Committee 2
Doses From Radiation Exposure

Committee 2 is concerned with the development of reference dose coefficients for the assessment of internal and external radiation exposure, and the development of reference biokinetic and dosimetric models; and reference data for workers and members of the public.
Committee 2 Members

Hans-Georg Menzel (Chair) (CH)
John Harrison (Vice-chair) (UK)
Mike Bailey (UK)
Mikhail Balonov (RU)
David Bartlett (UK)
Vladimir Berkovski (Ukr)
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Akira Endo (JP)
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Joyce Lipsztein (BR)
Jizeng Ma (CHN)
Francois Paquet (FR)
Nina Petoussi Henss (DE)
Sambika Sahai Pradhan (IND)
Recent ICRP Publications
prepared by C2 and its Task Groups

- Publication 89
  Basic Anatomical and Physiological Data for Use in Radiological Protection Reference Values
- Publication 95
  Doses to Infants from Ingestion of Radionuclides in Mothers' Milk
- Publication 100
  Human Alimentary Tract Model for Radiological Protection
- Publication 107
  Nuclear Decay Data for Dosimetric Calculations
- Publication 110
  Adult Reference Computational Phantoms
Current Task Groups of Committee 2

- Task Group 4 (DOCAL) Dose Calculations
- Task Group 21 (INDOS) Internal Dosimetry
- Task Group 67 Radiation Protection in Space
- Task Group 79 jointly with C 1, C 2, C 4) The Use of Effective Dose

Active involvement in TGs of all other Committees
Conversion Coefficients for External Radiation

Conversion from field quantities (fluence, air kerma) to dose quantities (organ absorbed dose, equivalent dose, effective dose)

Why new dose conversion coefficients?

Published in 1997 also published as ICRU report 57
Joint Publication with ICRU

ICRP Publication 110 – Adult Reference Computational Phantoms

Anatomically detailed voxel models of the ICRP 89 Reference Adult Male and Reference Adult Female – 141 tissue structures for each phantom
Share identical anatomy except gender organs

*Likely future ICRP Reference phantoms developed at the University of Florida*
Dose quantities are evaluated using Monte Carlo simulations of radiation transport in the reference phantoms for reference irradiation geometries.
### Parameter Matrix

<table>
<thead>
<tr>
<th>Particles</th>
<th>Energies</th>
<th>Geometries</th>
<th>Primary Calculations</th>
<th>Secondary Calculations</th>
<th>Spot Checks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neutrons</td>
<td>1 MeV – 10 GeV</td>
<td>AP, PA, LLAT, RLAT, ISO, ROT</td>
<td>JAEA (Endo) – PHITS</td>
<td>INFN (Pelliccioni) – FLUKA</td>
<td>RPI (Xu) – MCNPX 2.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>GTech (Hertel) – MCNPX-CEM</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>HMGU (Simmer) – GEANT4</td>
</tr>
<tr>
<td>Electrons / Positrons</td>
<td>50 keV – 10 GeV</td>
<td>AP, PA, ISO</td>
<td>GTech (Hertel) – MCNPX-CM</td>
<td>HMGU (Schlattl) – EGSnrc</td>
<td></td>
</tr>
<tr>
<td>Protons</td>
<td>1 MeV – 10 GeV</td>
<td>AP, PA, LLAT, RLAT, ISO, ROT</td>
<td>JAEA (Endo) – PHITS</td>
<td>INFN (Pelliccioni) – FLUKA</td>
<td>JAEA (Endo) – MCNPX</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>HMGU (Simmer) – GEANT4</td>
</tr>
<tr>
<td>Pions negative/ Pions positive</td>
<td>1 MeV – 200 MeV</td>
<td>AP, PA, ISO</td>
<td>JAEA (Endo) – PHITS and FLUKA</td>
<td>GTech (Hertel) – MCNPX-CEM</td>
<td></td>
</tr>
<tr>
<td>Muons negative/ Muons Positive</td>
<td>1 MeV to 10 GeV</td>
<td>AP, PA, ISO</td>
<td>JAEA (Endo) – FLUKA and MCNP2.6</td>
<td>JAEA (Endo) – PHITS</td>
<td>Muons negative: HMGU (Simmer) – GEANT4</td>
</tr>
<tr>
<td>He Ions</td>
<td>1 MeV/n to 100 GeV/n</td>
<td>AP, PA, ISO</td>
<td>JAEA (Endo) – PHITS</td>
<td>JAEA (Endo) – FLUKA</td>
<td>RPI (Xu) – MCNPX 2.5</td>
</tr>
<tr>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>
### List of tables of conversion coefficients
(Male, Female sets will be given separate)

<table>
<thead>
<tr>
<th>Effective dose</th>
<th>Lens of Eye</th>
<th>Saliver glands</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adrenals</td>
<td>Liver</td>
<td>Skin</td>
</tr>
<tr>
<td>Brain</td>
<td>Lungs</td>
<td>Small Intestine wall</td>
</tr>
<tr>
<td>Breast</td>
<td>Lymph</td>
<td>Spleen</td>
</tr>
<tr>
<td>Colon</td>
<td>Muscle</td>
<td>Stomach wall</td>
</tr>
<tr>
<td>Endost-BS</td>
<td>Oesophagus</td>
<td>Thyroid</td>
</tr>
<tr>
<td>ET</td>
<td>Oral Mucosa</td>
<td>Thymus</td>
</tr>
<tr>
<td>GB-wall</td>
<td>Pancreas</td>
<td>Urinary Blader wall</td>
</tr>
<tr>
<td>Gonads</td>
<td>Prostate</td>
<td>Uterus</td>
</tr>
<tr>
<td>Heart wall</td>
<td>R-marrow</td>
<td></td>
</tr>
<tr>
<td>Kidneys</td>
<td>Remainder</td>
<td></td>
</tr>
</tbody>
</table>
• The skeletal microstructure (bone trabeculae and marrow cavities) is not represented in the ICRP voxel phantoms – only their macroscopic locations (skeletal spongiosa).

• In spongiosa, strong elemental and mass density differences present themselves in the tissues of the mineral bone (trabeculae) and the marrow (red and yellow).
Different Transport Codes

Organ Absorbed Dose

Photons

Neutrons
Dose Conversion Coefficients – Reference Values

External Photons

External Neutrons
Comparison ICRP 74 ↔ New Coefficients
Photons

<table>
<thead>
<tr>
<th>Photon energy (MeV)</th>
<th>Effective dose per air kerma (Sv Gy$^{-1}$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.01</td>
<td>0.0</td>
</tr>
<tr>
<td>0.10</td>
<td>0.2</td>
</tr>
<tr>
<td>1.00</td>
<td>0.4</td>
</tr>
<tr>
<td>10.00</td>
<td>1.0</td>
</tr>
</tbody>
</table>

Effective dose
AP

EGSnrc
GEANT4
MCNPX
ICRP74
Comparison ICRP 74 ↔ New Coefficients

Neutrons

Effective dose per fluence (pSv cm$^2$)

- PHITS
- FLUKA
- GEANT4
- ICRP74

Effective dose

Neutron Energy (MeV)

ICRP

INTERNATIONAL COMMISSION ON RADIOLOGICAL PROTECTION
The joint ICRP/ICRU Publication is composed of a printed copy with explanatory text and examples of results. It includes also data for the lens of the eye.

The 620 tables of data for reference dose conversion coefficients for organ absorbed dose and effective dose and additional information and explanation are given in an accompanying CD.
Dose coefficients for internal emitters

1. Quantified intake by inhalation or ingestion

2. Mean absorbed dose, $D_{T,R}$ in an organ or tissue

3. Equivalent dose, $H_T$ in an organ or tissue

4. Effective dose, $E$

Factors:
- Radiation weighting factors, $w_R$
- Tissue weighting factors, $w_T$

Biokinetic and Dosimetric Models
The human respiratory tract model (ICRP publication 66, 1994)

deposition, transport and absorption of particles into blood after inhalation
A new alimentary tract model (2006)

Human Alimentary Tract Model for Radiological Protection

ICRP PUBLICATION 100

PUBLISHED FOR
The International Commission on Radiological Protection
by
ELSEVIER
Internal Dosimetry (INDOS)

Current tasks

Providing new models to

Update publications 30 (1982), 68 (1995) for occupational intake of radionuclides
- Update reports on bioassay interpretation publications 54 (1988) and 78 (1997)


OIR Document
The OIR document

Dose coefficients for Occupational INTAKES of Radionuclides (OIR) by inhalation and ingestion.
Main features

1. Revision of the Publication 66 Human Respiratory Tract Model (HRTM) which takes account of more recent data.

2. Revisions of models for the systemic biokinetics of radionuclides absorbed to blood for physiologically more realistic representations of uptake and retention in organs and tissues and of excretion.

3. Data for the interpretation of bioassay measurements

4. Dose coefficients for about 40 elements including Radon
The OIR document will be published in 4 parts

Part 1 : Main text (2012)
Contains chapters on control of occupational exposures, biokinetic and dosimetric models, monitoring methods and programmes, and retrospective dose assessment.

Part 2, 3 and 4 : Element sections (2012-2014)
Contain biokinetic data and models for individual elements and their radioisotopes, dose coefficients and data for bioassay interpretation.
CD-ROMs accompanying this series give extensive additional information.

ICRP
INTERNATIONAL COMMISSION ON RADIOPHYSICAL PROTECTION
Introduction
Control of exposure
Models
Monitoring

Elements

H, C, P, S, Ca, Fe, Co, Zn, Zr, Nb, Ru, Sb, Te, Sr, Ir, Y, Cs, I, Ba, Pb, Bi, Po, Rn, Ra, U, Th
The quantity effective dose has gained widespread acceptance worldwide for regulatory purposes.

The objective of the TG is to clarify the circumstances under which effective dose can be applied and when it should not be used. Alternatives to the use of effective dose will be provided for specific situations including patient exposure in radiological diagnostics.

Come tomorrow at 8:30 to Session Applications of Effective Dose
Task Group 67
Assessment of Radiation Exposure of Astronauts in Space

- Radiation environment in space
- Radiation fields inside space vehicles and on planetary surfaces
- Radiation fields and absorbed doses in the human body
- Organisation of radiation protection in space

⚠️ Come tomorrow at 10:40 to Session Radiation Protection in Space
Some other planned ICRP Publications

- Internal SAF Values for the Reference Adult Male and Female
- Computational Phantoms for the Infant and Children
- Internal SAF Values for the Infant and Children
- Computational Phantoms for the Pregnant Female, Embryo, and Foetus
- Internal SAF Values for Embryo, Foetus, Children and Pregnant Female
- Public Exposures to Radionuclides
- Doses to the Embryo, Foetus, and Nursing Infant
• Reference dose conversion coefficients for external radiation will be published in the near future.

• In spite of significant changes in weighting factors and introduction of reference phantoms, the differences in conversion coefficients between ICRP 74 and new data is generally small.

► Effective Dose is a robust quantity.