

Dose Calculations Screen

The **Dose Calculations** screen (Figure 5.1) opens when you *click* the "**Dose Calculations**" *button* (on the **Main Screen**).

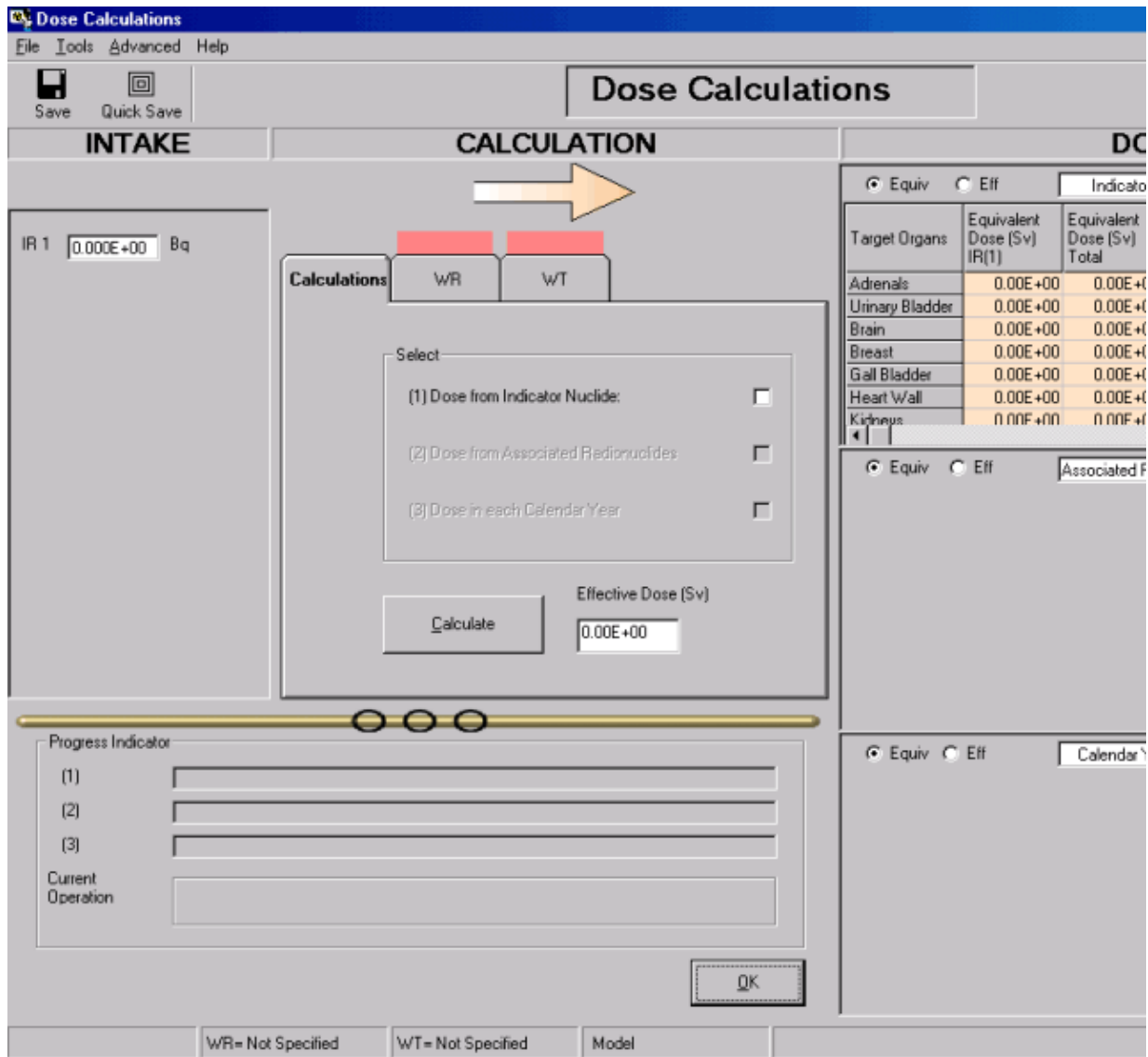


Figure 5.1. The **Dose Calculations** screen.

The screen is divided into these functional parts:

- [Menu Bar](#).
- **Intake** sub-panel.
- **Calculation** sub-panel.
- **Calculation Progress Indicator**.
- **Dose Results** windows.

Dose Calculations Menus



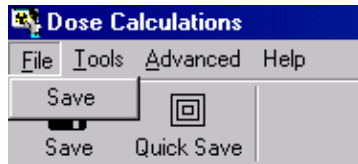


Figure 5.2. Dose Calculations Menus.

These are:

- the [File](#) menu - to **Save** all parameter values to a **Parameter File**;
- the [Tools](#) menu - to open the "**Equivalent Doses to Selected Organ Calculated in Each Calendar Year**" window;
- the [Advanced](#) menu – to open "**Advanced Dosimetry Options**";
- the [Help](#) menu - giving access to the full range of [Help](#) facilities.

Dose Calculation Tools

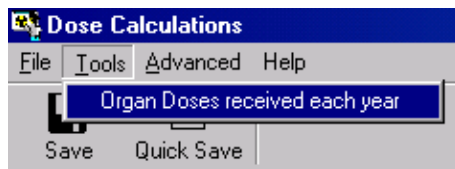


Figure 5.3. Tool to open "**Equivalent Doses to Selected Organ Calculated in Each Calendar Year**" window.

Clicking on "**Organ Doses received each year**" opens the "**Equivalent Doses to Selected Organ Calculated in Each Calendar Year**" window (Figure 5.4). This option (developed for [IMBA Expert™ OCAS-Edition](#)) is provided in IMBA Professional Plus, Add-On 9, [Dose Calculation For Causation](#). It will enable you to calculate equivalent doses received by a specified organ over a prescribed time period, as used to calculate cancer causation probability - see the OCAS-IREP web page (<http://www.cdc.gov/niosh/ocas/ocasirep.html#irep>).

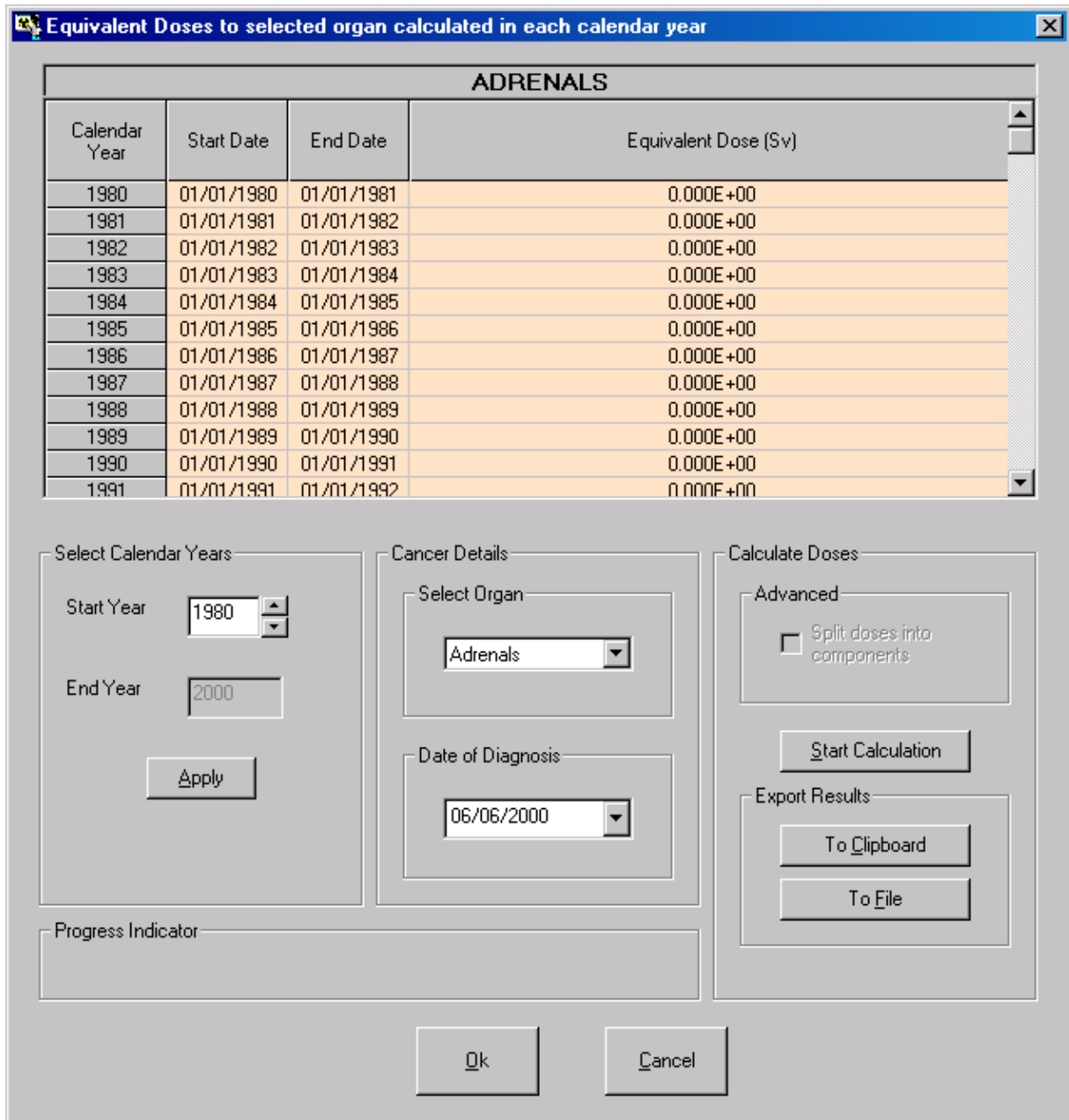


Figure 5.4. Window used to calculate equivalent doses received by a specified organ in each year.

Advanced Dose Calculations Menu

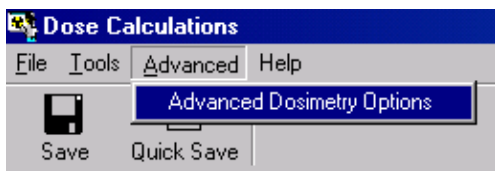


Figure 5.5. Tool to open the "Advanced Dosimetry Options" window.

The "Advanced Dosimetry Options" window gives the following options:

- [Exclude nuclear recoil energy](#) from the [SEEs](#) for alpha emissions.
- Use **Bayesian Analysis** in the [bioassay fitting procedure](#).
- Use measurements of [Am-241 activity to evaluate Pu-241](#) content.
- [Miscellaneous special functions](#) - reserved for the future.

Nuclear Recoil Energy in SEE

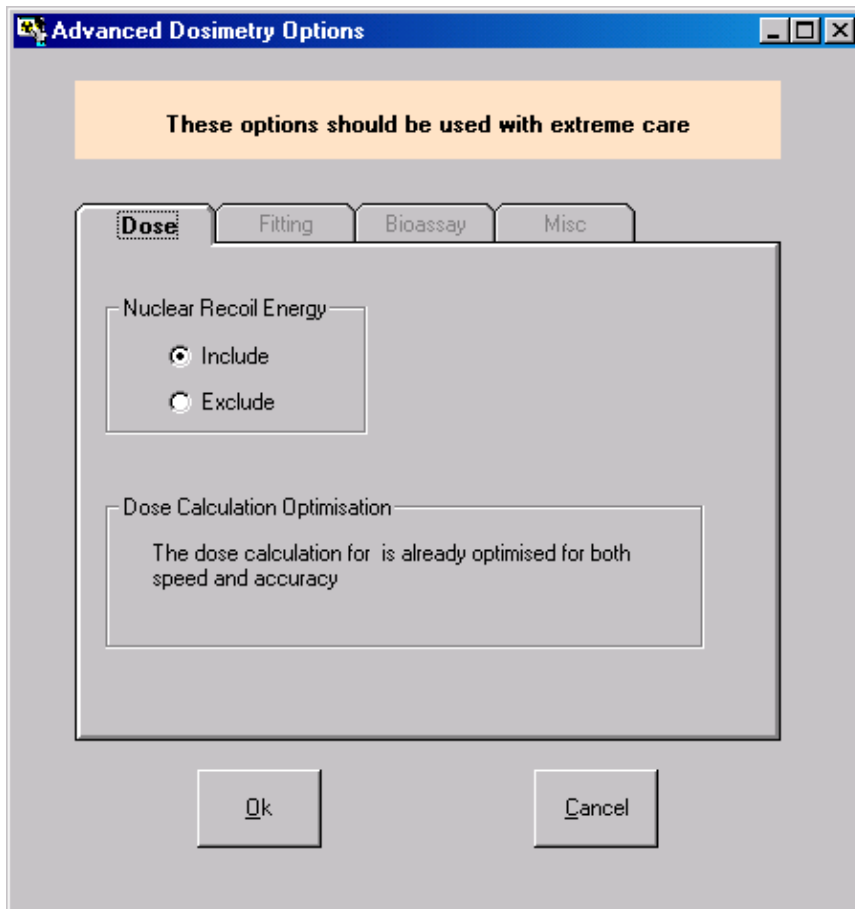


Figure 5.6. **Advanced Dosimetry Options** window showing option to **Exclude nuclear recoil energy** from the **SEEs** for alpha emissions.

In the basic software version (*IMBA Professional [Lite-Edition](#)*), nuclear recoil energy is (by default) **included** in the SEEs for alpha emissions.

Special Fitting Procedure



Select to apply the "[Least Squares](#)", "[Maximum Likelihood](#)" (the default), or "[Bayesian](#)" fitting method (Figure 5.7) in the calculation of intake(s). This option is also available from the [Bioassay Calculations](#) screen ([Advanced Menu](#)).

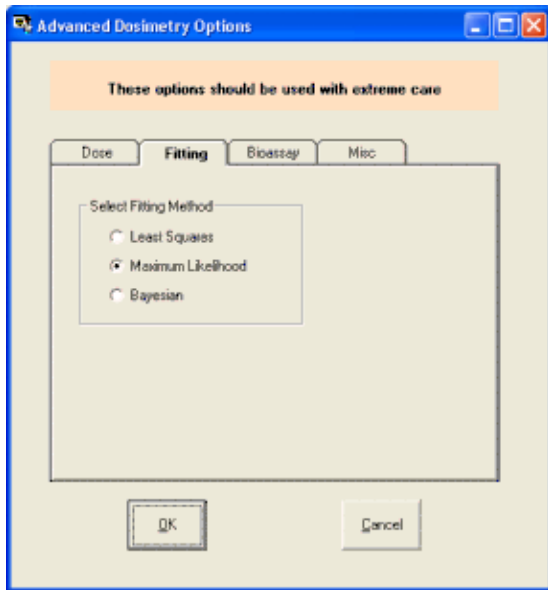


Figure 5.7. "Fitting" Options window.

Special Bioassay Procedure



This will enable measurements of ^{241}Am , e.g., in the lungs, to be used as an indicator of ^{241}Pu activity (Figure 5.8), by automatically accounting for ^{241}Am in-growth over time. The option is made available [automatically](#) when the **Indicator Nuclide** is defined as ^{241}Am , **AND** ^{241}Pu is included in the list of **Associated Radionuclides**. See [Case Of Am-241 In-growth](#) as an example.

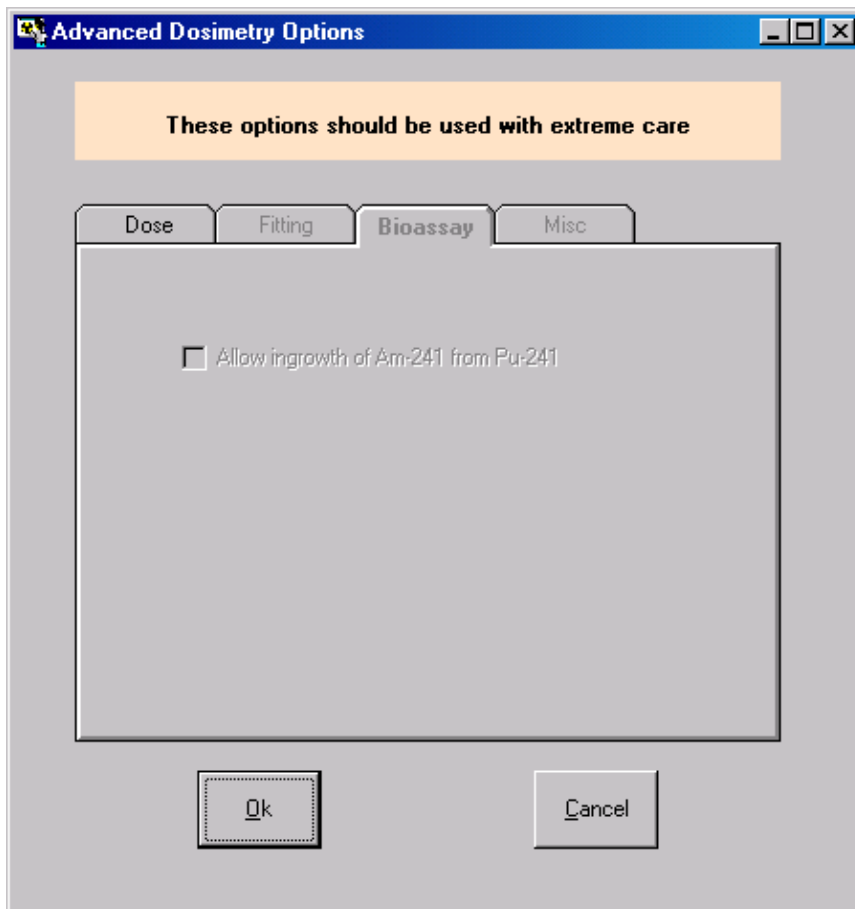


Figure 5.8. Future **Special Bioassay** feature.

Specify Intakes In Mass Units (mg)

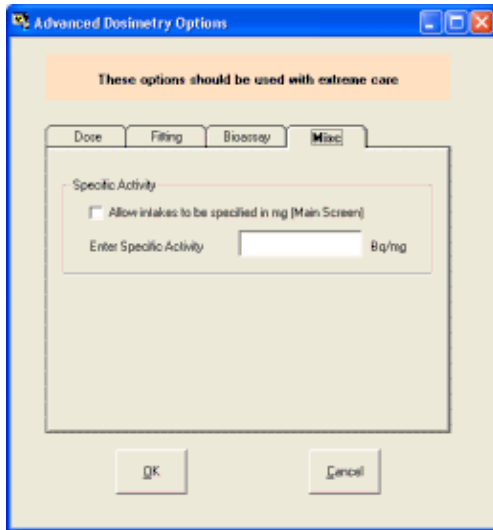


Figure 5.9. "Miscellaneous" Option - Use of "Mass" as the **Unit of Intake**.

When *checked*, this option allows **Intakes** to be specified in terms of **Mass** rather than **Activity**, with the associated **Specific Activity**. If you don't define the specific activity, you will be prompted to do this (figure 5.10).

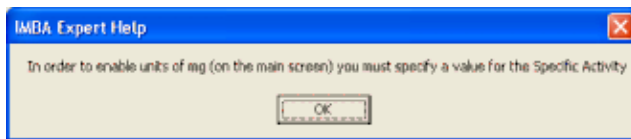


Figure 5.10. Prompt to define **Specific Activity** in order to use **Mass** as the **Unit of Intake**.

Checking this option automatically highlights and enables the "**mg**" *Unit of Intake* in the "**Units**" panel of the **Main Screen** (Figure 5.11).

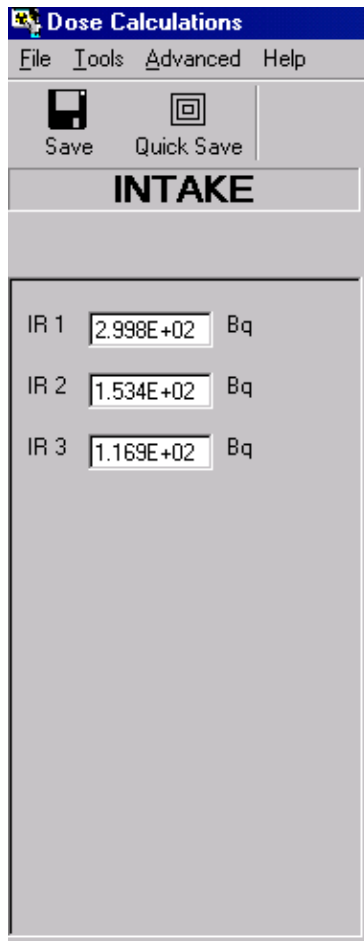


Figure 5.11. "**mg**" **Unit of Intake** enabled.

For an example of the use of "**Mass**" as the **Unit of Intake**, see Example Bioassay Cases - "[Case of Uranium Isotopic Mixture](#)".

Intake Sub-Panel - Dose Calculations





Intake Rate	Value	Unit
IR 1	2.998E+02	Bq
IR 2	1.534E+02	Bq
IR 3	1.169E+02	Bq

Figure 5.12. Intake sub-panel.

The **Intake** sub-panel shown in Figure 5.12 is displaying the calculated amounts of three intakes (IR1, IR2 and IR3). These values are the result of the [Example of Estimating Multiple Intakes](#) using the [Miller et al. \(1999\)](#) data. You can also enter hypothetical values of intake, or values from other sources, directly in the **Intake** dialog boxes.

Dose Calculations Sub-Panel




Figure 5.13. Dose Calculation sub-panel at start-up.

Figure 5.13 shows the **Dose Calculation** sub-panel as it appears for a **New** case (blank **Parameter File**). Note the red flags above the "WR" and "WT" tabs, signifying that neither the **Radiation Weighting Factors** nor the **Tissue Weighting Factors** to be used in the dose calculation have yet been defined. Also, no **Indicator Nuclide** has yet been defined - signified by the absence of a named radionuclide in the "**(1) Dose from Indicator Nuclide**" label.

Dose from Associated Radionuclides



Returning to the [Miller et al. \(1999\)](#) example case, let's assume that each intake of ²³⁸Pu was associated with two additional radionuclides, ²³⁹Pu and ²⁴¹Am. Let's hypothesize that the ²³⁹Pu activity concentration in the inhaled material was 15% of the indicator ²³⁸Pu value, and the ²⁴¹Am activity concentration 5%. These values are set up in the **Associated Radionuclides** sub-panel of the **Main Screen**, as shown in Figure 5.14.

Full Edition 

Intake (IR 1)
 Bq

Indicator Nuclide
 Pu-238

Number of Associated Radionuclides:
 Half Life: 32030 d

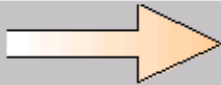
Associated Radionuclides

Abundance %
 Half Life: 157800 d

Figure 5.14. Example of two **Associated Radionuclides**, with ²³⁸Pu as the **Indicator Nuclide**.

For this example, the **Dose Calculation** sub-panel will appear as shown in Figure 5.15. Note that a second checkbox is now activated - for "**(2) Dose from Associated Radionuclides**".

CALCULATION



Calculations

Select

(1) Dose from Indicator Nuclide: Pu-238

(2) Dose from Associated Radionuclides

(3) Dose in each Calendar Year

Effective Dose (Sv)

Figure 5.15. **Dose Calculation** sub-panel for case with **Associated Radionuclides**.

Defining the Radiation Weighting



Factor

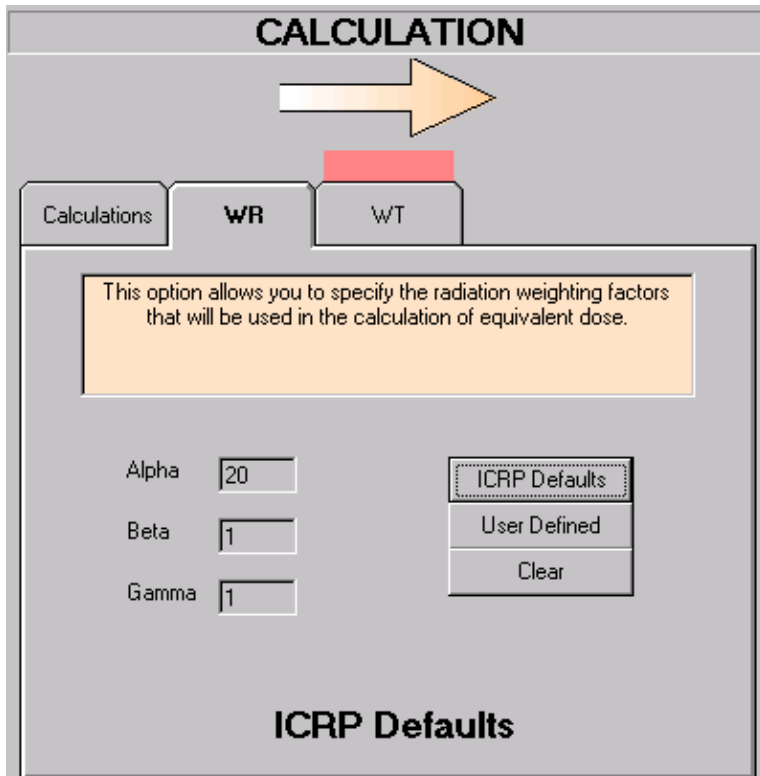


Figure 5.16. Selection of **ICRP-recommended Radiation Weighting Factors**.

Click the "WR" tab and click the "ICRP Defaults" button to load the ICRP-recommended values for the [Radiation Weighting Factors](#). You can also define your own (**User Defined**) value for Alpha, Beta and/or Gamma radiation.

Selecting the Tissue Weighting Factors



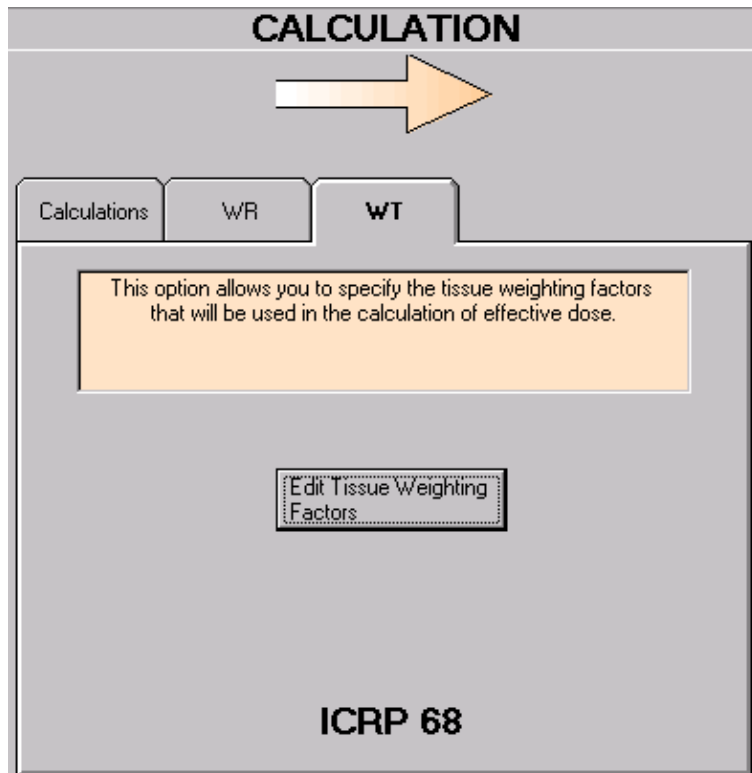


Figure 5.17. Selection of **ICRP60/68 Tissue Weighting Factors** and **Remainder Tissue Rules**.

Click the "**WT**" tab to select or edit the **Tissue Weighting Factors** and **Remainder Tissue Rules** to be used for the calculation of **Effective Dose** (Figure 5.17). In this example, the values recommended in ICRP 60/68 have been selected. Click the "**Edit Tissue Weighting Factors**" button to view these selected (and loaded) values (Figure 5.18).

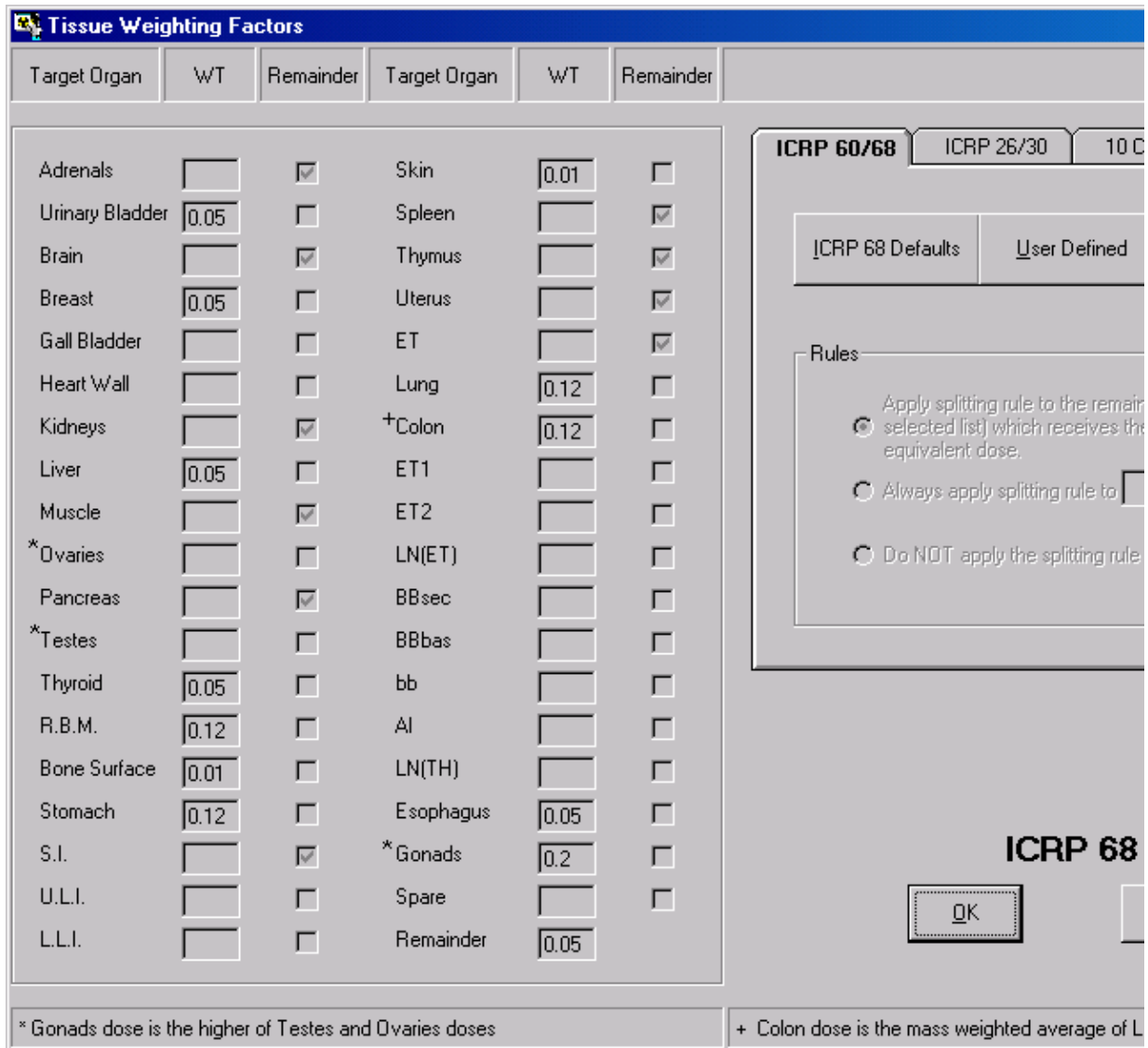


Figure 5.18. The **Tissue Weighting Factors** window.

In this window, you can also *opt* to use the values of **Tissue Weighting Factor** and **Remainder Tissue Rules** required in [10 CFR 835](#) (for use in the U.S.), or those recommended in [ICRP26/30](#), on which the **10 CFR 835** values are based.

Dose Calculation Progress Indicator



To *calculate* (and display) the resulting doses, *check* the required calculation(s), and *click* the "Calculate" button. If you have forgotten to *specify* the **Biokinetic Model** for the **Indicator Nuclide**, you will see the **Warning Notice** shown in Figure 5.19. Once you have *selected* the **Biokinetic Model**, the dose calculation will proceed automatically.

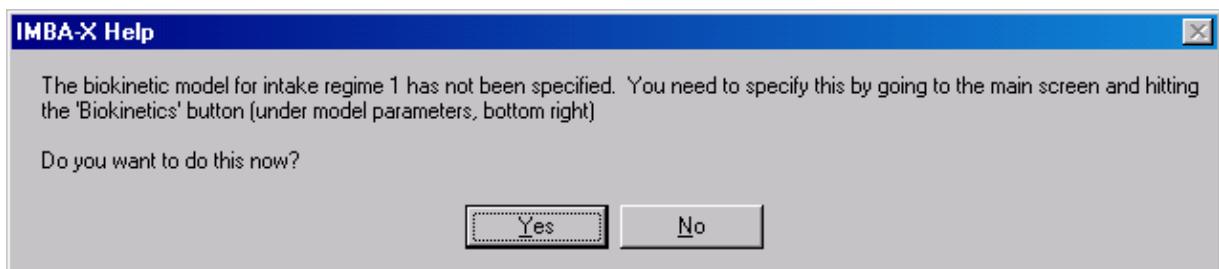


Figure 5.19. **Warning Notice** to select a **Biokinetic Model** for the **Indicator Nuclide**.

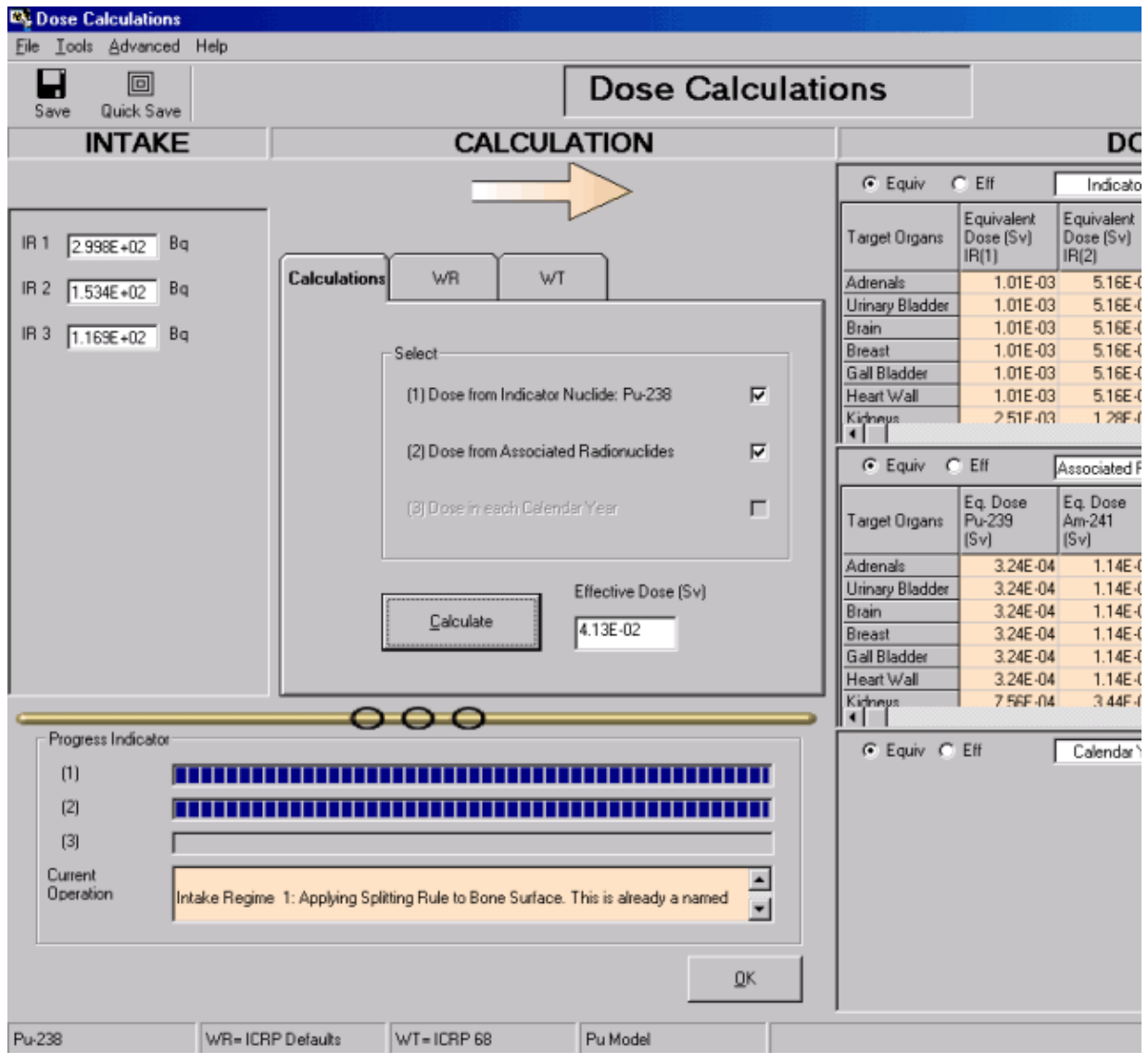


Figure 5.21. Displayed results of a completed **Dose Calculation** set to show **Equivalent Doses** in the "Dose" windows.

Figure 5.21 shows the results for **Equivalent Dose** displayed in two windows:

- **Indicator Radionuclide** window - for each separate **Intake Regime (IR)**, together with the **Total Equivalent Dose** from all intake regimes to each **Target Organ**;
- **Associated Radionuclide** window - for each **Associated Radionuclide**, together with the **Total Equivalent Dose** from all associated radionuclides to each **Target Organ**.

You can *toggle* the "**Equiv/Eff**" selector for either window to switch the display instantly between **Equivalent Dose** and **Effective Dose**. Figure 5.22 shows both window displays switched to **Effective Dose**.

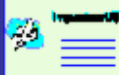
DOSE					
<input type="radio"/> Equiv		<input checked="" type="radio"/> Eff		Indicator Nuclide	
				tool	
Target Organs	Cont. to Eff Dose (Sv) IR(1)	Cont. to Eff Dose (Sv) IR(2)	Cont. to Eff Dose (Sv) IR(3)	Effective Dose (Sv) Total	
Adrenals	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
Urinary Bladder	5.05E-05	2.58E-05	1.97E-05	9.59E-05	
Brain	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
Breast	5.05E-05	2.58E-05	1.97E-05	9.59E-05	
Gall Bladder	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
Heart Wall	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
Kidneys	0.00E+00	0.00E+00	0.00E+00	0.00E+00	

<input type="radio"/> Equiv		<input checked="" type="radio"/> Eff		Associated Radionuclides	
				tool	
Target Organs	Eff Dose from Pu-239 (Sv)	Eff Dose from Am-241 (Sv)	Eff Dose from ALL AR's (Sv)		
Adrenals	0.00E+00	0.00E+00	0.00E+00		
Urinary Bladder	1.62E-05	5.70E-06	2.19E-05		
Brain	0.00E+00	0.00E+00	0.00E+00		
Breast	1.62E-05	5.70E-06	2.19E-05		
Gall Bladder	0.00E+00	0.00E+00	0.00E+00		
Heart Wall	0.00E+00	0.00E+00	0.00E+00		
Kidneys	0.00E+00	0.00E+00	0.00E+00		

Figure 5.22. Displayed results of a completed **Dose Calculation** set to show **Effective Doses** in the "Dose" windows.

Note: During a calculation, the dialog box labeled "**Effective Dose (Sv)**" in Figure 5.21 displays first the **Effective Dose** calculated for the **Indicator Nuclide** - as soon as this result is available. Once the calculations are completed for the **Associated Radionuclide(s)**, the total **Effective Dose** from the latter is automatically **added** to that from the **Indicator Nuclide**, and the result (overall total) is displayed in the dialog box. _

Example Dose Calculation



Note: This example illustrates the calculation of doses for the multiple intakes case (Miller et al., 1999) described earlier.

Clicking the "**Dose Calculations**" button in the **Main Screen**, opens the **Dose Calculations** screen (Figure 5.23). The **Indicator Nuclide** defined in the **Main Screen** is automatically shown in the "**Dose from indicator radionuclide**" label - under the "**Calculations**" tab in this example "**Pu-238**." Also, the previously estimated amounts of each intake (in this example **IR1**, **IR2** and **IR3**) are also displayed automatically under "**INTAKE**."

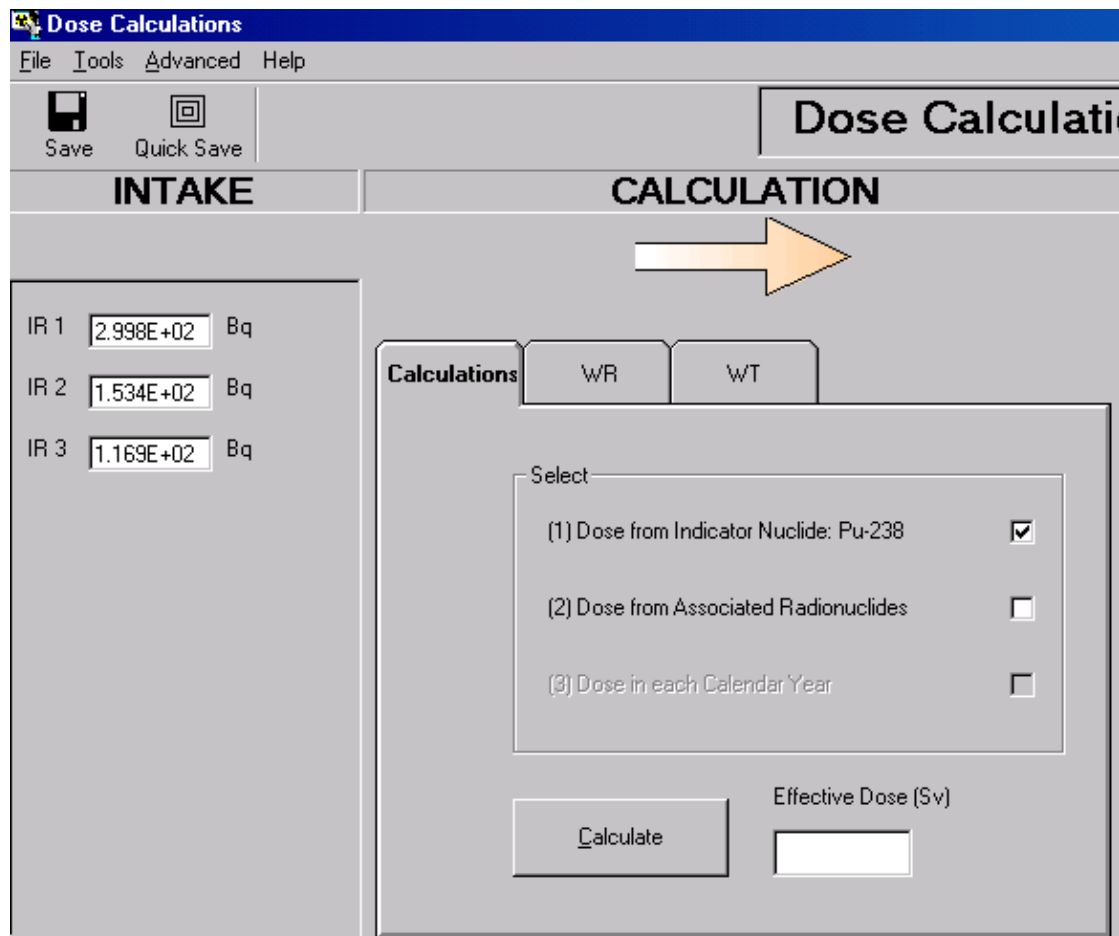


Figure 5.23. Checking the "**Dose from indicator radionuclide (Pu-238)**" dialog box in the **Dose Calculations** screen.

BEFORE *calculating* any doses, you need to *select* the values of Radiation Weighting Factor (w_R) to be used. This is done by *clicking* the "**WR**" tab in the "**CALCULATION**" sub-panel. If the values of w_R have NOT already been specified, the "**WR**" tab will appear as in Figure 5.24.

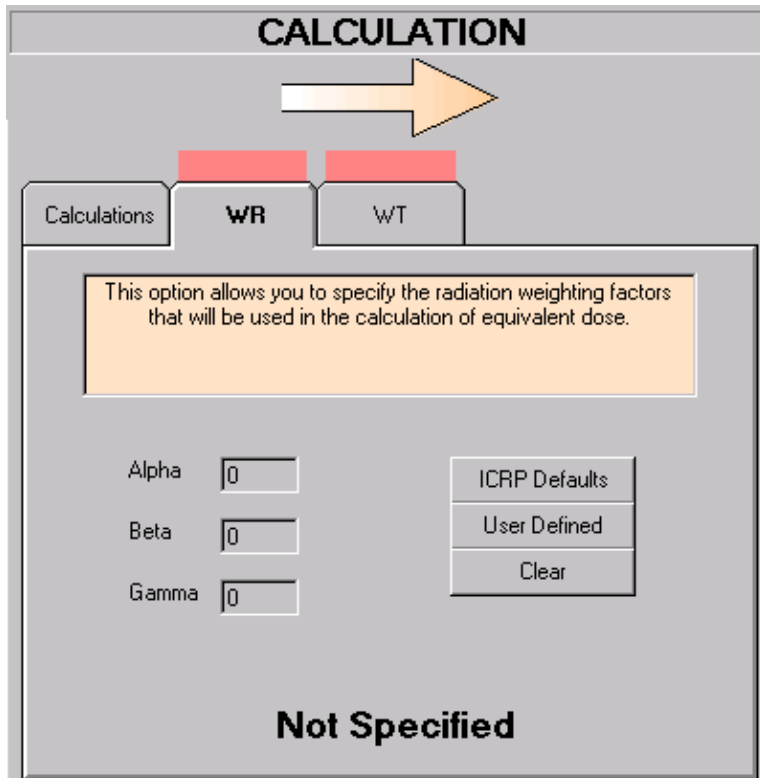


Figure 5.24. "WR" tab before values of the radiation weighting factor have been defined.

Click the "ICRP Defaults" button, to load the **ICRP-recommended** (as also prescribed by **10-CFR-835**) values of w_R :

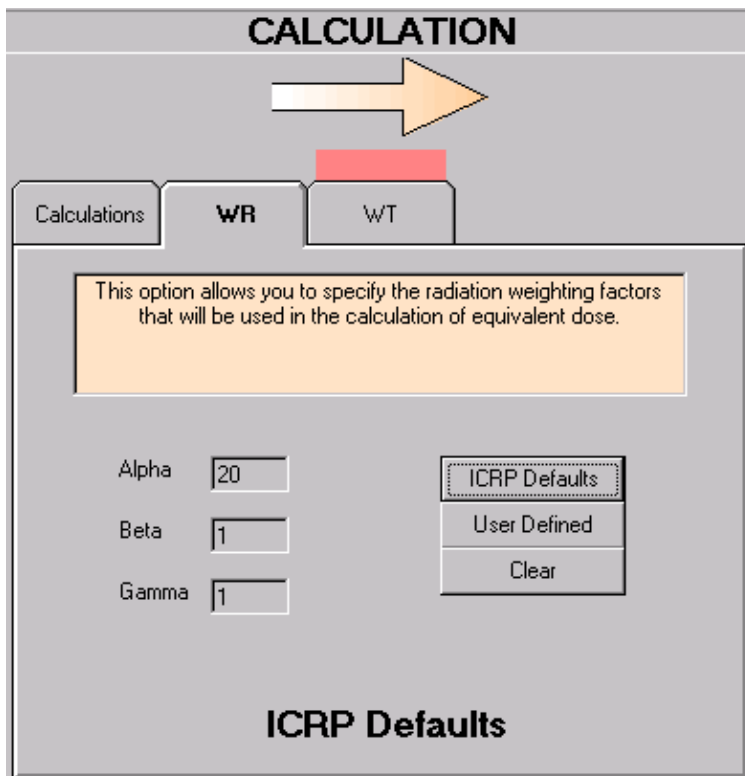


Figure 5.25. Loading the **ICRP Default** values of radiation weighting factor.

Click the "WT" tab to select (or confirm the previous selection of) the **ICRP60/68** tissue weighting factors (w_T) - see Figure 5.26.

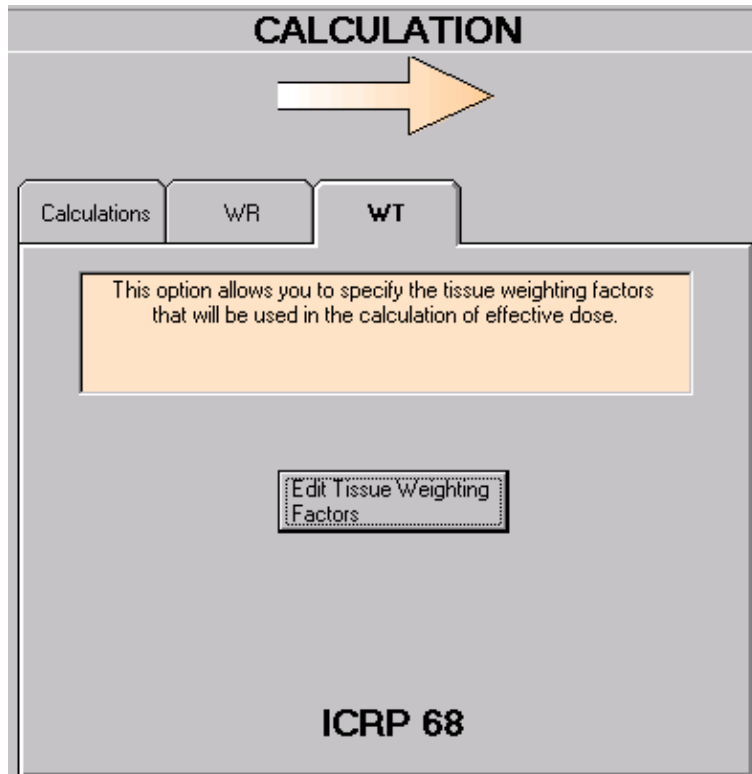


Figure 5.26. Selection of **ICRP60/68** tissue weighting factors.

Click the "**Edit Tissue Weighting Factors**" button to select and/or confirm the **ICRP60/68** values of tissue weighting factors and the remainder tissue rules (Figure 5.27). Click the "**OK**" button to return to the **Dose Calculations** screen.

Target Organ	WT	Remainder	Target Organ	WT	Remainder
Adrenals		<input checked="" type="checkbox"/>	Skin	0.01	<input type="checkbox"/>
Urinary Bladder	0.05	<input type="checkbox"/>	Spleen		<input checked="" type="checkbox"/>
Brain		<input checked="" type="checkbox"/>	Thymus		<input checked="" type="checkbox"/>
Breast	0.05	<input type="checkbox"/>	Uterus		<input checked="" type="checkbox"/>
Gall Bladder		<input type="checkbox"/>	ET		<input checked="" type="checkbox"/>
Heart Wall		<input type="checkbox"/>	Lung	0.12	<input type="checkbox"/>
Kidneys		<input checked="" type="checkbox"/>	+Colon	0.12	<input type="checkbox"/>
Liver	0.05	<input type="checkbox"/>	ET1		<input type="checkbox"/>
Muscle		<input checked="" type="checkbox"/>	ET2		<input type="checkbox"/>
*Ovaries		<input type="checkbox"/>	LN(ET)		<input type="checkbox"/>
Pancreas		<input checked="" type="checkbox"/>	BBsec		<input type="checkbox"/>
*Testes		<input type="checkbox"/>	BBbas		<input type="checkbox"/>
Thyroid	0.05	<input type="checkbox"/>	bb		<input type="checkbox"/>
R.B.M.	0.12	<input type="checkbox"/>	Al		<input type="checkbox"/>
Bone Surface	0.01	<input type="checkbox"/>	LN(TH)		<input type="checkbox"/>
Stomach	0.12	<input type="checkbox"/>	Esophagus	0.05	<input type="checkbox"/>
S.I.		<input checked="" type="checkbox"/>	*Gonads	0.2	<input type="checkbox"/>
U.L.I.		<input type="checkbox"/>	Spare		<input type="checkbox"/>
L.L.I.		<input type="checkbox"/>	Remainder	0.05	

ICRP 60/68 ICRP 26/30 10 C

ICRP 68 Defaults User Defined

Rules

- Apply splitting rule to the remainder (selected list) which receives the equivalent dose.
- Always apply splitting rule to []
- Do NOT apply the splitting rule

ICRP 68

OK

* Gonads dose is the higher of Testes and Ovaries doses + Colon dose is the mass weighted average of L

Figure 5.27. Selection of **ICRP60/68** values for the tissue weighting factors and **ICRP60/68** remainder tissue rules.

Calculation of Equivalent Doses



To *calculate* the equivalent doses received by **all** target tissues (from **each of the 3 intakes**):

- click the "**Calculations**" tab;
- click the "**Calculate**" button.

The **calculated doses** will be displayed in the "**DOSE**" table for the **Indicator Radionuclide** (Figure 5.28). Use the *scroll bar* (right-side) to view the **equivalent doses** calculated for the additional **Target Organs**.

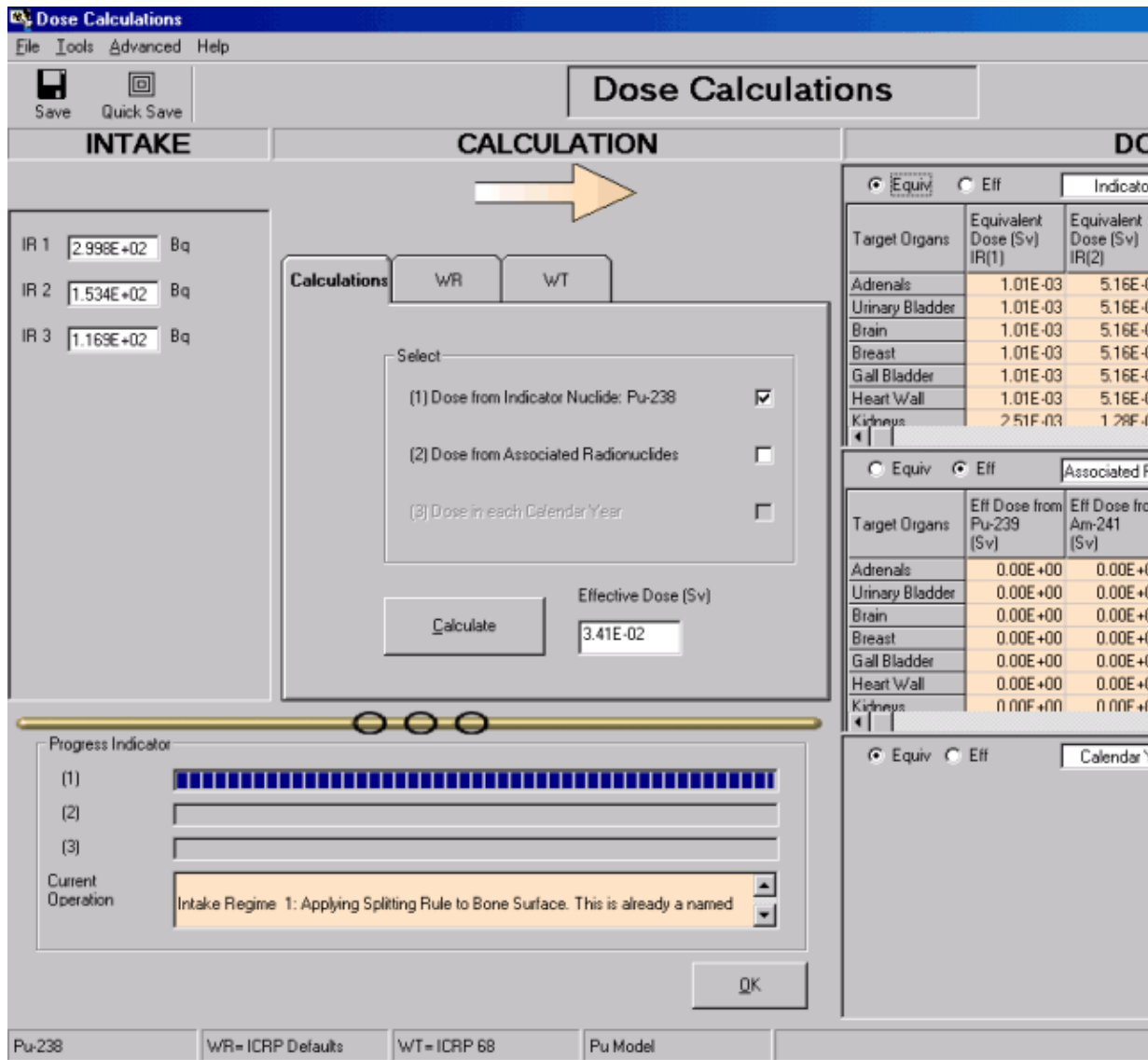


Figure 5.28. Calculated values of **Equivalent Dose** (for the **Indicator Radionuclide**).

Display of Effective Doses



IMBA Professional Plus calculates (and **stores**) ALL doses of interest (including the **effective dose resulting from each intake**) in one step. Therefore, it is not necessary to carry out a further calculation to **display the effective doses**. Simply *click* the **"Eff"** option to *switch* the display to Effective Dose (Figure 5.29).

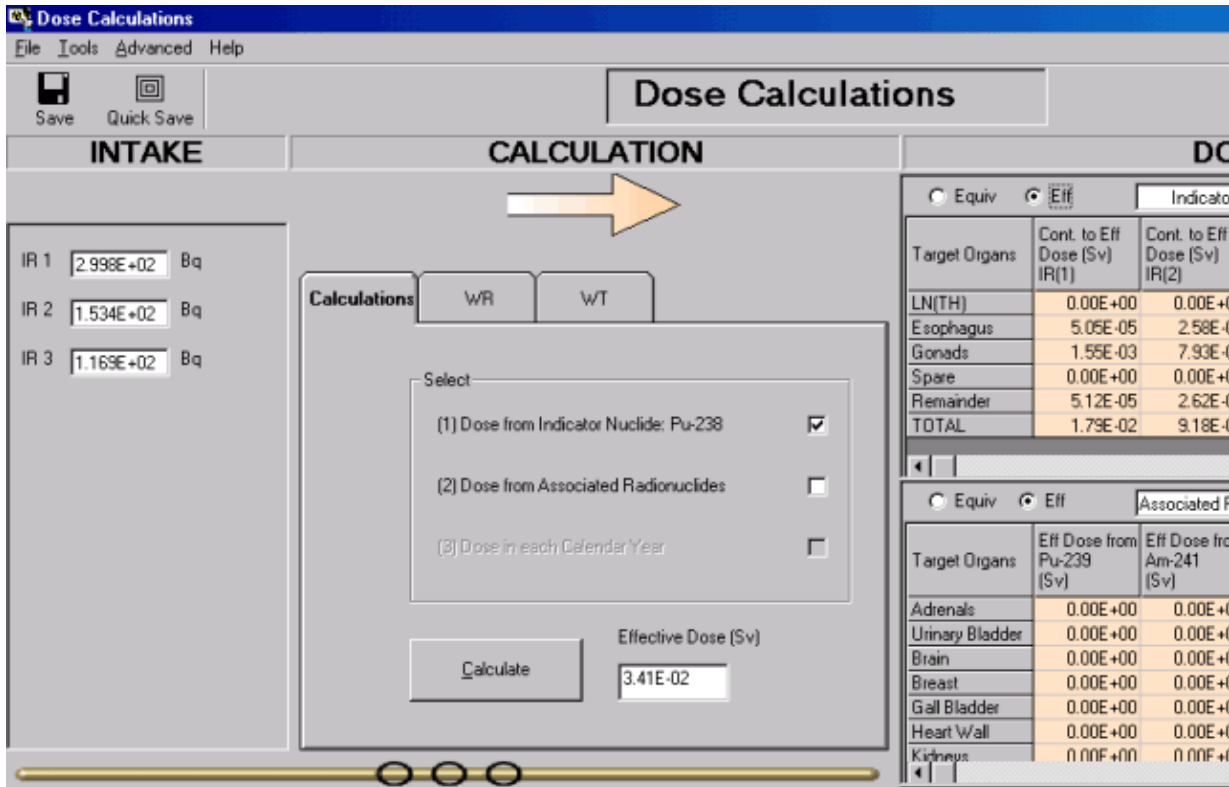



Figure 5.29. Displaying the **TOTAL Effective Dose** resulting from each intake (and the contributions from each target organ).


The values of **Effective Dose** that are calculated to result from **each separate intake** (in the **multiple intakes** example case) are:

- **EIR1 = 17.9 mSv** (1.8 rem);
- **EIR2 = 9.2 mSv** (0.9 rem);
- **EIR3 = 7.0 mSv** (0.7 rem).

The **TOTAL Effective Dose** (from **all Intakes**) is calculated to be **34.1 mSv** (3.4 rem).



Tip: It is instructive to repeat the above calculation for the "initial" and each subsequent estimate of the intake amounts (see [Optimizing the Intake Estimation](#)), together with their respective assumed **Model Parameters**. This will indicate the **range of uncertainty** in the calculated **Effective Dose** that results solely from the **intake estimation process**. Try this for yourself - it is quick and easy! Uncertainties in the biokinetic models (and dose-weighting factors) will, of course, contribute **additional uncertainty** to the **Effective Dose**.



Tip: Also try repeating the example dose calculation after selecting 10 CFR 835 tissue weighting factors and remainder tissue rules.

Calculating Doses from Associated Radionuclides (Using Add-On 3)



Doses from [Associated Radionuclides](#) are calculated at the same time as those from the **Indicator Nuclide** - see [Dose Results Windows](#). In fact, setting up the dose calculation for **Associated Radionuclides** is even simpler than setting up the **Indicator Radionuclide** dose calculation:

1. *Select* each **Associated Radionuclide** - from the **Periodic Table of the Elements** (in the **Main Screen**).
2. *Define* the **Abundance** (in %) of each **Associated Radionuclide** relative to the activity of the **Indicator Nuclide** - this is assumed to be the same for **all Intake Regimes**.
3. *Check* the "**Dose from Associated Radionuclides**" box in the "**Calculations**" sub-panel (**Dose Calculations** screen).
4. *Click* the "**Calculate**" *button*.

IMBA Professional Plus will automatically load the recommended **ICRP Biokinetic Model** for each **Associated Radionuclide** (to calculate the number of disintegrations in each Source Organ) and then use the recommended **ICRP SEE Data File** to calculate the resulting doses to Target Organs. See also the **Technical Basis** section on Treatment of Associated Radionuclides.