Presenting the Consultation Document:

“Reference Organ and Effective Dose Coefficients for Common Radiographic Examinations”

Task Group 113 Workshop

22 July 2024

Nina Petoussi-Henss, Ph.D.
Co-chair of ICRP Task Group 113
Member of ICRP Committee 2

Objective of today´s Webinar

- **To give you a flavour of the report and to seek your views**
  - **Consultation document is out now**
  - **http link: https://icrp.org/consultation.asp?id=80184A07-1989-47A4-B99C-147D96A32529**
  - **Reply by 16 August 2024**

- **Happy to answer questions during the Questions & Answers session**

Agenda

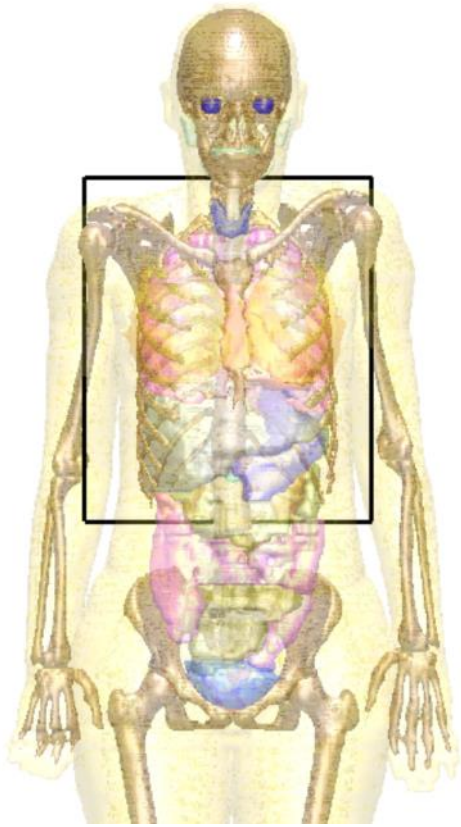
Introduction to Task Group and Consultation Document	Nina Petoussi-Henss
Projections Considered and Definition of Fields	Donald L Miller, Kimberly Applegate
Calculation of Dose Coefficients	Yeon Soo Yeom
Application of Dose Coefficients	David G Sutton
The Electronic Annex& Viewer	David G Sutton
Questions and Answers	All

Reminder: What is a dose coefficient?

In this report, the dose coefficient relates a calculated dose quantity – either the organ absorbed or effective dose – to a measured quantity such as air kerma or Kerma Area Product (KAP)

- **The coefficient is function of the source and field parameters** (tube voltage, filtration, field size, field position, focus-to-skin distance, etc.), the anatomical properties of **the phantom**, the elemental composition of relevant body tissues, and the radiation transport method applied
- **Multiplied by one of these (measurable) quantities, the dose can be estimated**

Introduction to Task Group 113



Nina Petoussi-Henss

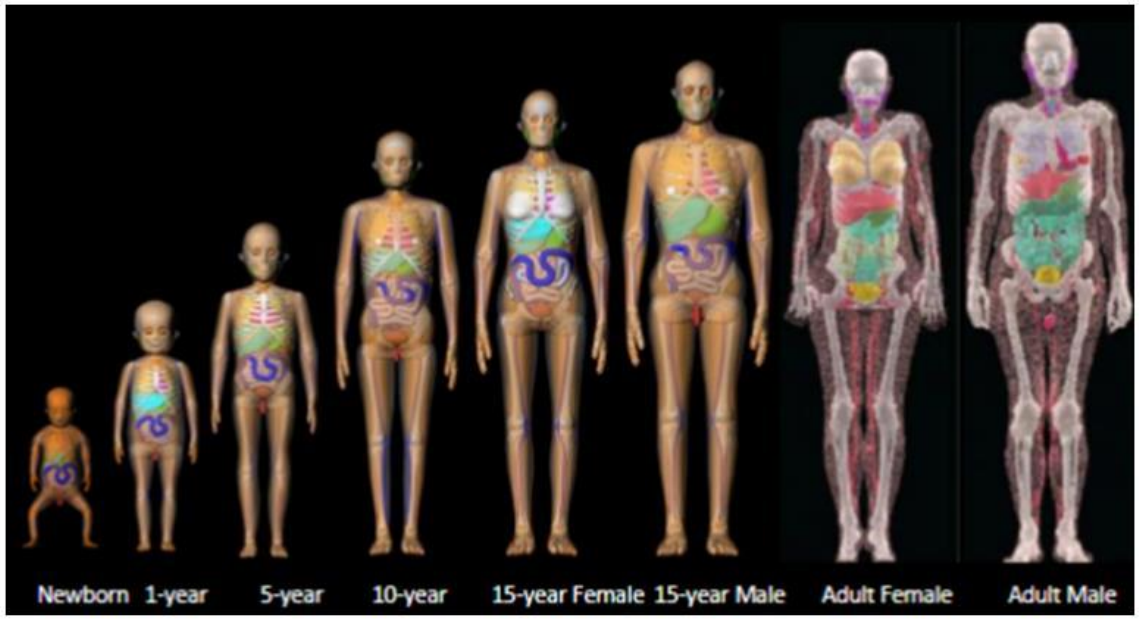
Federal Office for Radiation Protection

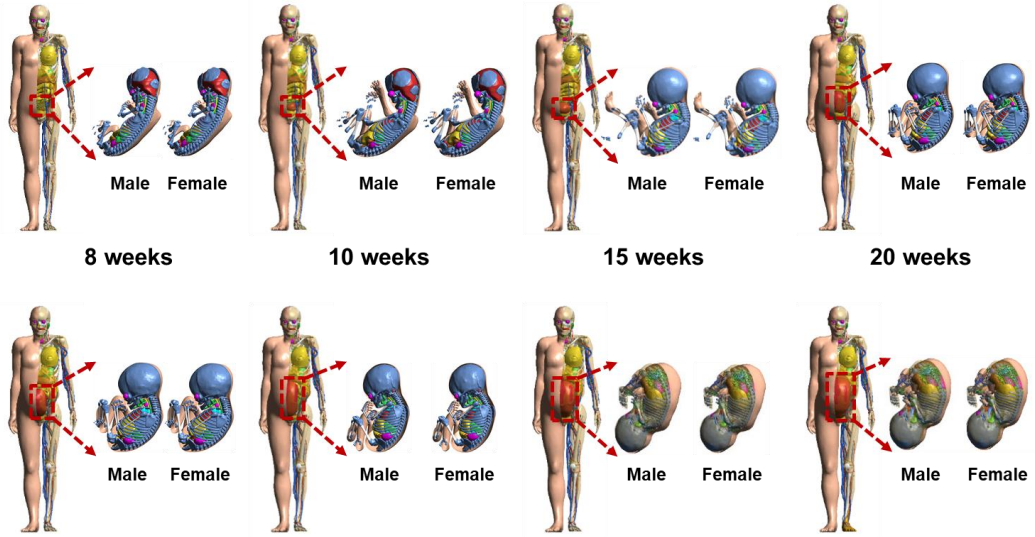
Task Group 113

- **For many years, the ICRP has produced reference dose coefficients for common diagnostic nuclear medicine procedures (Report 36 et seq.)**
- **The ICRP has established TG113 to provide reference dose coefficients for radiographic, CT and fluoroscopic X-ray imaging procedures**
- **The Task Group is mandated to perform Monte Carlo radiation transport simulations on a series of reference imaging examinations and to report the resulting organ absorbed and effective dose coefficients**

Reference individuals – Reference Phantoms

- **The scope of this work includes the use of the reference voxel computational phantoms of the ICRP, male and female newborn, 1-year-old, 5-year-old, 10-year-old, 15-year-old, and adult. Also, the recently developed ICRP pregnant female phantom series is employed**





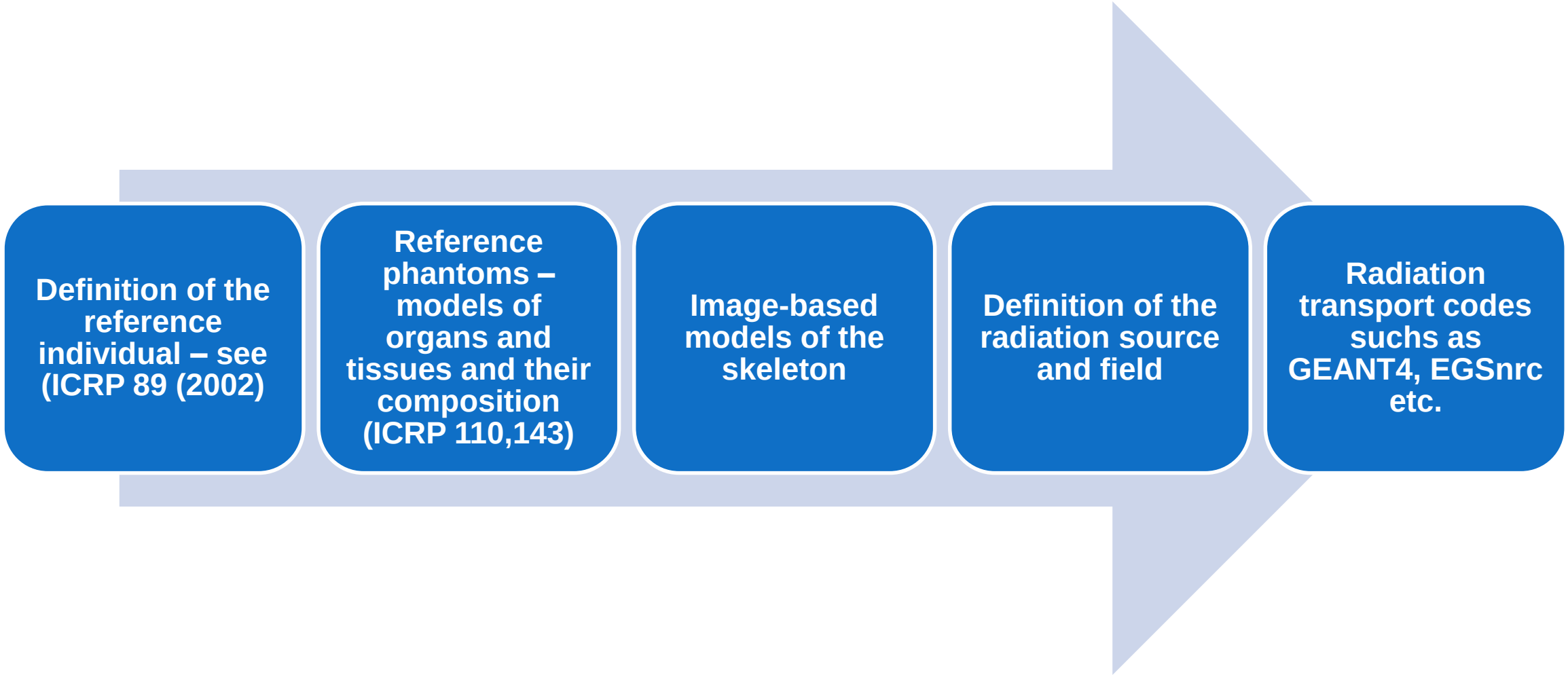
Why is ICRP doing this work?

- **Coefficients relating absorbed dose to organs at risk and measurable quantities commonly used in X-ray imaging procedures have been calculated using Monte Carlo methods for the last 40 years**
- **However, there is no standard reference methodology and consequently many different approaches are used**
- **The new dose coefficients developed with the widely accepted ICRP method, would standardize the procedure of converting dose metrics across modalities (such as KAP for radiography or fluoroscopy and $CTDI_{vol}$ and DLP for CT) to estimates of effective dose or some surrogate of effective dose**

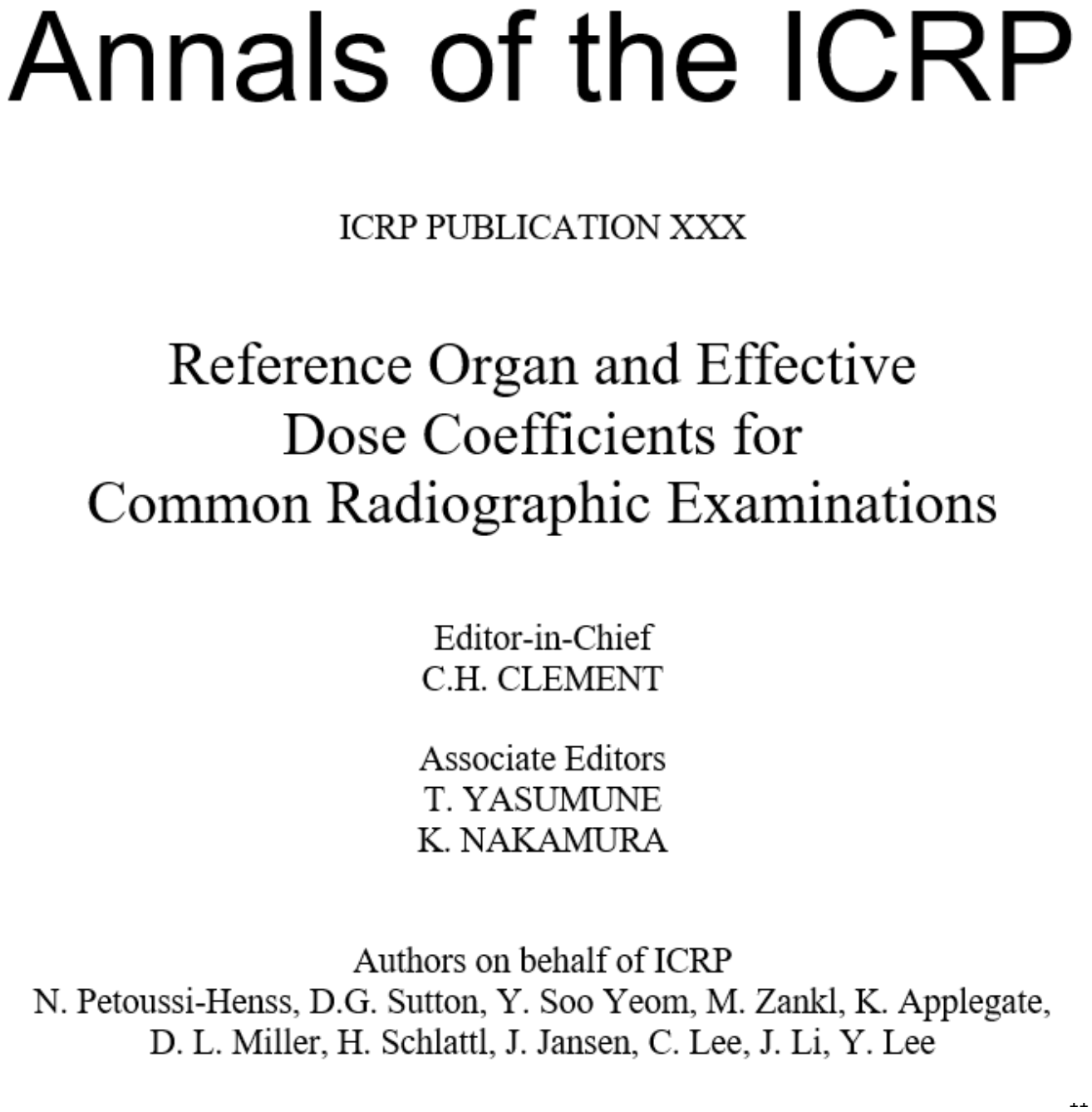
Task Group 113: Work streams

Work Stream	Scope
Radiography	**Adult & Paediatric**
Computed Tomography	Adult & Paediatric
Diagnostic Fluoroscopy	Pregnant Patient & Foetus Paediatric
Radiography, Computed Tomography	Pregnant Patient & Foetus
Fluoroscopically Guided Interventions	Adult, reference and not Reference Patient
Radiography, Computed Tomography	Non Reference Patient

To compute the Reference Dose Coefficients we need:



The Consultation Document



Annals of the ICRP

ICRP PUBLICATION XXX

Reference Organ and Effective Dose Coefficients for Common Radiographic Examinations

Editor-in-Chief
C.H. CLEMENT

Associate Editors
T. YASUMUNE
K. NAKAMURA

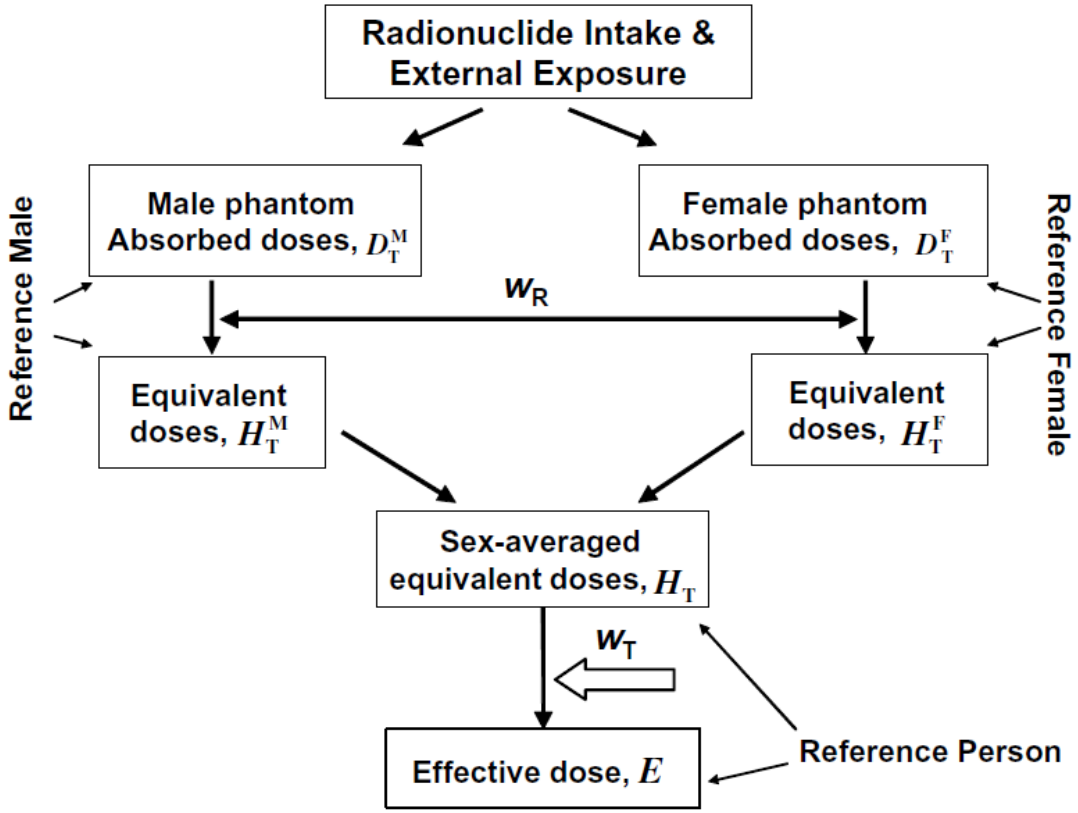
Authors on behalf of ICRP
N. Petoussi-Henss, D.G. Sutton, Y. Soo Yeom, M. Zankl, K. Applegate, D. L. Miller, H. Schlattl, J. Jansen, C. Lee, J. Li, Y. Lee

Radiography – Summary of method

- **For each procedure to be simulated the following have been identified:**
  - Anatomical landmarks to be covered, Focus to Skin Distance, Focus to Detector Distance, Field Size
- **Calculations have been carried out for monoenergetic photons between 3-150 keV for adult and 1-100 keV for paediatric radiography in 1 keV steps. The results can then be convolved with any X-ray spectral distribution that a user wishes to choose**
- **For convolution purposes, the dose coefficients are reported as organ absorbed and effective doses per fluence at 1 m distance from the source**
- **Data are also provided for selected bremsstrahlung spectra between 50 and 120 kV and total filtration between 2.5 and 3.5 mm Al. These are reported as organ absorbed doses per KAP and per air kerma free in air at 1 m distance from the source**

The Reference Dose Coefficients in the report were calculated with the current ICRP dosimetric methodology

- **Use of ICRP 103 recommendations, including tissue weighting factors**
- **Use of the ICRP reference male and female voxel phantoms, instead of hermaphrodite mathematical phantoms**
- **Improved skeletal dosimetry**
- **Definition of age-dependent effective doses based on male/female phantoms**
- **Effective dose is calculated for adults and children using one set of tissue weighting factors**



$$e(\tau) = \sum_T w_T \left[\frac{h_T^M(\tau) + h_T^F(\tau)}{2}\right]$$

Radiography Report: List of Contents

1. **Introduction**
2. **The ICRP reference phantoms**
3. **Radiographic projections considered**
4. **Determination of organ doses and effective dose coefficients for monoenergetic values**
5. **Organ and effective dose coefficients for example x-ray spectra**
6. **Application of dose coefficients**
7. **Uncertainties and limitations**
8. **Conclusions**

Annexes

- A: Dosimetric quantities used in patient dosimetry in radiography
- B: Definition of fields for the projections considered
- C: Application of skeletal fluence to dose-response functions (DRF) for photons in Monte Carlo radiation transport codes
- D: Description of electronic supplement

Data Files

- The data files provide organ absorbed dose coefficients for both male and female phantoms and each reference age
- They also provide, for each examination and phantom, a coefficient for either

$$\sum w_T \times H_T^M \quad \text{or} \quad \sum w_T \times H_T^F .$$

- Effective dose coefficients $(\sum w_T \times H_T^M + \sum w_T \times H_T^F) / 2$ are also provided for use where appropriate

Target Audience

The publication is aimed at all those who have an interest in patient dosimetry and optimisation, including national and international authorities, medical physicists, radiologists, radiographers, researchers and other radiological practitioners

Summary

- The organ absorbed and effective dose coefficients provided are estimated for the Reference Person at each age
- They are specific to the exposure conditions
- They have been calculated using the ICRP methodology, based on the current ICRP recommendations, which includes the use of age-dependent male and female phantoms, definition of effective dose and improved skeletal dosimetry
- **The calculated organ and effective dose is the dose which the reference person would experience, if irradiated with the same exposure conditions as an individual patient**

Authors of the Document

N. Petoussi-Henss, D.G. Sutton,

Y. Soo Yeom,

M. Zankl, K. Applegate,

D. L. Miller, H. Schlattl, J.T.M. Jansen,

C. Lee, J. Li, Y. Lee

npetoussi-henss@bfs.de