HelmholtzZentrum münchen
German Research Center for Environmental Health

Scientific Highlight March 2012

☒ co-ordinated with the Director of the Institute / Research Unit

Institute / Research Unit / Clinical Co-operation Group / Junior Research Group:
Research Unit Medical Radiation Physics and Diagnostic, AMSD

PSP-Element:
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Title of the highlight:
Reference external dose coefficients based on reference computational phantoms

Keywords:
External radiation; conversion coefficients; effective dose; dose limitation

Central statement of the highlight in one sentence:
This report presents reference conversion coefficients for effective dose and organ absorbed doses for various types of external exposures, calculated following the 2007 Recommendations of the International Commission on Radiological Protection (ICRP, 2007), to be used for national and international legislation.

Text of the highlight:
Practical radiological protection for workers and members of the public uses dosimetric quantities to ensure compliance with the fundamental principles of limitation and optimization. Effective dose is the primary radiation protection quantity in the system of the International Commission on Radiological Protection (ICRP) which provides the framework and recommendations for all national and international legislation and standards. Effective dose is a doubly weighted absorbed dose which takes into account the type of radiation and the radiation sensitivity of a tissue. For regulatory purposes, reference values of conversion coefficients of effective dose are needed, to assign values for a given exposure which convert a measurable field quantity to a risk-related quantity for a reference individual.

In order to estimate effective dose for the ICRP System of Dose Limitation, a well defined framework was followed, using reference computational phantoms describing the anatomy (earlier developed at HMGU and adopted to be the official ICRP phantoms) and computer codes simulating the transport of radiation. Many radiation types were considered and coefficients for all radiations were tabulated in an ICRP (and ICRU - International Commission on Radiation Units and Measurement) Publication as effective dose and tissue-specific absorbed dose coefficients derived for the Reference Male and Reference Female as a function of incident energy for various idealized exposure geometries simulating the work place. The calculation of the coefficients was enabled by today's advanced computing environment and the availability of a suite of Monte Carlo radiation transport codes with supporting data and physics models. This large task, initiated by ICRP, was shared between several international partners in Europe, USA and Japan under the lead of Helmholtz Zentrum München.

The conversion coefficients tabulated in this publication, within the scope of their intended use, are considered by ICRP to be reference data, per the guidance of the Joint Committee for Guides in Metrology.

Publication:
International Commission of Radiological Protection (authors on behalf of ICRP: N. Petoussi-Henss, W.E. Bolch, K.F. Eckerman, A. Endo, N. Hertel, J. Hunt, M. Pelliccioni, H. Schlattl, M. Zankl). Conversion Coefficients for Radiological Protection Quantities for External Radiation Exposures. ICRP Publication 116, Ann. ICRP 40(2–5) (2010[1])

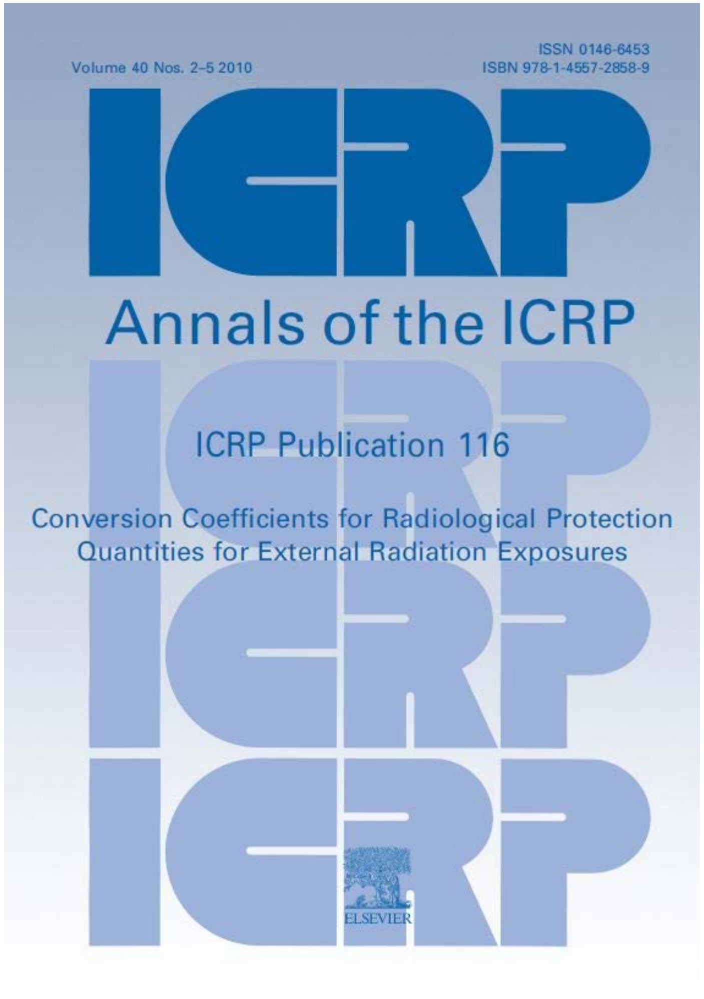
Taking account of the HMGU mission:
The conversion coefficients for radiological protection quantities for external radiation exposures are one of the main components for protecting humans from harm caused by ionising radiation after external exposure. They help to protect the health of occupationally exposed persons, e.g., in medical radiological departments, against such adverse effects while taking advantage of the many positive effects of ionising radiation, such as for patients in diagnostic radiology, radiation therapy and nuclear medicine.

The internal HMGU co-operation partners with whom the highlight was compiled, if appropriate:
Not applicable

[1] Although the publication appeared in 2012, 2010 is indicated officially as the publication year, due to special arrangements that are not under control of the authors.

HMGU — main contributor of ICRP Publication 116 which would be part of legislations

AMSD



- The ICRP is an advisory international body that offers its recommendations to regulatory and advisory agencies
- Currently, most national regulations, as well as European directives on radiological protection, international standards such as the IAEA International Basic Safety Standards, are based on ICRP Recommendations and Publications
- The new basic recommendations of ICRP 2007 necessitated a re-computation of dose conversion coefficients

ICRP Publication 116: Conversion Coefficients for Radiological Protection against External Radiation

- Link dose equivalent quantities (i.e. quantities related to potential risk) to physical quantities characterizing a radiation field
- Form the basis for dose estimates
- Assess / Demonstrate compliance with limiting quantities

Effective dose: the central quantity in radiological protection, constructed from weighted absorbed doses

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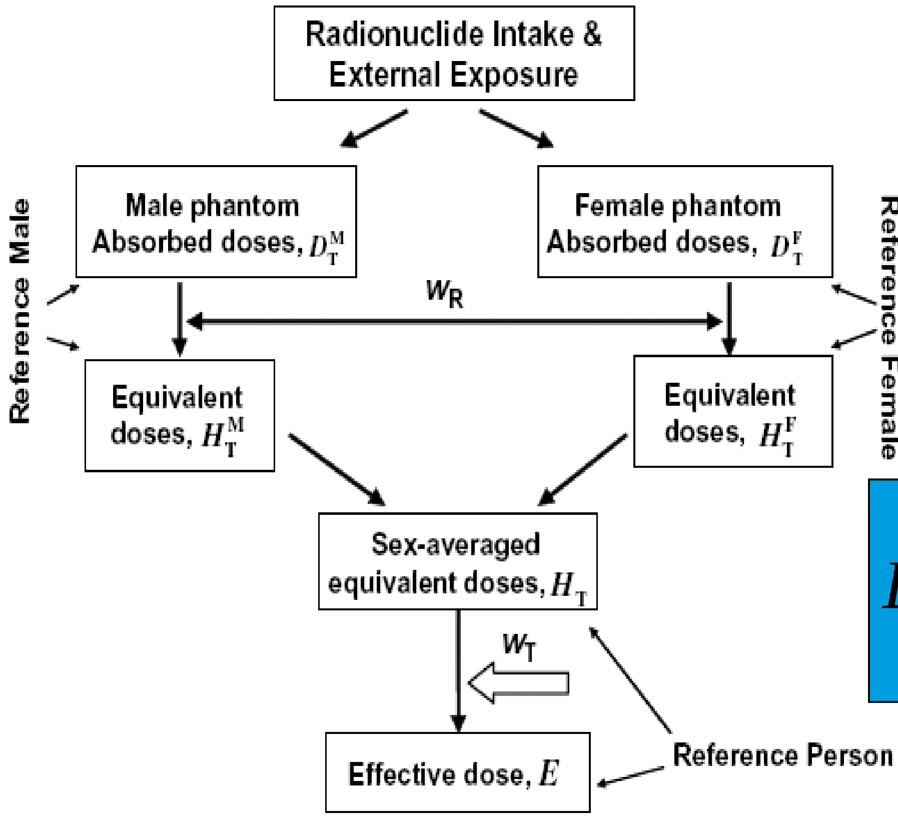

$$E = \sum w_T \left[\frac{H_T^M + H_T^F}{2} \right]$$

The effective dose is related to the “risk” of radiation detriment (cancer and hereditary disease)

Calculation of organ dose conversion coefficients with radiation transport codes (Monte Carlo)

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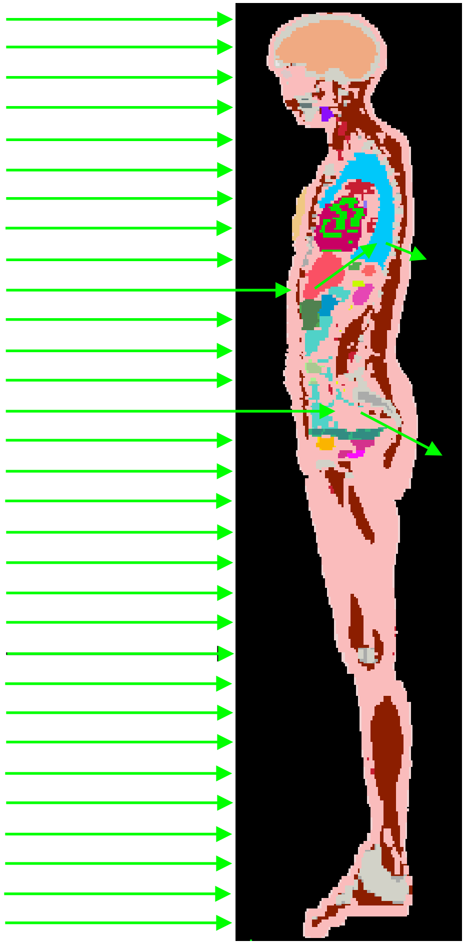
Requirements:

- Model of the source
- Model of the body (i.e. anatomy)
- Simulation of:
  - particle interactions
  - energy deposition
- Appropriate algorithms and physical models



Reference ICRP voxel phantoms (constructed at HMGU)

Operational quantities for most cases still fulfill their purpose, i.e. estimate conservatively the protection quantity

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Example:

Ambient dose $H^*(10)$ as conservative estimator of effective dose E