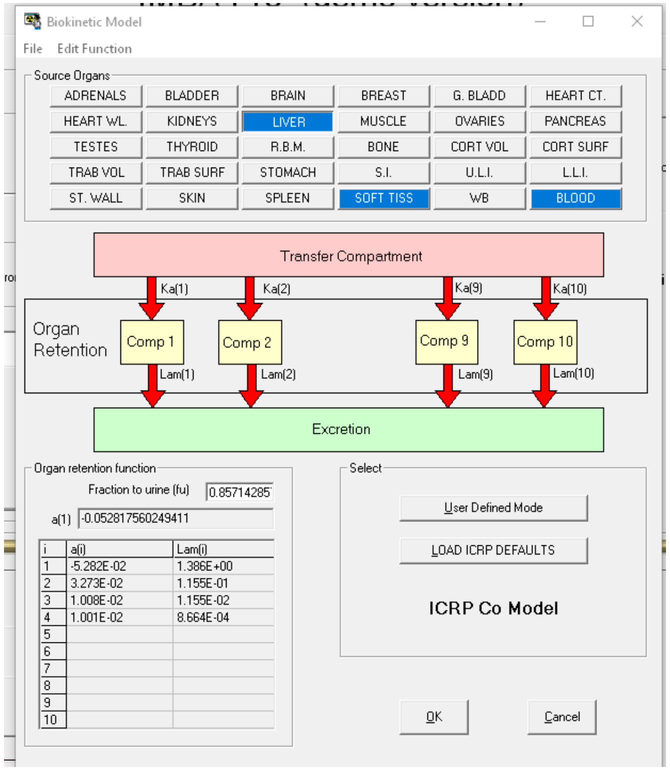
A simple Biokinetics calculation

- Select the “Load ICRP Defaults” tab once in this drop down menu.
- Once the ICRP defaults are selected you should notice that based on our previous selections, three source organs have become highlighted in blue.
- If you move your pointer-cursor over either of these and select it by “left clicking” your mouse button, information on the coefficients of the organ retention function for the organ highlighted in blue (that you selected) will populate the drop down box “organ retention function” sub-section.



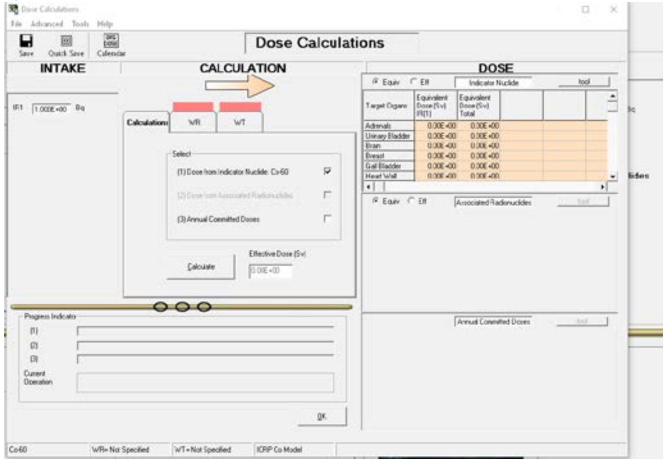
A simple Biokinetics calculation

- This is slick: Because if you remember our intake was just 1.0 Bq, so this retention function is the retention in that organ per unit intake.
- In this particular case being demonstrated on the slide it is for the liver.
- Selecting "OK" on the drop down menu allows one to proceed.
- It is usually prudent to save input data. Of course this is feasible in IMBA, one just moves the cursor pointer to the save icon on the main menu bar and saves the file. After naming the file, one can use the quick save option.



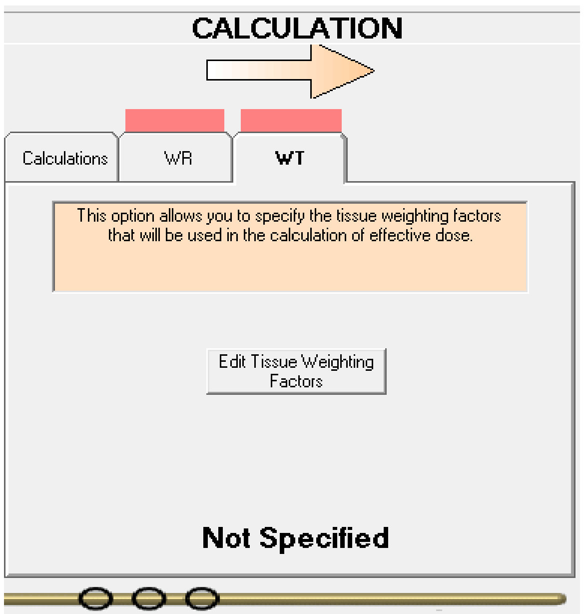
A Dose Calculation

- Moving the cursor-pointer to the **<u>Calculations</u>** region of the Main Menu ne could select for example the “Dose Calculation” option. The popup screen would appear as follows:

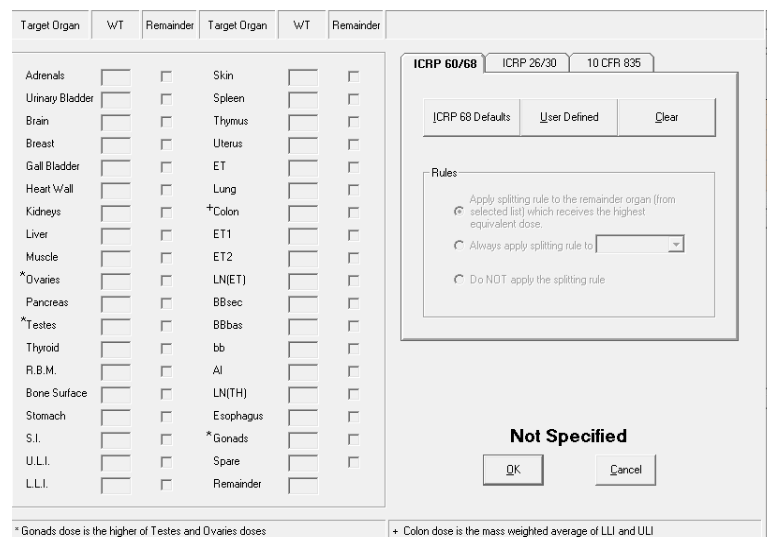


- Notice the red-highlighted areas….more information is necessary. The problem is solved by first hovering over and left clicking on the WR tab. Alternately one could do the same for the WT tab.

A Dose Calculation

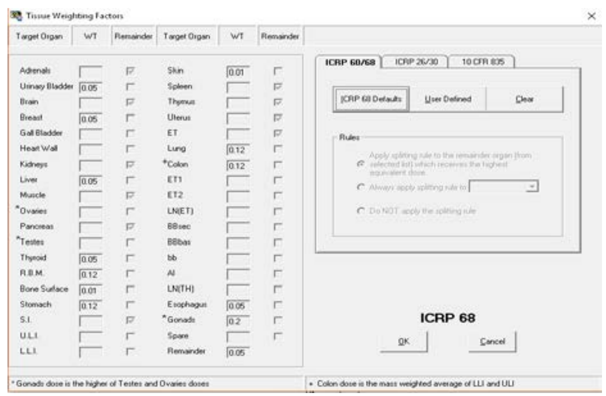


Moving to the Tissue Weighting factors popup box and select the tissue weighting factors tab provides a popup box in which tissue weighting factor options may be selected.



- Various sets of tissue weighting factors are available: ICRP 68 defaults, ICRP 26/30 Defaults, and 10 CFR 835.
- Of course one would select the tab by which you are regulated!

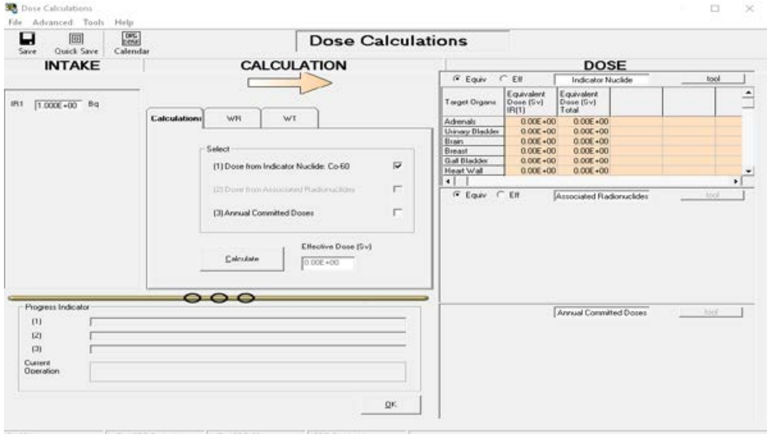
- Select the ICRP 68 tab, and load the ICRP 68 default values.



- Selecting “OK” to returns one to the Dose Calculation sub-menu.

A Dose Calculation

- Once in the Dose Calculations Sub-Menu one Selects the Calculations tab.



- In this situation one could select “Dose from Indictor Nuclide Co-60” or “Annual Committed” doses or both. I have Selected Dose from Indicator Nuclide” for our purpose.
- After doing this, one could hover the cursor-pointer over the calculate button and left click the mouse button to perform a calculation.

A Dose Calculation

- After clicking the calculate button IMBA <u>*calculates*</u>*. If you were actually running IMBA one would* Notice pretty blue highlights in the progress indicator area!
- The right hand side of the Dose Calculation pop-box provides a summary of the dose consequences associated with the intake.
  - Selecting the tools option in that section of the popup box. This will provide a detailed table of the organ doses.
  - The example at the right is the Equivalent dose table, but one could alternately review a table of effective dose.

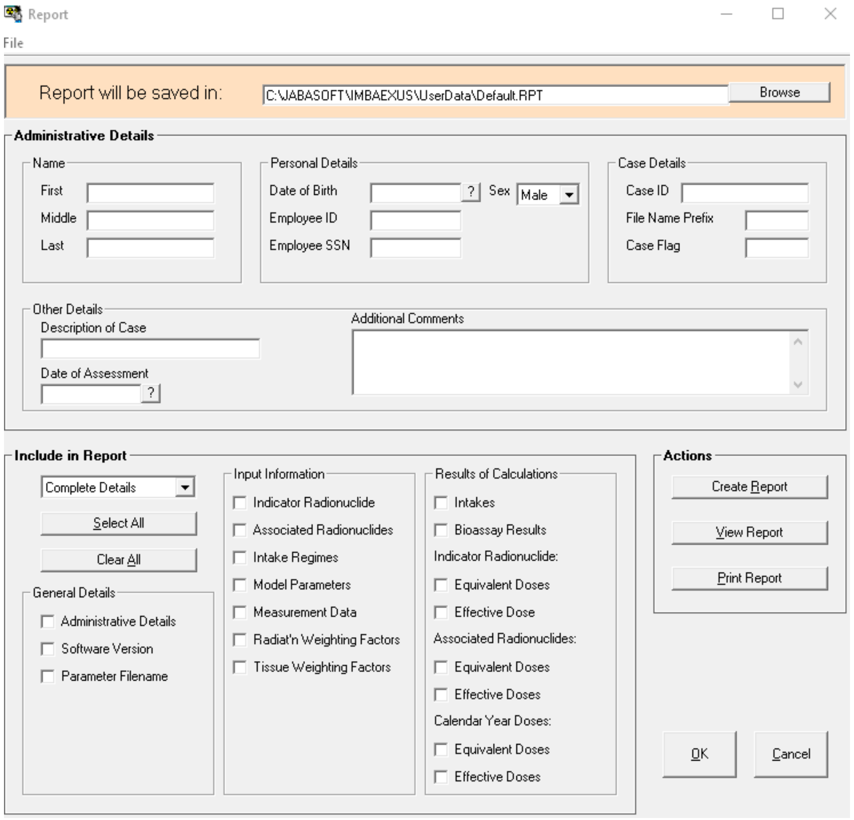
Dose Tool : Equivalent Doses (Co-60)

File Edit Help

Target Organs	Equivalent Dose (Sv) IR(1)	Equivalent Dose (Sv) Total
Adrenals	1.31E-09	1.31E-09
Urinary Bladder	1.68E-09	1.68E-09
Brain	6.78E-10	6.78E-10
Breast	6.91E-10	6.91E-10
Gall Bladder	1.99E-09	1.99E-09
Heart Wall	9.93E-10	9.93E-10
Kidneys	1.36E-09	1.36E-09
Liver	2.34E-09	2.34E-09
Muscle	1.10E-09	1.10E-09
Ovaries	3.38E-09	3.38E-09
Pancreas	1.44E-09	1.44E-09
Testes	1.03E-09	1.03E-09
Thyroid	8.54E-10	8.54E-10
R.B.M.	1.30E-09	1.30E-09
Bone Surface	1.12E-09	1.12E-09
Stomach	1.67E-09	1.67E-09
S.I.	3.28E-09	3.28E-09
U.L.I.	5.74E-09	5.74E-09
L.L.I.	1.11E-08	1.11E-08
Skin	6.98E-10	6.98E-10
Spleen	1.16E-09	1.16E-09
Thymus	8.74E-10	8.74E-10
Uterus	2.05E-09	2.05E-09
ET	8.54E-10	8.54E-10
Lung	9.13E-10	9.13E-10
Colon	8.05E-09	8.05E-09
ET1	8.54E-10	8.54E-10
ET2	8.54E-10	8.54E-10
LN(ET)	8.54E-10	8.54E-10
BBsec	9.13E-10	9.13E-10
BBbas	9.13E-10	9.13E-10
bb	9.13E-10	9.13E-10
AI	9.13E-10	9.13E-10
LN(TH)	9.13E-10	9.13E-10
Esophagus	8.74E-10	8.74E-10
Gonads	3.38E-09	3.38E-09
Spare	0.00E+00	0.00E+00
Remainder	1.14E-09	1.14E-09

A Dose Calculation

- That is all there is to it!
- To document the evaluation one Selects the report option off from the menu bar. This provides a self-evident popup screen that may be used to develop a customized report of the incident relative to an institutions needs.
  - The reporting options are exhaustive and not all incidents have sufficient basis to employ every possible option.
- I believe one can observe the versatility of this outstanding tool for work in Bioassay and Dosimetric Problems.



Acknowledgements

The late Dr. Alan Birchall is recognized for his work in producing many of the slides in this presentation.