

Office of Federal and State Materials and Environmental Management Programs

*Safety and Security in the Beneficial Applications
of Nuclear Materials*

Effective Dose and Numerical Values

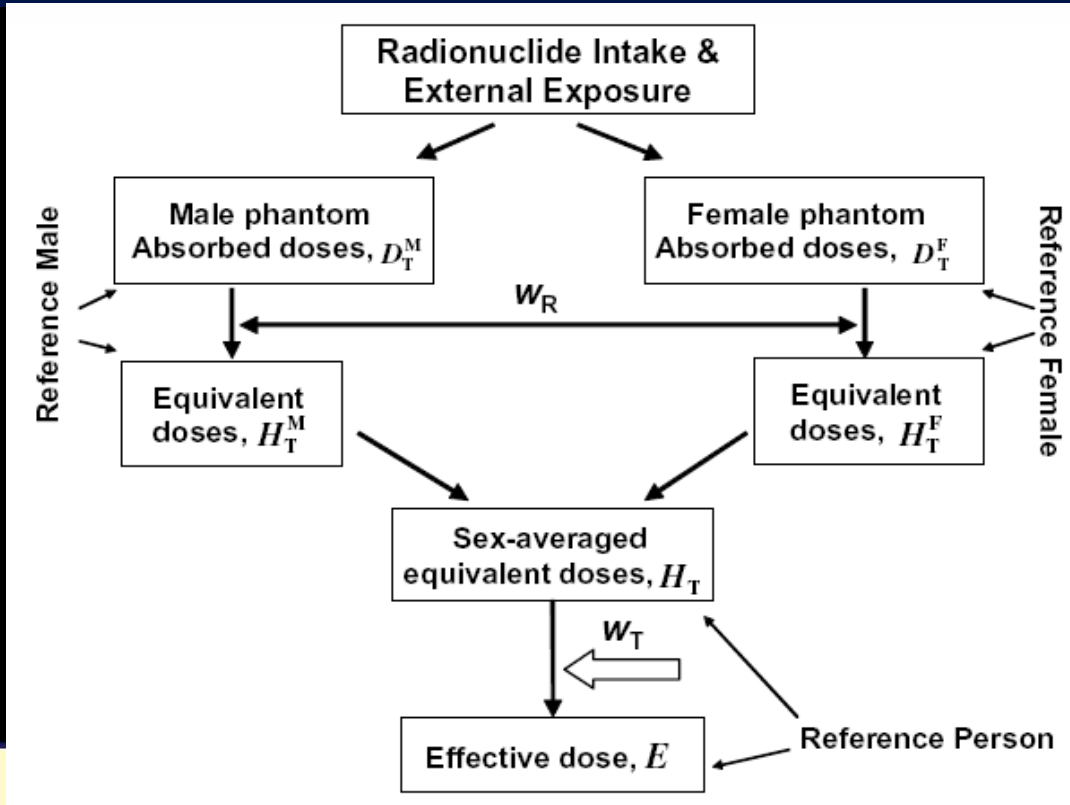
What is Total Effective Dose?

- **Total Effective Dose Equivalent is:**
 - External exposure reported as Deep Dose Equivalent
 - Internal exposure reported as Committed Effective Dose Equivalent
- **NRC definition amended to allow Effective Dose from external exposures using approved calculations**
- **Total Effective Dose is:**
 - External exposure reported as Effective Dose
 - Internal exposure reported as Committed Effective Dose

Effective Dose



Male



Female

$$E = \sum_T w_T \left[\frac{H_T^M + H_T^F}{2} \right]$$

Radiation Weighting

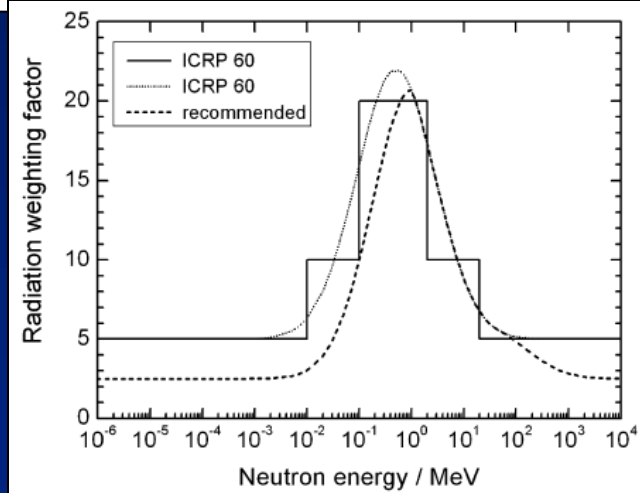
Table 1. Radiation weighting factors¹

Type and energy range ²	Radiation weighting factor, w_R
Photons, all energies	1
Electrons and muons, all energies ³	1
Neutrons, energy < 10 keV	5
10 keV to 100 keV	10
> 100 keV to 2 MeV	20
> 2 MeV to 20 MeV	10
> 20 MeV	5
(See also Figure 1)	
Protons, other than recoil protons, energy > 2 MeV	5
Alpha particles, fission fragments, heavy nuclei	20

¹ All values relate to the radiation incident on the body or, for internal sources, emitted from the source.

² The choice of values for other radiations is discussed in Annex A.

³ Excluding Auger electrons emitted from nuclei bound to DNA (see paragraph 116).



ICRP Publication 103

Table 2. Recommended radiation weighting factors.

Radiation type	Radiation weighting factor, w_R
Photons	1
Electrons ^a and muons	1
Protons and charged pions	2
Alpha particles, fission fragments, heavy ions	20
Neutrons	A continuous function of neutron energy (see Fig. 1 and Eq. 4.3)

All values relate to the radiation incident on the body or, for internal radiation sources, emitted from the incorporated radionuclide(s).

^a Note the special issue of Auger electrons discussed in paragraph 116 and in Section B.3.3 of Annex B.

Tissue Weighting

1990 RECOMMENDATIONS OF THE ICRP

Table 2. Tissue weighting factors¹

Tissue or organ	Tissue weighting factor, w_T
Gonads	0.20
Bone marrow (red)	0.12
Colon	0.12
Lung	0.12
Stomach	0.12
Bladder	0.05
Breast	0.05
Liver	0.05
Oesophagus	0.05
Thyroid	0.05
Skin	0.01
Bone surface	0.01
Remainder	0.05 ^{2,3}

ICRP Publication 103

Table 3. Recommended tissue weighting factors.

Tissue	w_T	$\sum w_T$
Bone-marrow (red), Colon, Lung, Stomach, Breast, Remainder tissues*	0.12	0.72
Gonads	0.08	0.08
Bladder, Oesophagus, Liver, Thyroid	0.04	0.16
Bone surface, Brain, Salivary glands, Skin	0.01	0.04
Total		1.00

* Remainder tissues: Adrenals, Extrathoracic (ET) region, Gall bladder, Heart, Kidneys, Lymphatic nodes, Muscle, Oral mucosa, Pancreas, Prostate (♂), Small intestine, Spleen, Thy-mus, Uterus/cervix (♀).

Dose Coefficients

- Represents the Effective Dose from a unit exposure
- Based on:
 - Tissue Weighting
 - Radiation Weighting
 - Types of radiation
- ALI's and DAC's
 - Calculated using the dose coefficient
 - Values used to help demonstrate compliance

Updates to Dose Coefficients

- **ICRP currently preparing new dose coefficients based on world cancer incidence**
- **EPA using BEIR VII and U.S. specific cancer incidence to develop revised values for the United States**
- **Values will be different because:**
 - **US and World cancer rates are different**
 - **Changes to effectiveness of some radionuclides**

Effective Dose Options

- **Options:**
 - **1.1a: No change in the current terminology (terminology remains TEDE)**
 - **1.1b: Change the current regulation to align with the current ICRP Publication 103: Express as Total Effective Dose**
 - **1.1c: Allow use of either term**

Effective Dose Questions

Q1.1-1: Are there any potential impacts on the ability to comply with the options for dose limits (DDE vs. TED)?

- What are the impacts and implications of using updated terminology?**

Effective Dose Questions

Q1.1-2: What are the anticipated impacts on records and reports?

Numerical Values Options

- **1.2a: No change**
- **1.2b: Change the current regulation to align with the current ICRP Publication 103: Update to new values, models, and radionuclide decay data**

Numerical Values Questions

Q1.2-1: Are there any foreseen impacts of the timing (2014) of making changes to the current numerical values and weighting factors?

- Should NRC consider moving forward with a more limited set of radionuclides that would be available more quickly, and make subsequent amendments to add additional values as they are published by the ICRP?**

Numerical Values Questions

Q1.2-2: Should the NRC use the values developed by the EPA, which will be based on a US population, instead of the ICRP values, which are based on a more diverse world population?

Other Questions?

