Examples of new dose coefficients and differences with previous recommendations

ICRP Task Group 95 webinar

Internal Dose Coefficients for Workers and Members of the Public

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Calculation of effective dose

Fundamentally the same:

$$E = \sum_T w_T H_T \qquad (Sv)$$

except that we sex-average the doses

- Sex-averaging was previously implicit in the use of hermaphrodite phantoms and is now explicit in the use of sex-specific phantoms

Changes to w_T

Tissue or organ	ICRP 103	ICRP 60	New/Old
Bone marrow, colon, lung, stomach	0.12	0.12	1.0
Breast	0.12	0.05	2.4
Remainder	0.12	0.05	2.4
Gonads	0.08	0.2	0.4
Urinary bladder, oesophagus, liver, thyroid	0.04	0.05	0.8
Bone surface	0.01	0.01	1.0
Brain	0.01	-	
Salivary glands	0.01	-	
Skin	0.01	0.01	1.0

Tissues that contribute to remainder dose

Adrenals	Oral mucosa
Extrathoracic regions of the respiratory tract	Pancreas
Gall bladder	Prostate (male), uterus/cervix (female)
Heart	Small intestine
Kidneys	Spleen
Lymphatic nodes	Thymus
Muscle	

Red indicates ICRP 103 additions

Brain was included in the ICRP 60 calculation but now has an explicit wT

Remainder dose calculation

ICRP 60 ‘split’ remainder rule

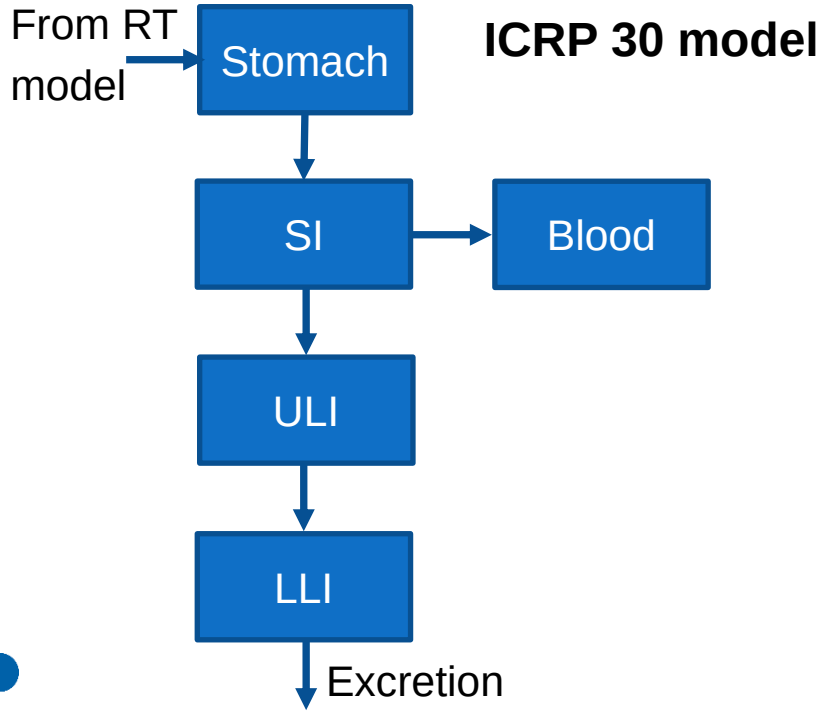
- ‘In those exceptional cases in which a single one of the remainder tissues or organs receives an equivalent dose in excess of the highest dose in any of the twelve organs for which a weighting factor is specified, a weighting factor of 0.025 should be applied to that tissue or organ and a weighting factor of 0.025 to the average dose in the rest of the remainder as defined above.’
- The contributions to remainder dose were mass-weighted

ICRP 103

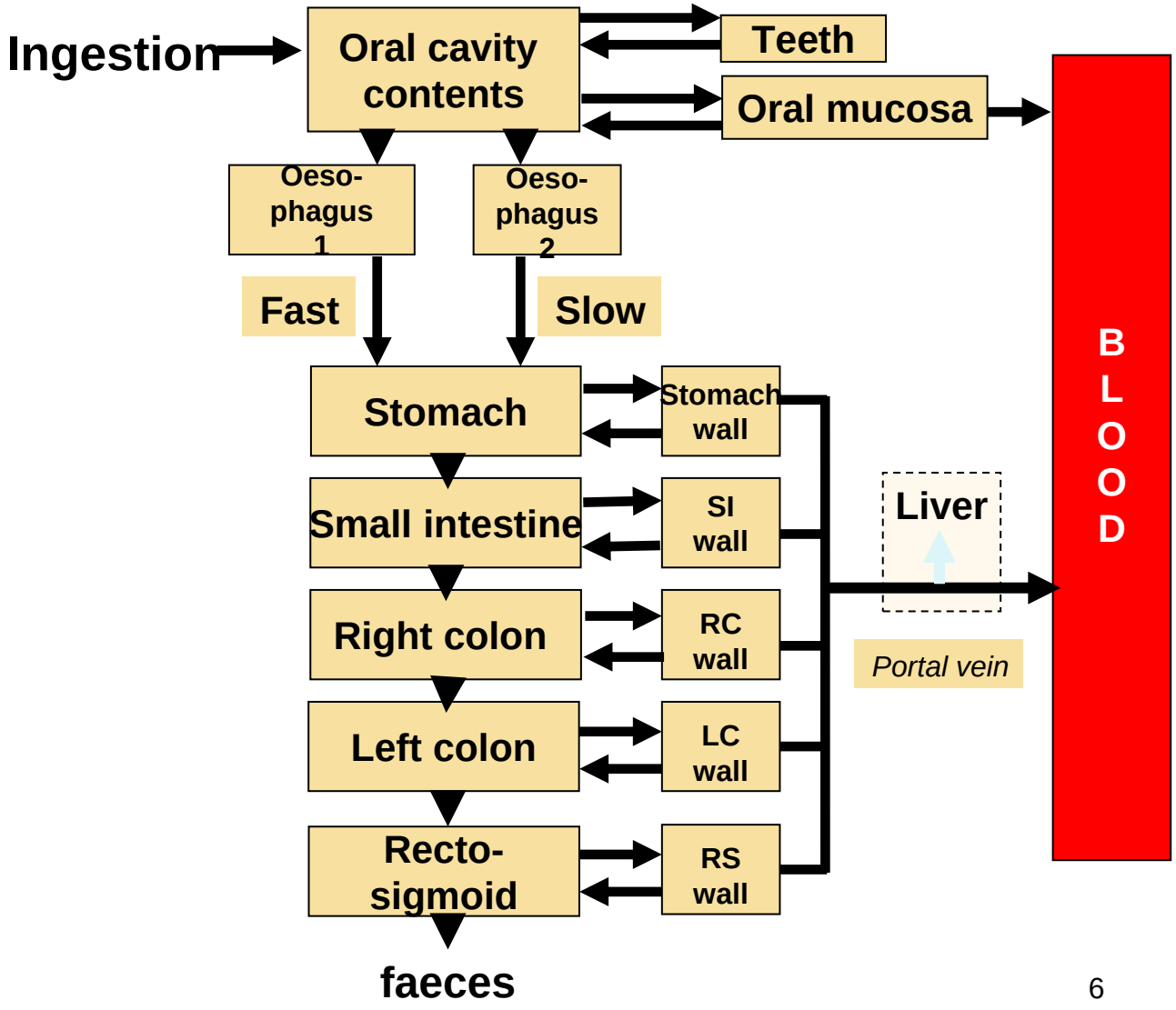
- Arithmetic average of the 13 tissues/organs for each sex

HRTM and HATM

- **HRTM - revised in ICRP Publication 130 (covered by Demetrio Gregoratto)**
- **HATM (Publication 100)**



ICRP 30 model



SAFs

Alphas

Under the ICRP 60 scheme there was limited energy dependence of SAFs (HRTM only)

3 categories

- **Self-dose (i.e. complete absorption)**
- **Walled organ, use the ICRP 30 Expression (Part 1 Page 33)**
- **Whole body source, all targets get the same SAF, equal to 1/WB_mass**

SAFs

Betas

Under the ICRP 60 scheme there was limited energy dependence of SAFs

- **Energy-dependence adopted piecemeal, e.g. Bone surface, HRTM and HATM**
- **Otherwise, same categories as for alphas**

Photons

- **Energy-dependent SAFs based on MIRD geometric phantoms**

SAFs

New - Inclusion of neutron SAFs with nuclide-specific w_R

- U-238
- Pu-236, 238, 240, 242, 244
- Cm-240, 242, 244, 245, 246, 248, 250
- Cf-246, 248, 249, 250, 252, 254
- Es-253, 254, 254m, 255
- Fm-252, 254, 255, 256, 257

SAFs

HRTM

- revisions required changes in dosimetric assumptions regarding the bronchial and bronchiolar regions
- Publication 66 electron SAFs were augmented with selected values from the reference computational phantoms in cases where the absorbed fractions had previously been assumed to be either unity or zero.
- inclusion of the bound compartment

SAFs

As already covered by Derek Jokisch, there are improved energy-absorption models for charged particles in the

- alimentary tract
- gall bladder
- and the skeleton

as well as changes for all other source/target pairs brought about by the move to voxel phantoms.

SAF limits as E→0

SAF limits

- $1/m_T$ for solid source–target regions
- ***New*** **- Blood as source**

$$SAF(T \leftarrow Blood, E \rightarrow 0) = f_{Blood\_T}/m_T$$

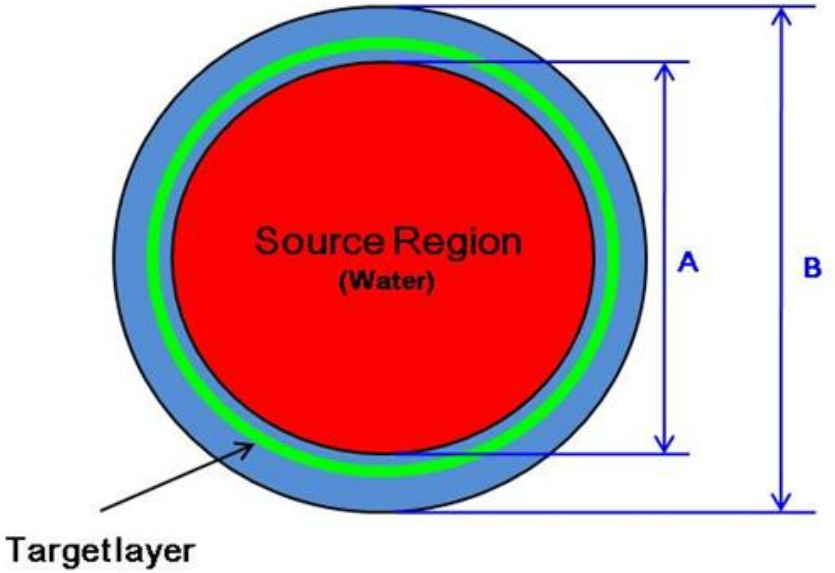
where f_{Blood_T} is the fraction of blood in target tissue, T

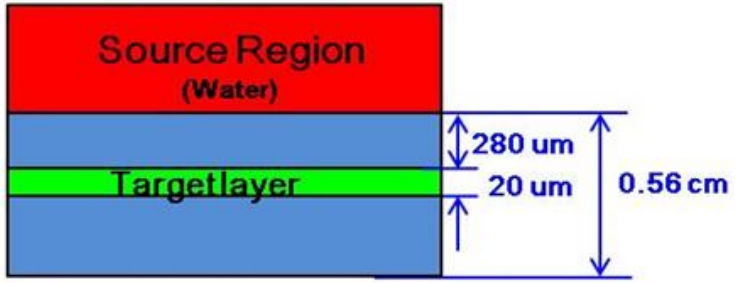
SAFs - Location of target cells

Alimentary tract

- ICRP 60 – whole gut wall was considered to be the target
- ICRP 103 – mucosa layer considered, differs for each section

e.g. large intestine





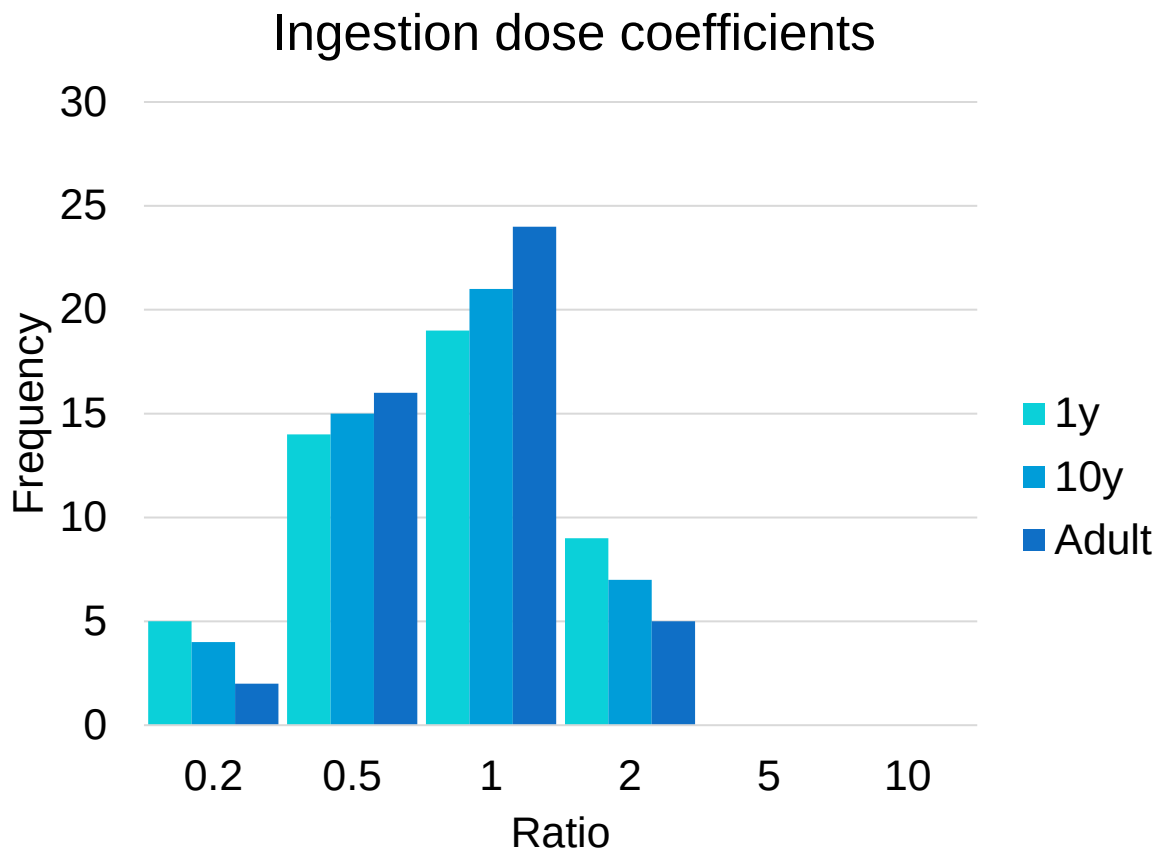
Biokinetic models

- The majority of calculations for the ICRP 60 series employed shared biokinetics – where the radioactive progeny share the biokinetic model of the parent.
- The OIR and EIR series have moved exclusively to independent biokinetics, where each member of the chain has its own model.
- Additionally, all biokinetic models are now physiologically based (i.e. involving recycling and excretion pathways).

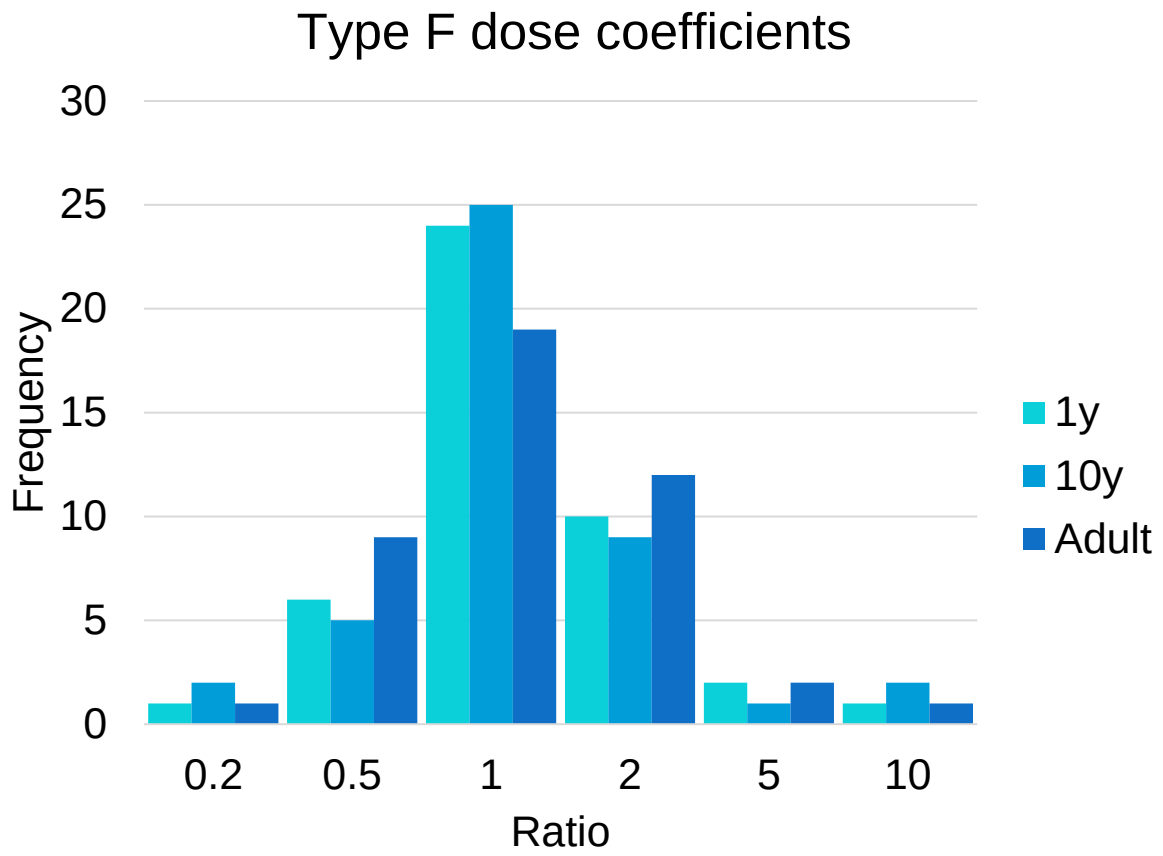
Biokinetic parameters

- Updates to lung absorption and clearance parameters.
- Updates to f_A (previously f_1) values.

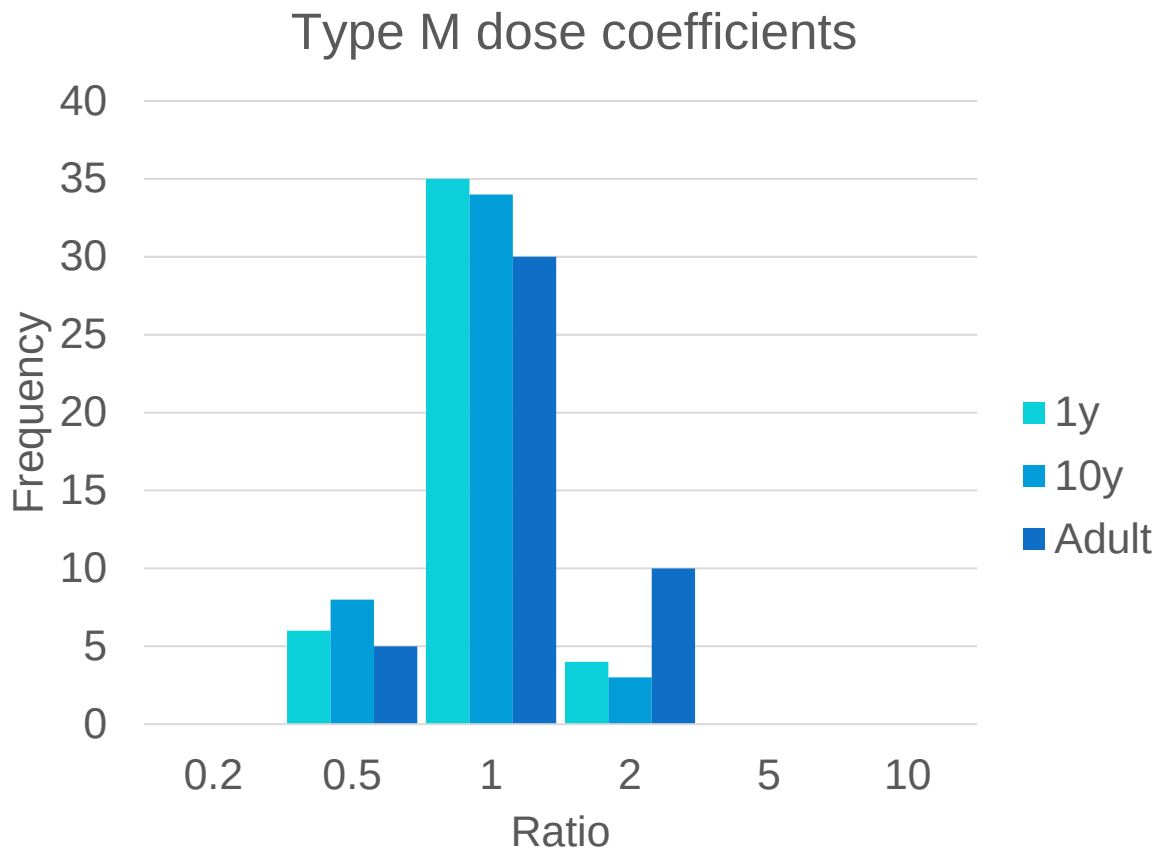
Ingestion - range of ratios (New/old)



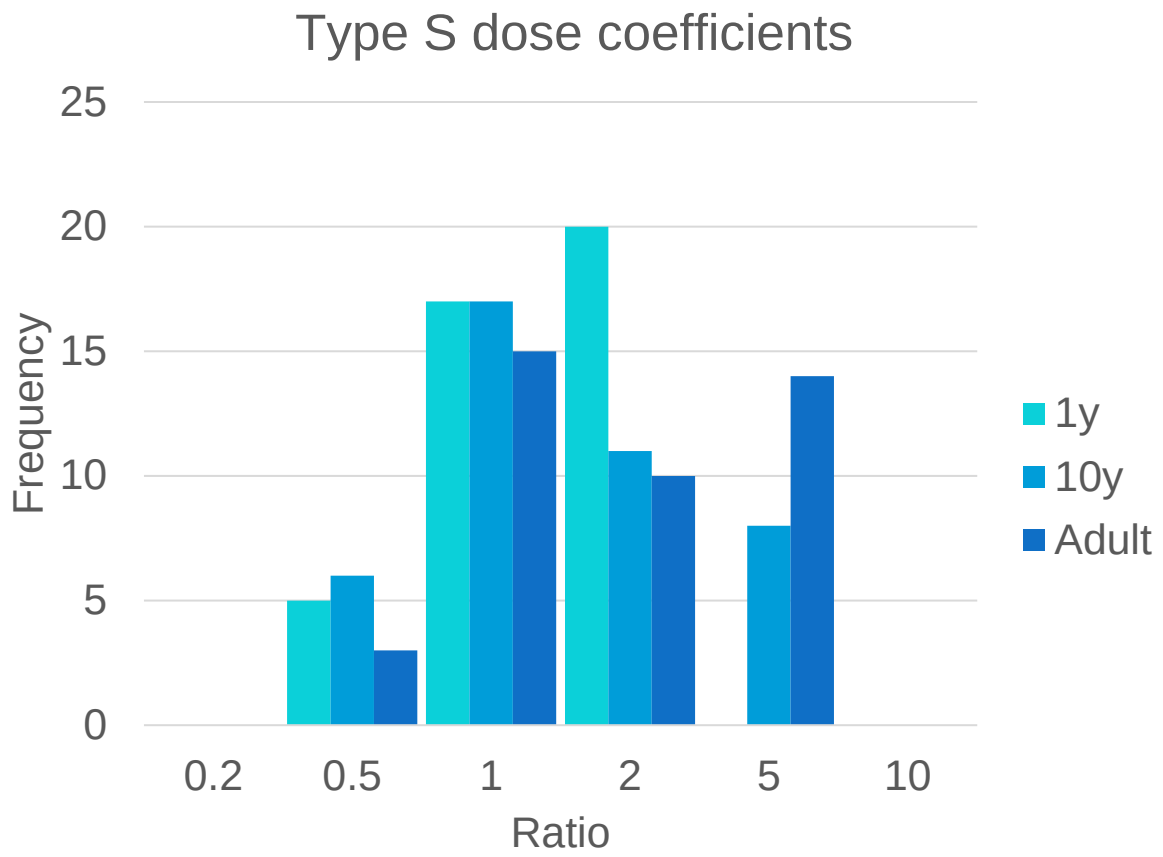
Type F - range of ratios (New/old)



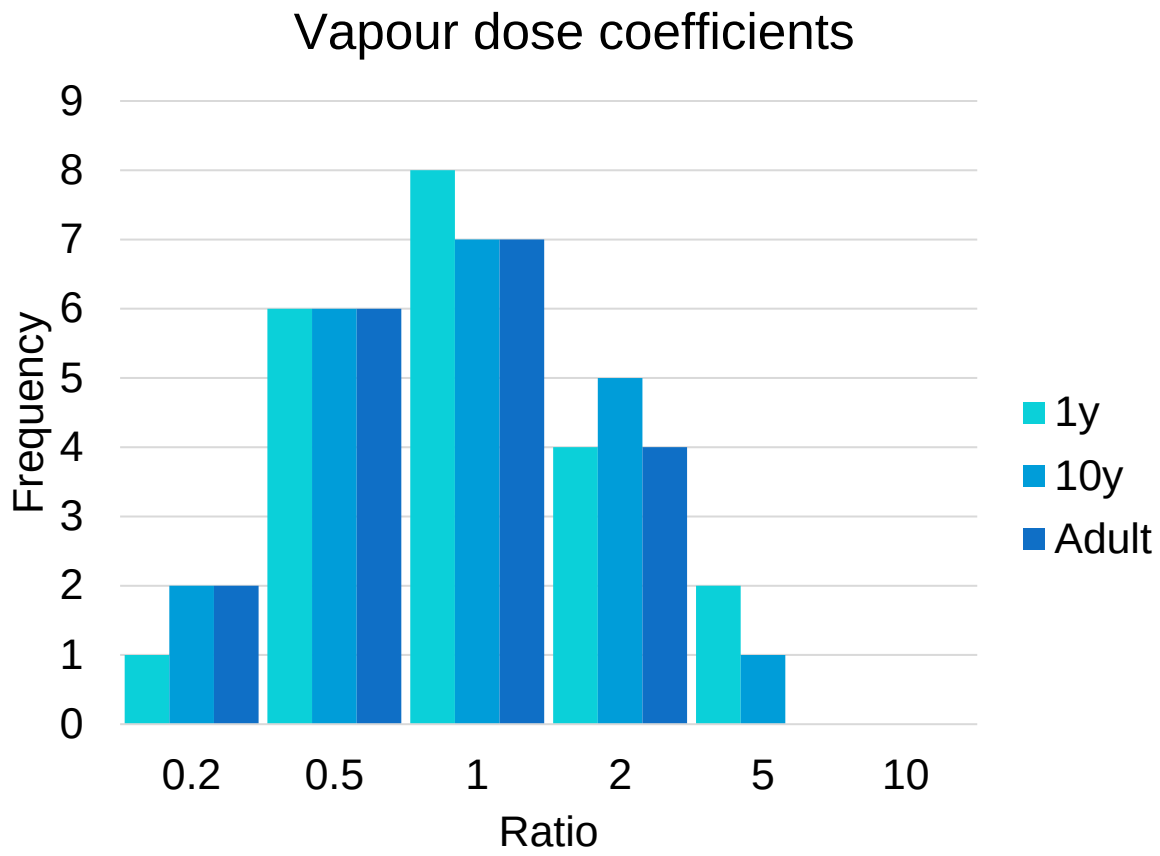
Type M - range of ratios (New/old)



Type S - range of ratios (New/old)



Vapours - range of ratios (New/old)



Tritiated water

Effective dose	Old	New	Change
Worker, inhalation 5μm	1.8E-11	2.0E-11	+11%
MoP, adult, ingestion	1.8E-11	1.9E-11	+6%
MoP, 10y, ingestion	2.3E-11	2.7E-11	+17%
MoP, 1y, ingestion	4.8E-11	7.2E-11	+50%

Tritium, 1y Ingestion HTO

- **Old: uniform tissue doses**
- **New: variation due to blood content**

	Old wT	New wT	Old h	New h	Change, %
Bone marrow	0.12	0.12	4.8E-11	7.8E-11	+63
Colon	0.12	0.12	4.8E-11	7.8E-11	+62
Lungs	0.12	0.12	4.8E-11	7.8E-11	+63
Stomach	0.12	0.12	4.8E-11	7.6E-11	+58
Breast	0.05	0.12	4.8E-11	6.2E-11	+30
Remainder	0.05	0.12	4.8E-11	6.8E-11	+41
Gonads	0.20	0.08	4.8E-11	6.2E-11	+28
Urinary bladder	0.05	0.04	4.8E-11	5.8E-11	+22
Oesophagus	0.05	0.04	4.8E-11	7.6E-11	+58
Liver	0.05	0.04	4.8E-11	7.9E-11	+64
Thyroid	0.05	0.04	4.8E-11	6.8E-11	+42
Bone surface	0.01	0.01	4.8E-11	7.6E-11	+59
Skin	0.01	0.01	4.8E-11	6.0E-11	+24
Brain		0.01		6.0E-11	
Salivary glands		0.01		6.2E-11	

ICRP

Sr-90 in diet, ingestion by MoP

Effective dose coefficients, Sv/Bq

	Old	New	Change
Adult	2.8E-08	2.4E-08	-14%
10y	6.0E-08	8.2E-08	+37%
1y	7.3E-08	1.1E-07	+51%

I-131, ingestion by MoP

Effective dose coefficients, Sv/Bq

	Old	New	Change
Adult	2.2E-08	1.6E-08	-27%
10y	5.2E-08	3.5E-08	-33%
1y	1.8E-07	1.2E-07	-33%

Cs-137 in diet, ingestion by MoP

Effective dose coefficients, Sv/Bq

	Old	New	Change
Adult	1.3E-08	1.4E-08	+8%
10y	1.0E-08	1.0E-08	-
1y	1.2E-08	1.7E-08	+42%

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