Segunda Jornada sobre

NOVEDADES Y TENDENCIAS
EN EL SISTEMA DE PROTECCIÓN
RADIOLÓGICA DE LA ICRP

Madrid, 25 de noviembre de 2016

Actividad del Comité 2 de la ICRP (Dosis por exposición a las radiaciones)

John Harrison, Public Health England, UK

Extracto de la presentación del Presidente del Comité 2 realizada el 25 de Octubre de 2016 en Shenzen (Session of the Chinese RP Society)

Presentado por: Eduardo Gallego, miembro del Comité 4 de la ICRP

Committee 2 Remit

Committee 2 develops references models and data, including dose coefficients, for the assessment of exposures to radiation from both internal and external sources

- Large programme of work to replace all published dose coefficients following :

Publication 103 The 2007 Recommendations of the International Commission on Radiological Protection. Ann ICRP 37 (2-4) 2007

Dose coefficients

Effective dose

Equivalent dose to organs and tissues

Internal: **Sv per Bq intake**

External: **Sv per fluence or air kerma**

Membership 2013 - 17

John Harrison (Chairman) UK
François Paquet (Vice-Chairman) France
Wesley Bolch (Secretary) USA

Mike Bailey UK
Vladimir Berkovski Ukraine
Luiz Bertelli USA
Doug Chambers Canada
Marina Degteva Russia
Akira Endo Japan

John Hunt Brazil
Chan Hyeong Kim Korea
Rich Leggett USA
Jizeng Ma China
Dietmar Noßke Germany
Nina Petoussi-Henss Germany
Frank Wissmann Germany

C2 in Seoul




INTERNATIONAL COMMISSION ON RADIOLOGICAL PROTECTION
The Korean Association for Radiation Protection
ICRP 2015
ICRP 2015
ICRP

Task Groups of Committee 2

- TG 36 – Radiopharmaceuticals (C2/C3)
  Dietmar Nosske + Sören Mattsson
- TG 79 – Effective Dose
  John Harrison
- TG 90 – Dose Coefficients for External Environmental Exposures
  Nina Petoussi-Henss
- TG 95 – Internal Dose Coefficients (IDC)
  François Paquet
- TG 96 – Computational Phantoms and Radiation Transport (CPRT)
  Wesley Bolch
- TG 103 – Mesh-type Computational Phantoms
  Chan Yeong Kim

Reports published / in press

Publication 119 Compendium of **Dose Coefficients based on ICRP Publication 60**. Ann ICRP 41 (Supp1) 2012 (en curso de actualización a los basados en la ICRP 103)

Publication 128 Radiation Dose to Patients from Radiopharmaceuticals: A Compendium of Current Information Related to Frequently Used Substances. Ann ICRP 44 (2S) 2015

Publication 130 Occupational Intakes of Radionuclides: Part 1 Ann ICRP 44 (2) 2015

Publication 133 The ICRP Computational Framework for Internal Dose Assessment for Reference Workers: **Specific Absorbed Fractions**. Ann ICRP 45 (2/3) 2016 (publicada en noviembre 2016)

Publication 134 Occupational Intakes of Radionuclides: Part 2. Ann ICRP 45 (4) 2016 (in press)

Planned publications

Phantoms and radiations transport calculations

- Pediatric Reference Computational Phantoms + SAFs
- Pregnant Female and Fetus Reference Computational Phantoms + SAFs
- Mesh-type Reference Phantoms

Internal dose coefficients

- Occupational Intakes of Radionuclides, Parts 3 - 5
- Internal Dose Coefficients for Members of the Public, Pts 1 & 2
- *In utero* Internal Dose Coefficients for Maternal Intakes
- Breast-feeding Infant Internal Dose Coefficients for Maternal Intakes

External dose coefficients

- External Dose Coefficients for Members of the Public

Use of Effective Dose

Phantom development

Stylized Phantoms

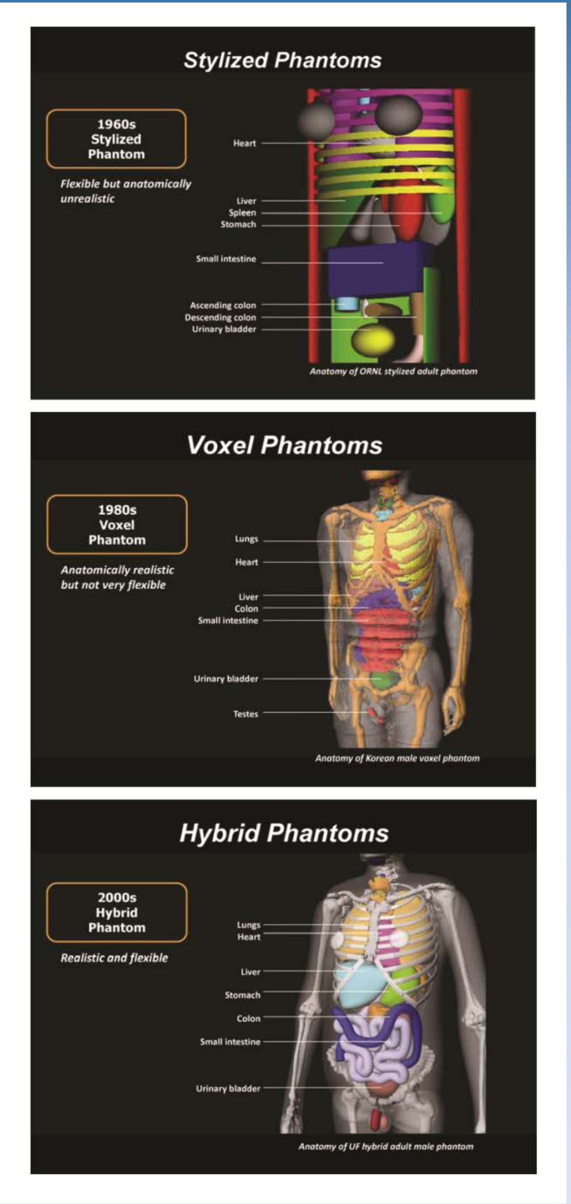
Organ / body contours defined by 3D mathematical surface equations

Voxel Phantoms

Organs and body tissues defined by groupings of 3D arrays of tagged image volume elements

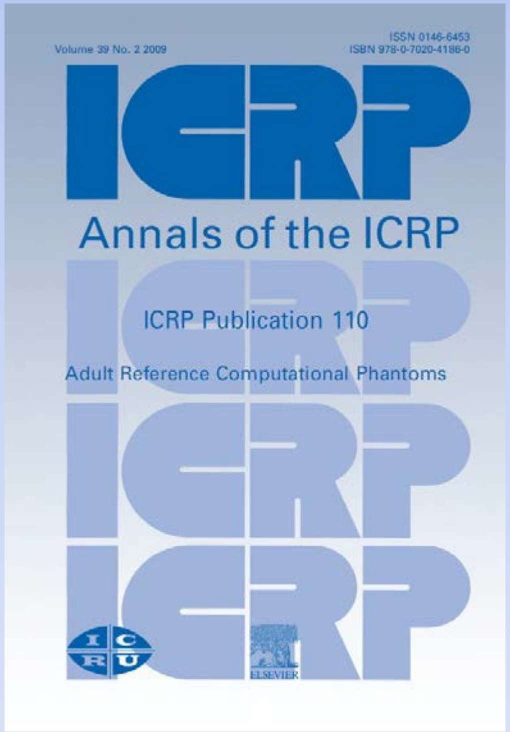
Hybrid Phantoms

Organ / body contours defined by non-uniform rational B-spline (NURBS) or polygon mesh (PM) surfaces

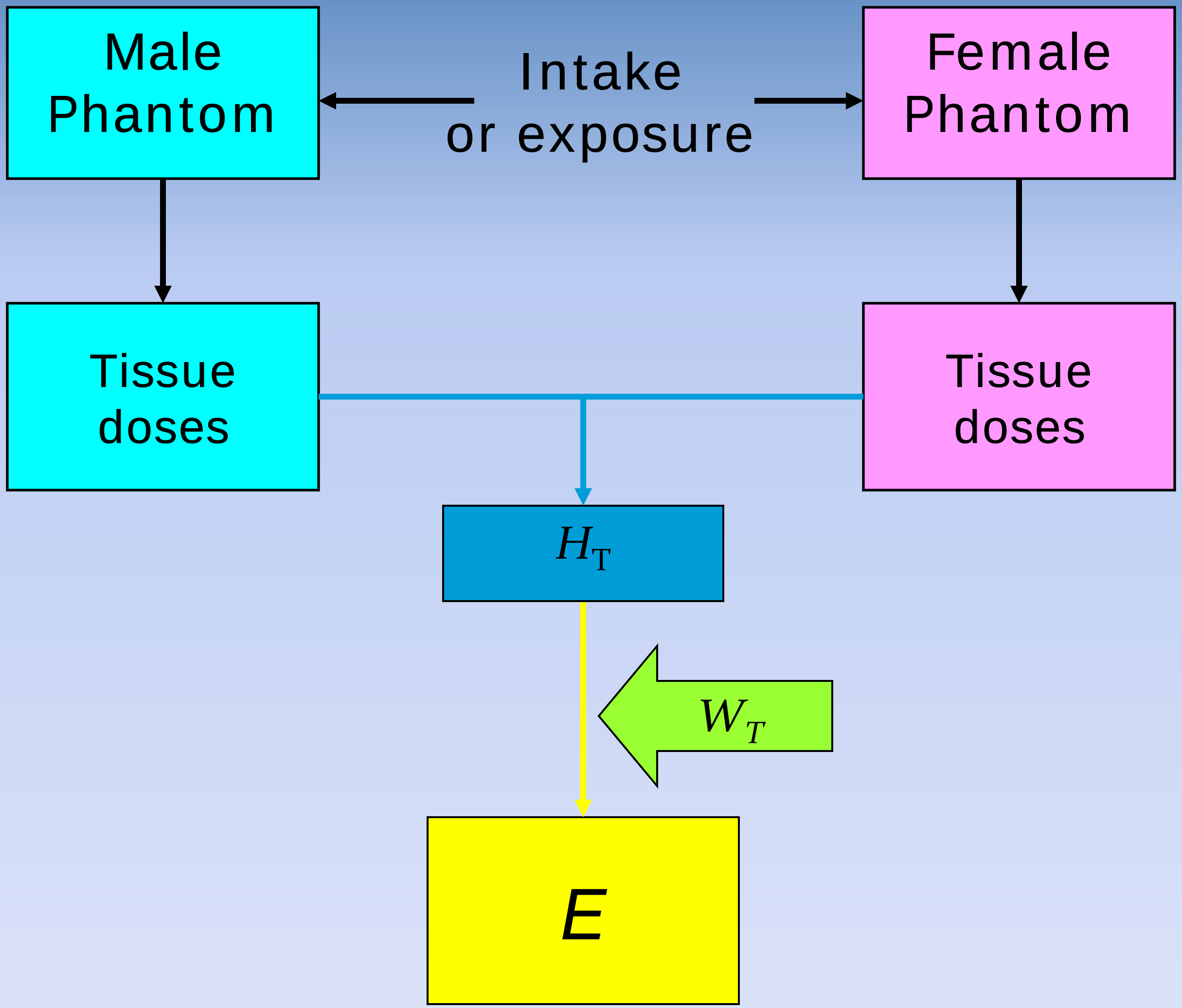


ICRP Adult Reference Computational Phantoms – Voxel Based

ICRP Publication 110
Ann ICRP 39 (2) 2009

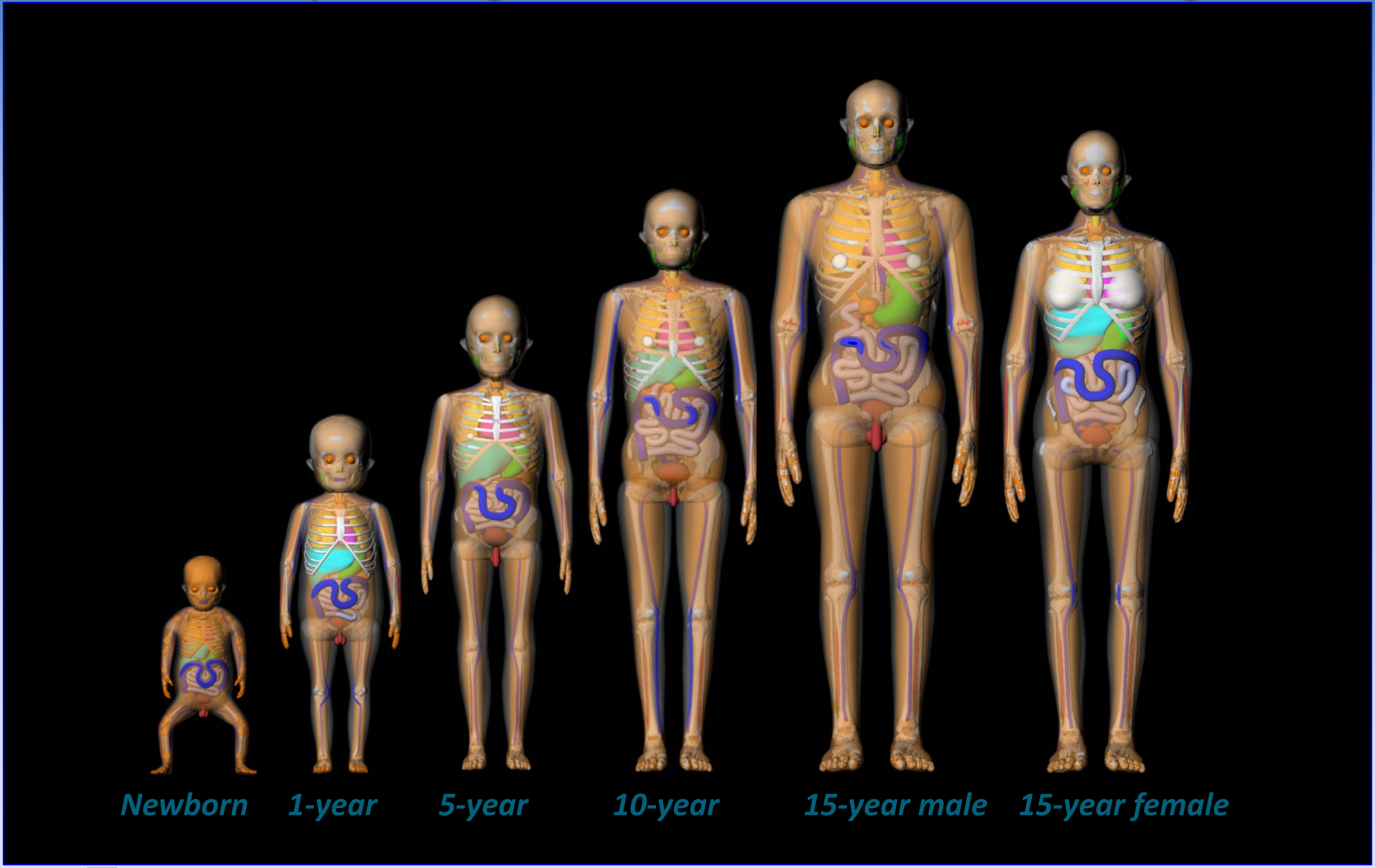


Sex averaging in calculation of *E*

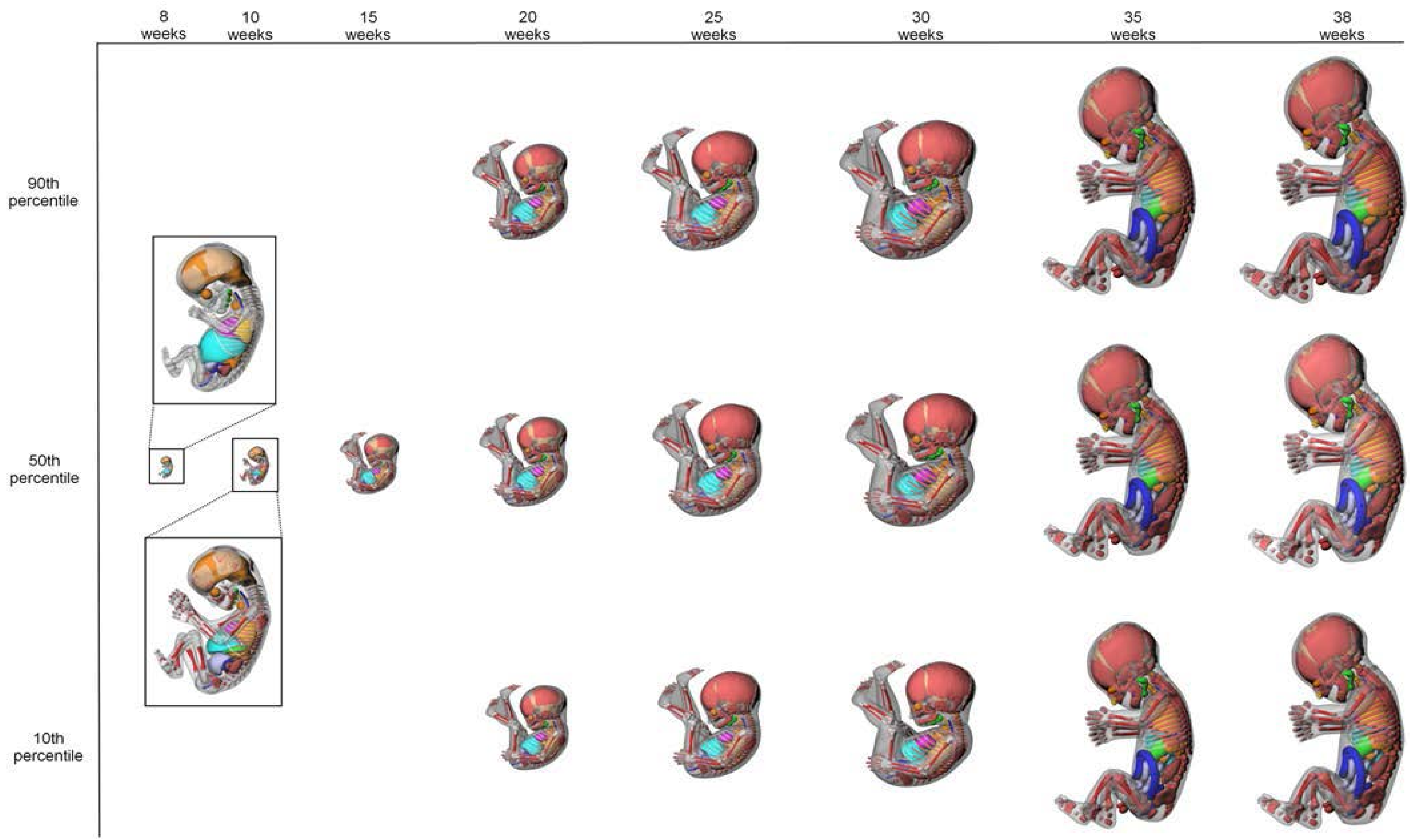


ICRP Computational Phantoms – Pediatric

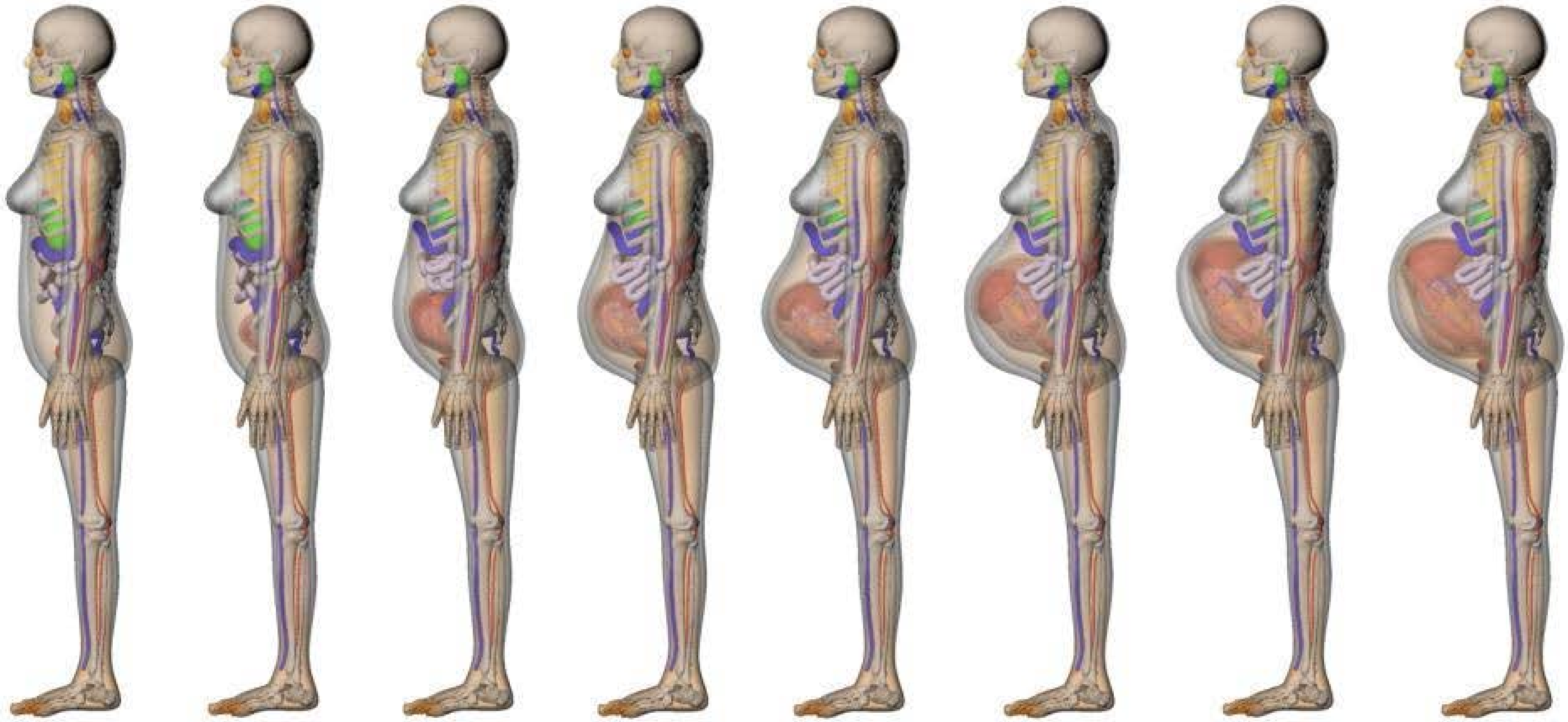
Developed using NURBS and PM Surface Modeling



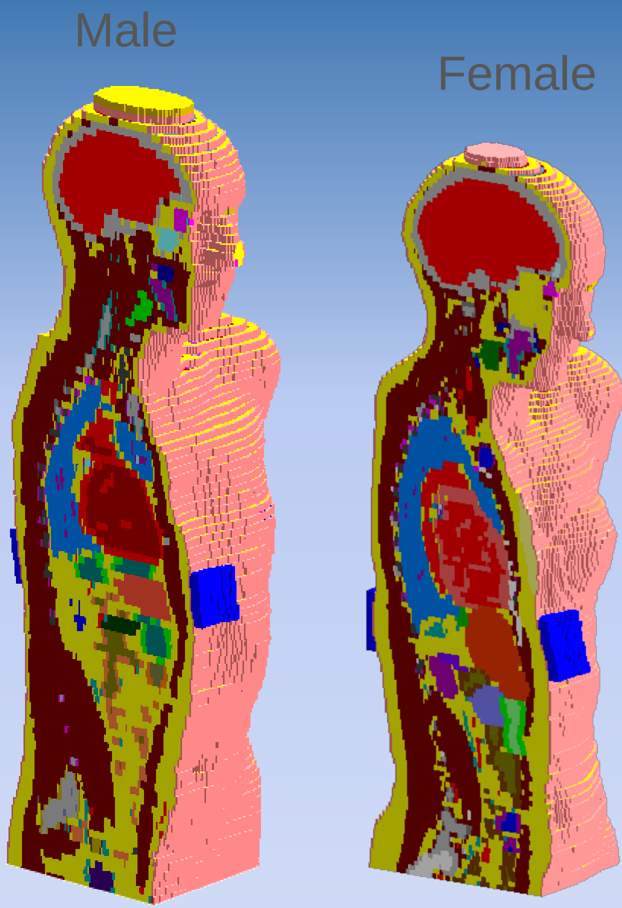
Age-adjusted models of the human fetus



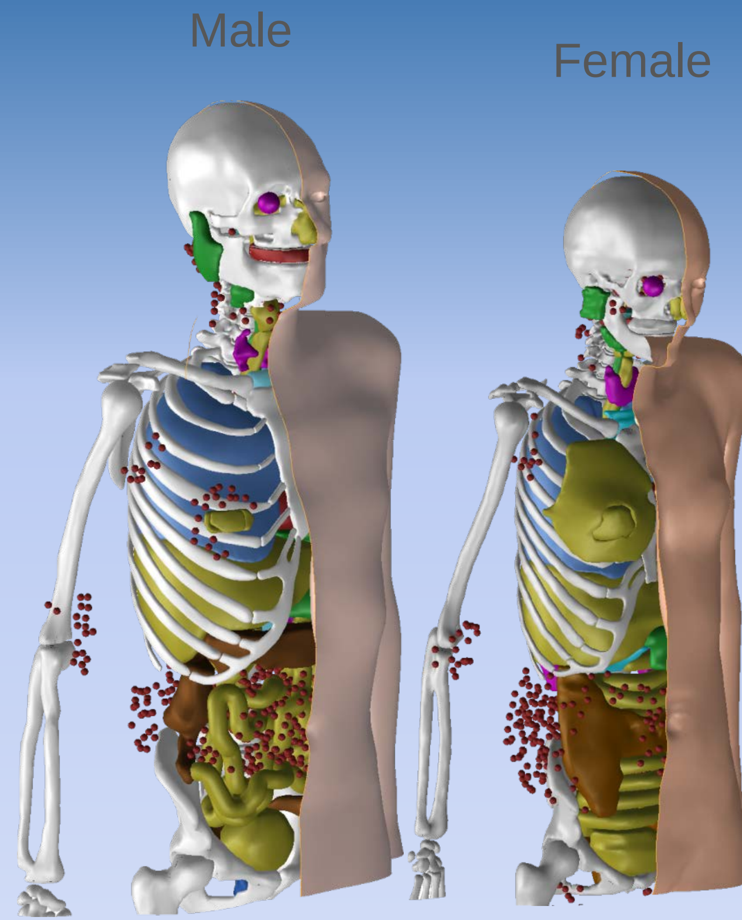
ICRP Reference series



Publication 110 Phantom Conversion



Publication 110 phantoms
(voxel geometry)



Polygon-mesh versions
(polygon-mesh geometry)

Occupational Intakes of Radionuclides

OIR Part 1 (2015)
Introduction (Descripción general de la metodología)

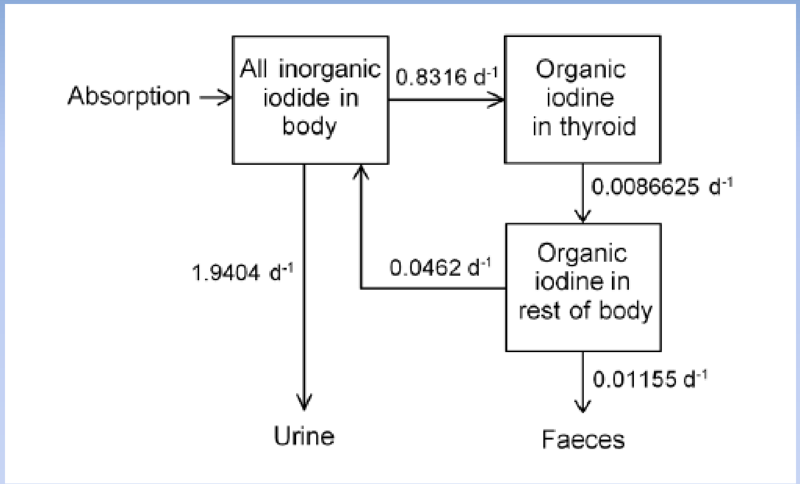
OIR Part 2 (2016)
H, C, P, S, Ca, Fe, Co, Zn, Sr, Y, Zr, Nb, Mo, Tc

OIR Part 3 (2017)
Ru, Sb, Te, I, Cs, Ba, Ir, Pb, Bi, Po, Rn, Ra, Th, U

OIR Part 4 (2017)
Lanthanides and Actinides

OIR Part 5
F, Na, Mg, K, Mg, Ni, Se, Mo, Tc, Ag

Systemic model for Iodine



Former model (ICRP 1994)

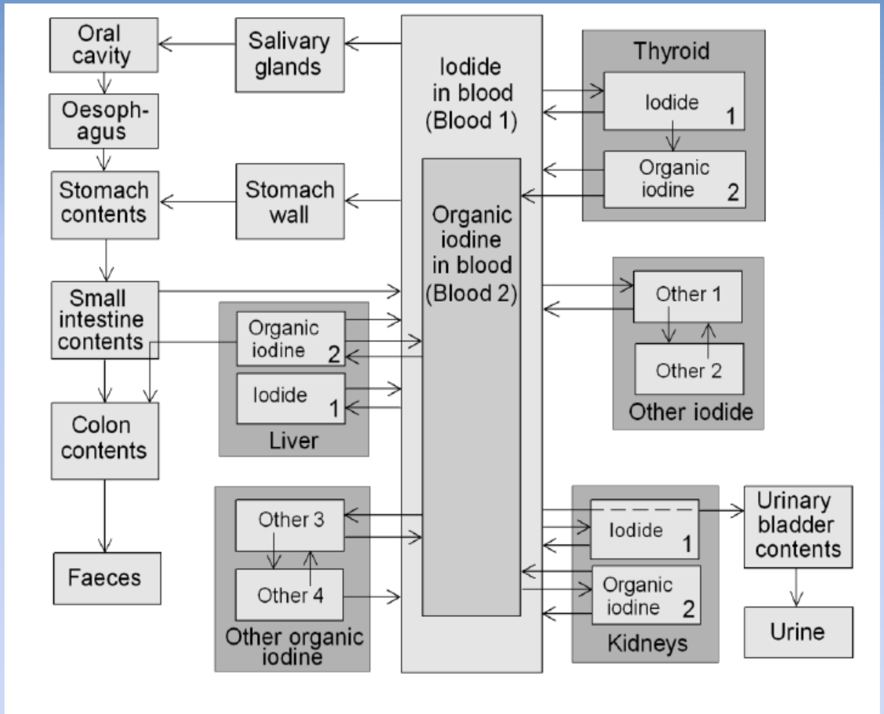


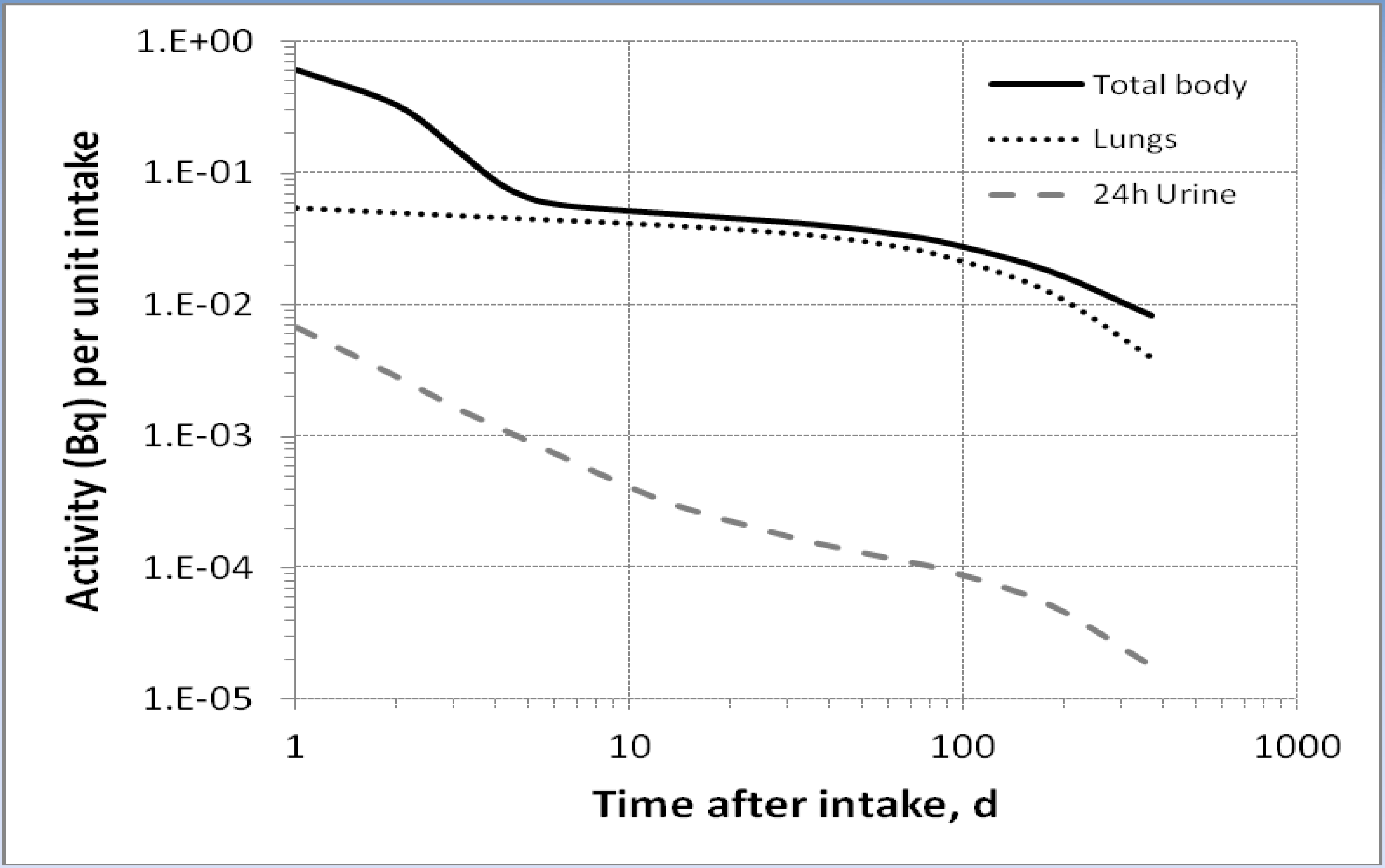
Figure 5-2. Structure of the biokinetic model for systemic iodine used in this report.

OIR model

OIR dose coefficients for cobalt

	Effective dose coefficients (Sv Bq^{-1})		
Inhaled particulate materials (5 µm AMAD aerosols)	^{57}Co	^{58}Co	^{60}Co
Type F, cobalt nitrate, chloride	3.3E-10	1.4E-09	1.1E-08
Type M, all unspecified forms	1.0E-09	4.3E-09	2.7E-08
Type S, cobalt oxide, FAP, PSL	2.4E-09	6.6E-09	1.7E-07
Ingested materials			
f_A = 0.1, all chemical forms	2.4E-10	1.2E-09	7.6E-09
f_A = 0.05, insoluble oxides	1.7E-10	9.8E-10	4.8E-09

Bioassay data for ^{60}Co : inhalation of 1 Bq Type M



Radon Publications

Publication 115 Lung Cancer Risk from Radon and Progeny and Statement on Radon. Ann ICRP 40 (1) 2010

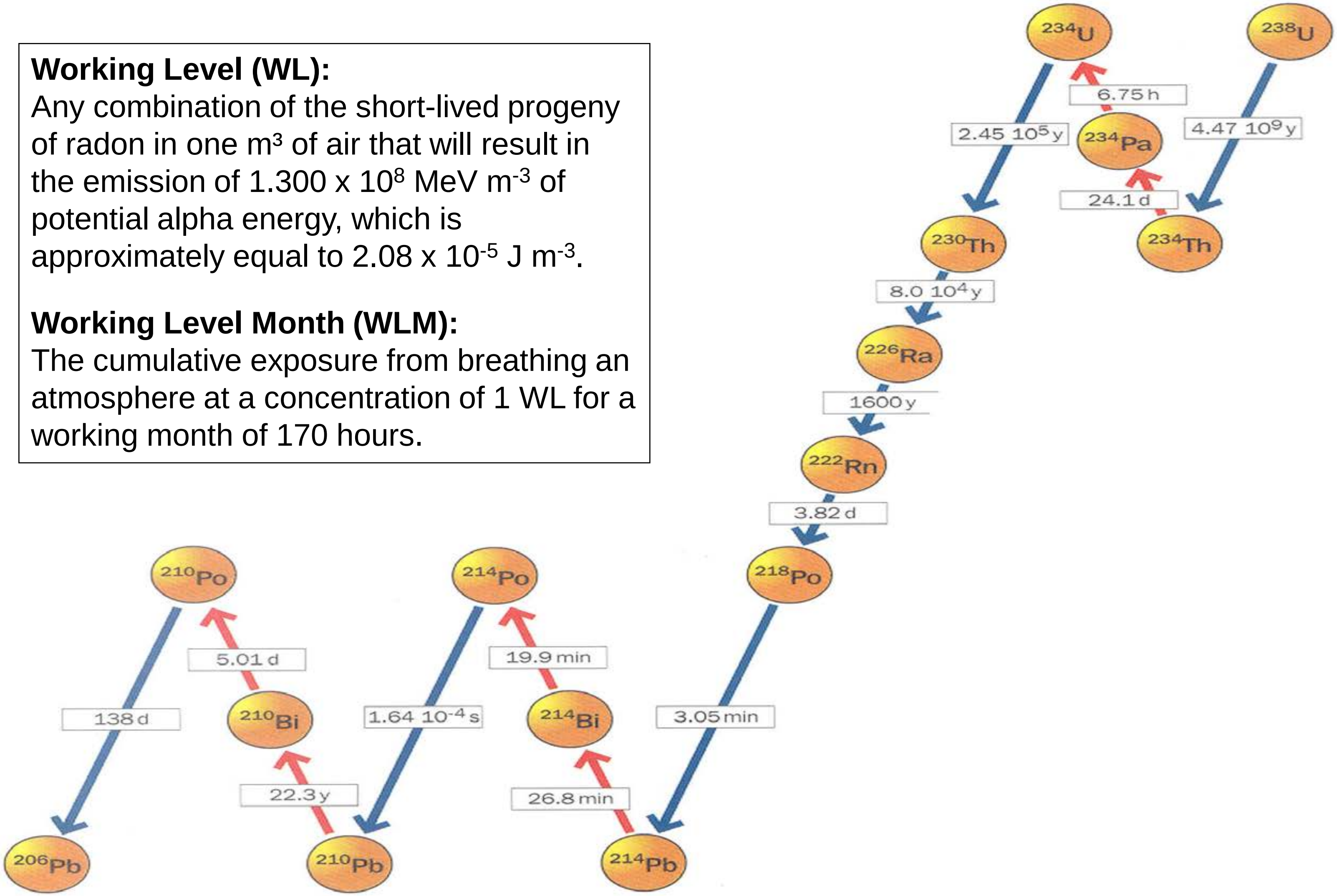
Publication 126 Radiological Protection against Radon Exposure. Ann ICRP 43 (3) 2014

Publication ? Occupational Intakes of Radionuclides : Part 3. Ann ICRP 2017

Radon-222 in the U-238 decay chain

Working Level (WL):
Any combination of the short-lived progeny of radon in one m^3 of air that will result in the emission of 1.300×10^8 MeV m^{-3} of potential alpha energy, which is approximately equal to 2.08×10^{-5} J m^{-3}.

Working Level Month (WLM):
The cumulative exposure from breathing an atmosphere at a concentration of 1 WL for a working month of 170 hours.



Publication 115 Statement on Radon

Revised nominal risk coefficient of 5 x 10^{-4} WLM^{-1} to replace the Pub 65 value of 2.83 x 10^{-4} WLM^{-1}

(5 10^{-4} WLM^{-1} divided by Pub 103 detriment values of 4.2 10^{-2} Sv^{-1} = 12 mSv WLM^{-1})

BUT signalled the intention that ICRP would in future publish dose coefficients for radon isotopes based on biokinetic / dosimetric models

Upper value of Reference Level for homes reduced from 600 Bq m^{-3} to 300 Bq m^{-3}

OIR 3 dose coefficients for radon

Inhalation or ingestion

Radon-222 (Radon)	Effective dose
Radon-220 (Thoron)	Organ equivalent doses
Radon-219 (Actinon)	

- For inhaled Rn-222 + progeny – use 12 mSv per WLM in most circumstances
- Information provided so that account can be taken of specific information on exposure conditions - aerosol characteristics, equilibrium factor

Publication 126 Radon

All buildings

Except specific workplaces.............................

(dwellings, "common workplaces", mixed-use buildings)

- Existing exposure situations
- Public exposure
- RL = 10 mSv/y
- Derived RL = 100 to 300 Bq/m^3
- ALARA (prevention + mitigation)
- Graded approach (action plan)
- Specific graded app. for workplaces:
  1. Action on concentration (derived RL)
  2. Action on dose (dose RL)
  3. Occupational exposure......................

Qualitative criterion (national list)

Specific workplaces

(mines, spas...)

- Managed as planned exp. sit.
- Occupational exposure
- Relevant requirements
- Dose limit: flexibility

Quantitative criterion (>10 mSv/y)

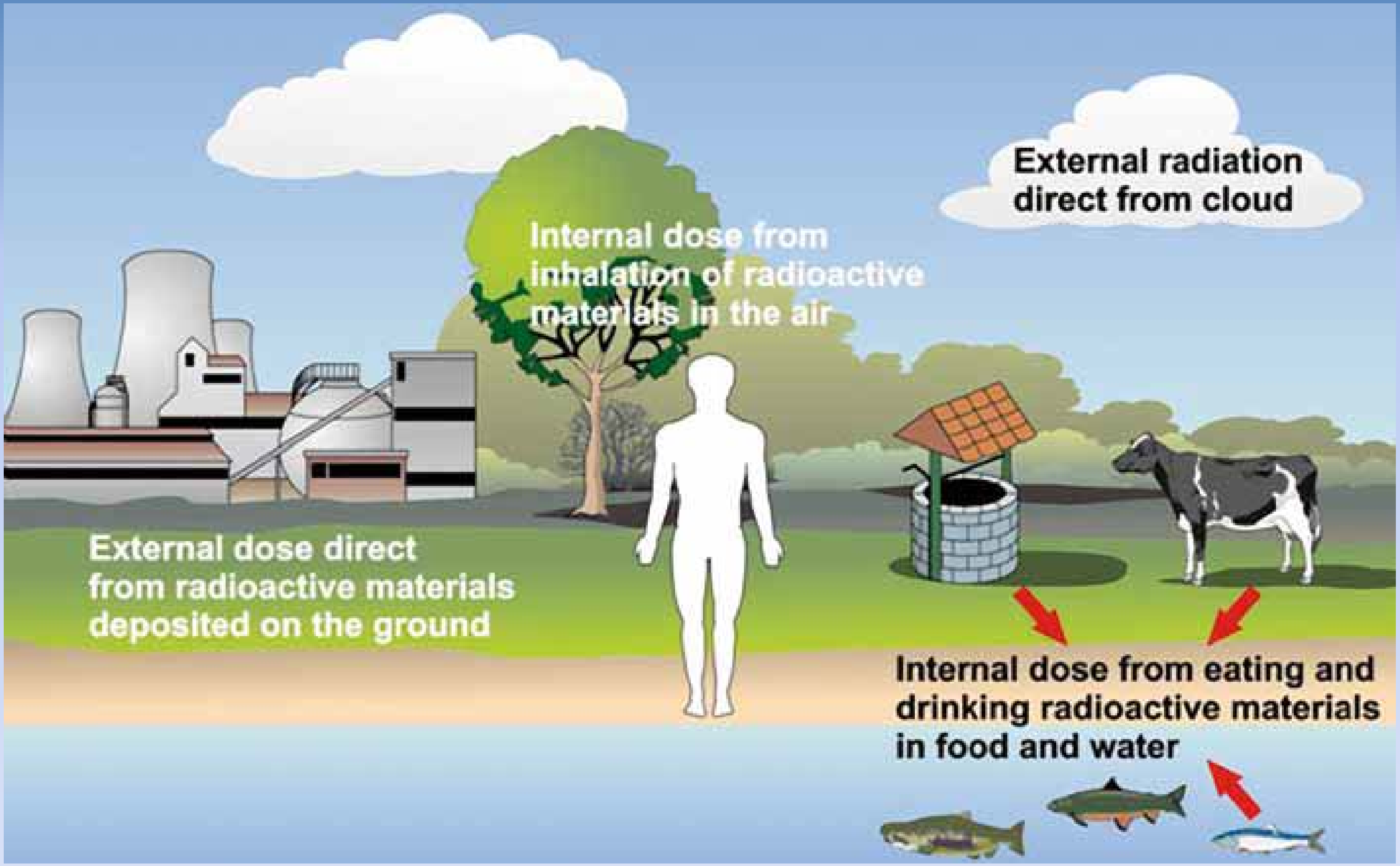
J.F. Lecomte, C4

Publication 126

Upper Reference Level of 300 Bq m^{-3} applying to all exposures in homes and workplaces

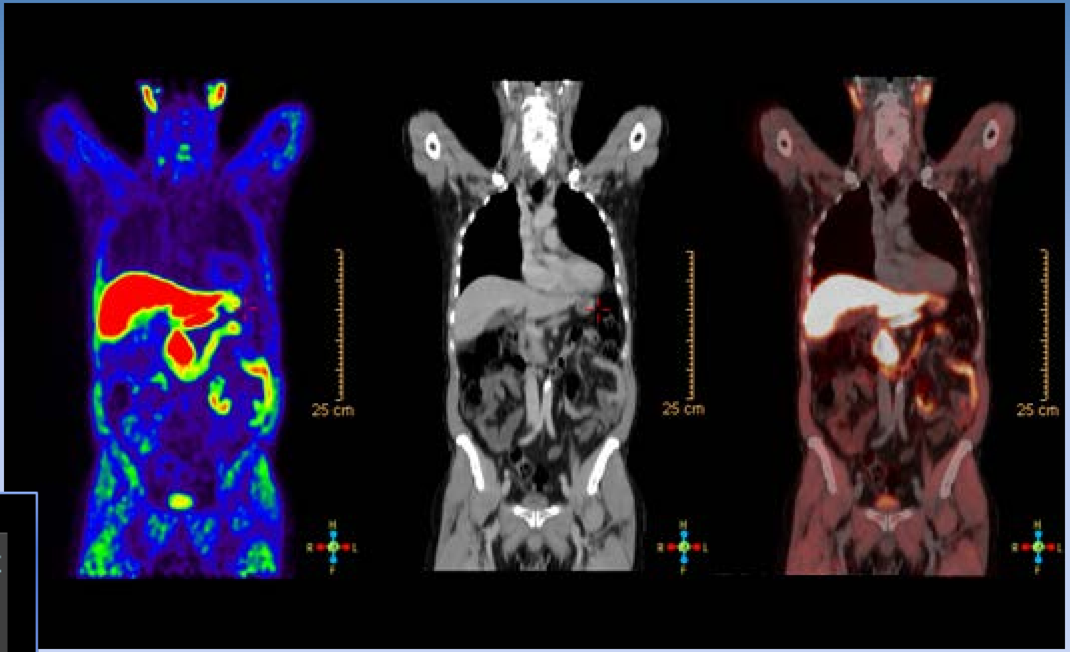
Exposure	Effective dose mSv / y
Home (≈7000h)	15.8
Work (≈ 2000h)	4.5
Total (8760h)	19.8

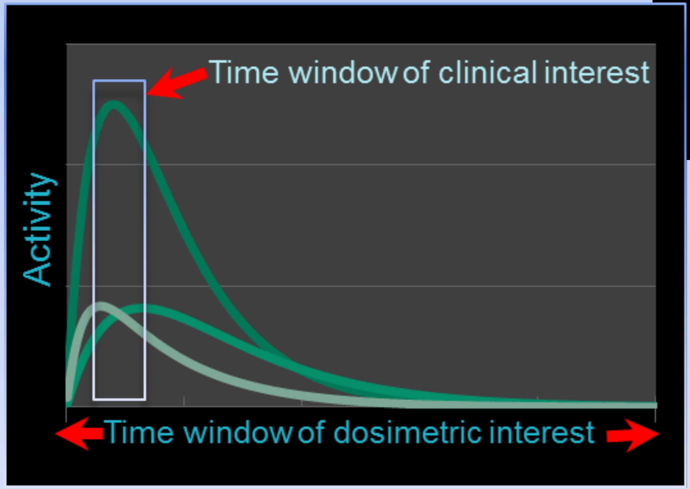
TG 90 : Dose Coefficients for External Environmental Exposures



TG 36 : Radiopharmaceuticals

What happens with the radiopharmaceutical after the image has been taken?





- Replacement for Publication 128
- New radiopharmaceuticals
- Educational slides

Task Group 79 : Use of Effective Dose as a Risk-related Radiological Protection Quantity

- **Equivalent dose and**
  Effective dose, *E*
- ***E* for children and fetus**
- ***E* as a measure of risk**

Effective Dose

- Enables the summation of all radiation exposures by risk adjustment using simplified weighting factors

- Applies to sex-averaged reference persons, and relates to nominal risk coefficients for uniform external low LET radiation exposure

- Applied without uncertainties, assumes LNT dose-response, chronic = acute, internal = external

Equivalent and effective dose

1. **Absorbed dose $D_{T,R}$** in human tissues/organs T, (averaged organ/tissue absorbed dose) **Gy**

2. **Equivalent dose** in tissues/organs, **Sv**

   $$H_T = \sum_R w_R D_{T,R}$$ w_R **: radiation weighting factor**

3. **Effective dose**, **Sv**

   $$E = \sum_T w_T H_T$$ w_T **: tissue weighting factor**

TG Draft Proposal

Discontinue use of Equivalent Dose as a separate protection quantity

- Avoids confusion between equivalent dose and effective dose. Eg. iodine-131, E = 40 mSv, thyroid dose = 1 Sv.

- Avoids confusion between equivalent dose and dose equivalent, Sv, the operational quantity used as a measure of effective dose for external sources

- **Equivalent dose, Sv, currently used to set limits to prevent deterministic effects:** eye lens, skin, hands & feet; the more appropriate quantity is absorbed dose, Gy

Other issues

- Committed effective dose
- Collective effective dose
- Revision of dose coefficients - and previous dose assessments
- Use of specific information on physical and chemical forms of ingested and inhaled radionuclides

C2 membership of other TGs

- **TG 64** Cancer Risk from Alpha Particles (C1) *Paquet*
- **TG 72** RBE and Reference Animals and Plants (C5) *Paquet*
- **TG 74** Dosimetry for Non-Human Species (C5) *Bolch*
- **TG 92** Terminology and Definitions (MC) *Wissmann*
- **TG 100** Review of NCRP Committee 1 report *Harrison*
- **TG 101** Protection in Radionuclide Therapy (C3) *Bolch*
- **TG 102** Detriment Calculation Methodology (C1) *Harrison*

C2

- *Large programme of work to provide new dose coefficients*
- *Biokinetic and dosimetric modelling is world leading, with scientific as well as protection applications*
- *Strong interactions between committees, including C2 membership of Task Groups*

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EN EL SISTEMA DE PROTECCIÓN
RADIOLÓGICA DE LA ICRP

Madrid, 25 de noviembre de 2016

Actividad del Comité 4 de la ICRP (Aplicación de las Recomendaciones de la Comisión)

Donald Cool, EPRI, USA

Extracto de la presentación del Presidente del Comité 4 realizada el 25 de Octubre de 2016 en Shenzen (Session of the Chinese RP Society)

Presentado por: Eduardo Gallego, miembro del Comité 4 de la ICRP

Committee 4 Responsibilities

- **Committee 4 is concerned with providing advice on the application of the recommended system of protection in all its facets for occupational and public exposure.**
- **It also acts as the major point of contact with other international organisations and professional societies concerned with protection against ionising radiation.**

- 17 Members from 14 countries
- 4 Major Areas of Work

  Existing Exposure Situations

  Response to Fukushima

  Foundations

  Topical Reports
- 5 Active Task Groups
- Participation in TG's of other Committees

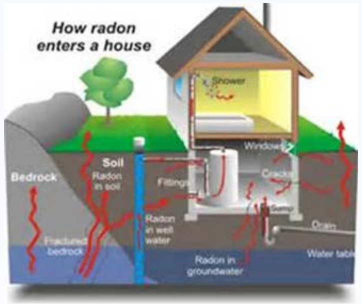
C4 Membership 2013 - 2017

- Donald Cool – USA *(Chair)*
- Kunwoo Cho – Korea (Vice-Chair)
- Jean-François Lecomte – France *(Secretary)*
- François Bochud - Switzerland
- Mike Boyd – USA
- Analia Canoba – Argentina
- Mark Doruff – USA
- Eduardo Gallego – Spain
- Ann Mc Garry – Ireland
- Toshimitsu Homma - Japan
- Michiaki Kai – Japan
- Shenli Niu – China
- Anne Nisbet – UK
- Deborah Oughton – Norway
- Thiagan Pather– South Africa
- Sergey Shinkarev – Russia
- John Takala - Canada
- Jacques Lochard – France (MC)

Los miembros del Comité 4 junto con representantes del OIEA, IRPA, AEN-OCDE y el Secretariado de la ICRP

C4 Recent Publications

- ***Publication 122*, Radiological Protection in Geological Disposal of Long-Lived Solid Radioactive Material, May 2013**
- ***Publication 124*, Protection of the Environment Under Different Exposure Situations, April 2014 (with C5)**

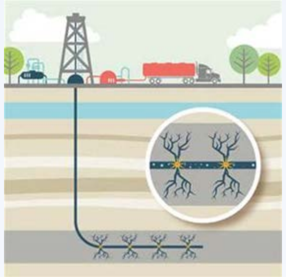


- ***Publication 125*, Radiological Protection in Security Screening, September 2014**
- ***Publication 126*, Radiological Protection against Radon Exposure, November 2014**

- ***Publication 132*, Radiological Protection from Cosmic Radiation in Aviation, June 2016**

C4 Program of Work

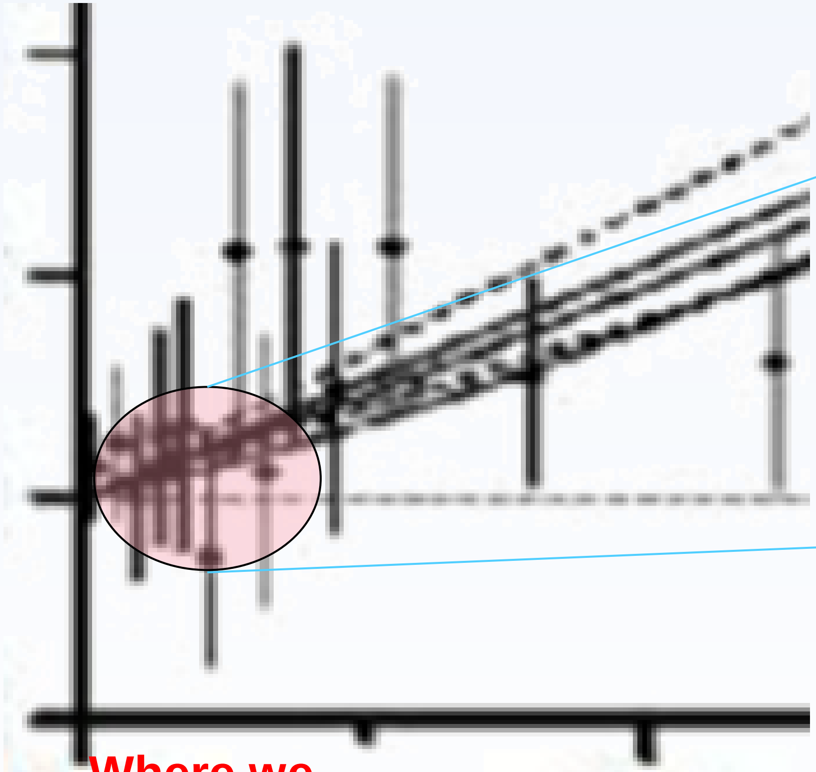
- **Task Groups**
  - TG 76 NORM
  - TG 93 Update Publications 109 (Emergencies) and 111 (Rehabilitation post-accident)
  - TG 94 Ethical Foundations of the System of RP
  - TG 97 Surface and Near Surface Waste Disposal
  - TG 98 Contaminated Sites
- **Support to Work of other Committees**
  - TG79 Effective Dose
  - TG89 Occupational Radiological Protection in Brachytherapy
  - TG91 Radiation Risk Inference at Low Dose and Low Dose Rate
  - TG92 Definitions
  - Collaborative work proposal with C5 under consideration



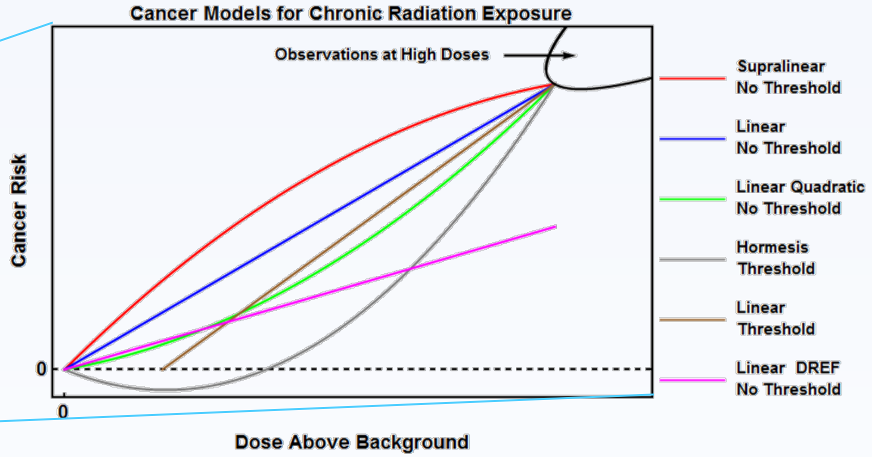
From the Beginning

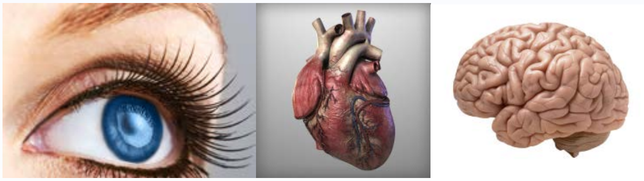
- **Protection Objectives**
  - Manage harm: prevent deterministic effects
  - Manage probability of harm: reduce exposures ALARA
    - Genetic
    - Cancer

We know a lot about radiation effects …
but the picture gets fuzzy…
and more complicated



Where we have great uncertainty





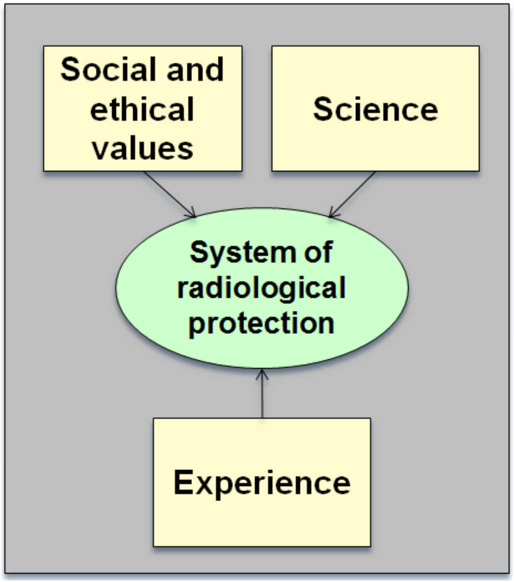
Non-Cancer Effects

Foundations

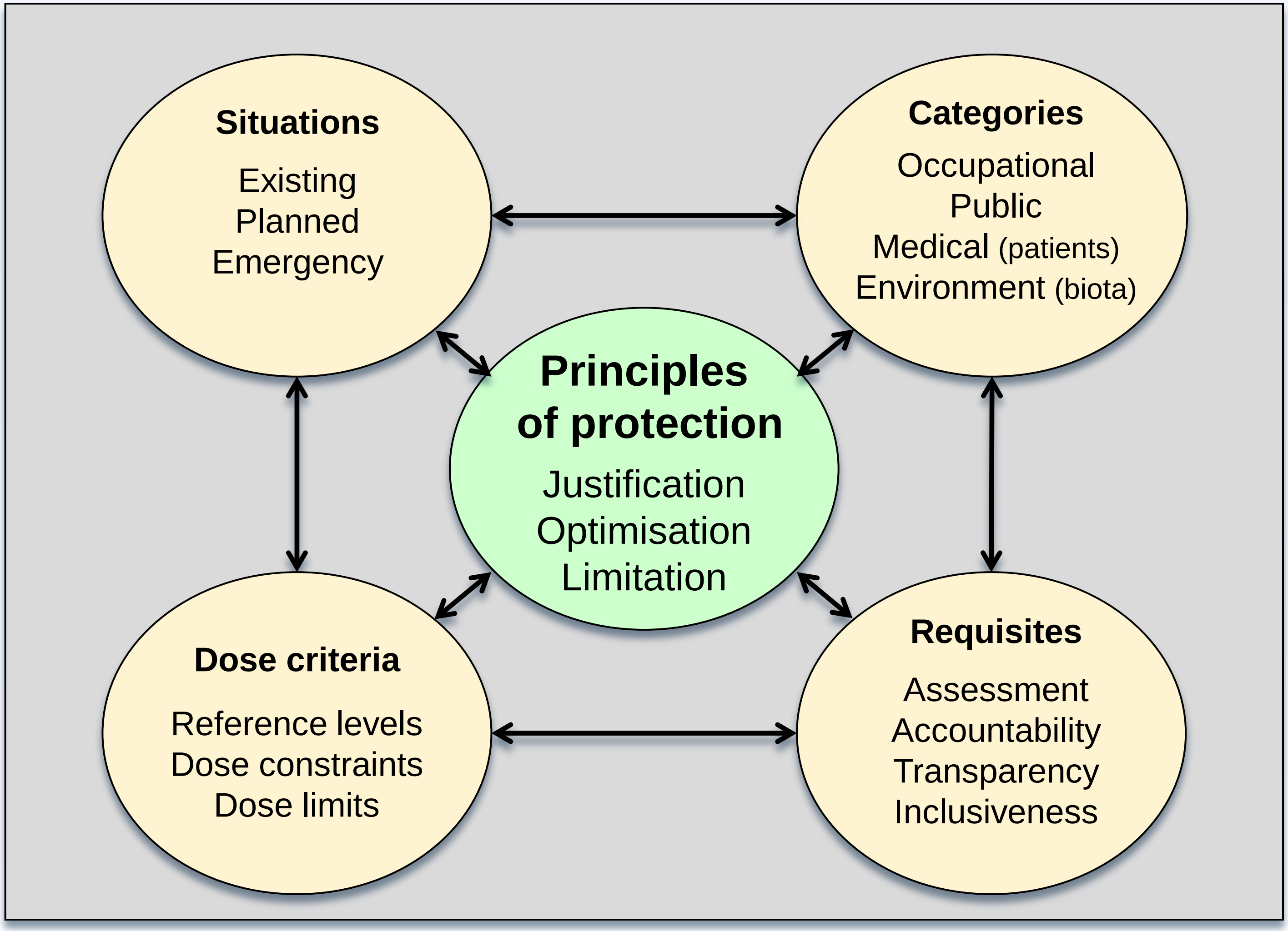
- **Social and Ethical Principles/Values**
  - Beneficence
  - Non-maleficence
  - Autonomy/Dignity
  - Justice
  - Prudence
    - Reasonableness
    - Tolerability
      - Peaceful
      - Vigilant
      - Reaction
    - Accountability
    - Inclusiveness
    - Conservation/biodiversity/ sustainability

- **Science**
  - Epidemiology
  - Radiobiology
  - Anatomy
  - Physiology
  - Metrology
  - ……

- **Experience**
  - Hiroshima/Nagasaki
  - Nuclear Installations
  - Industrial/Medical
  - Chernobyl
  - Fukushima
  - ……



System of Protection



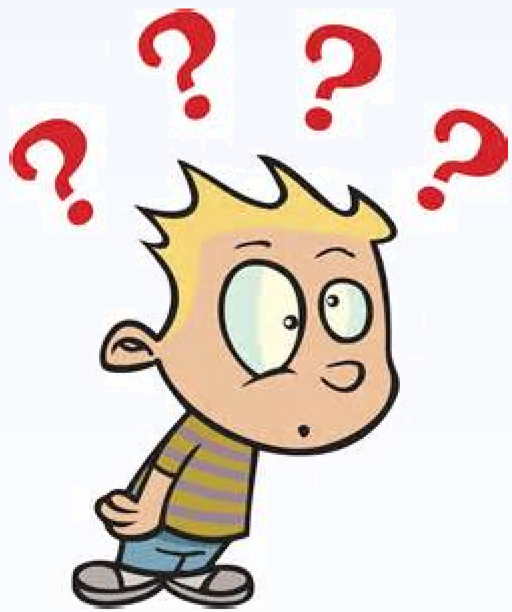
So the System is Simple … Right?

Effective Dose

Stochastic

Occupational

Existing Exposure Situation



Optimization

Gray, Sievert

Planned Exposure Situation

Limit

Constraint

Medical

Public

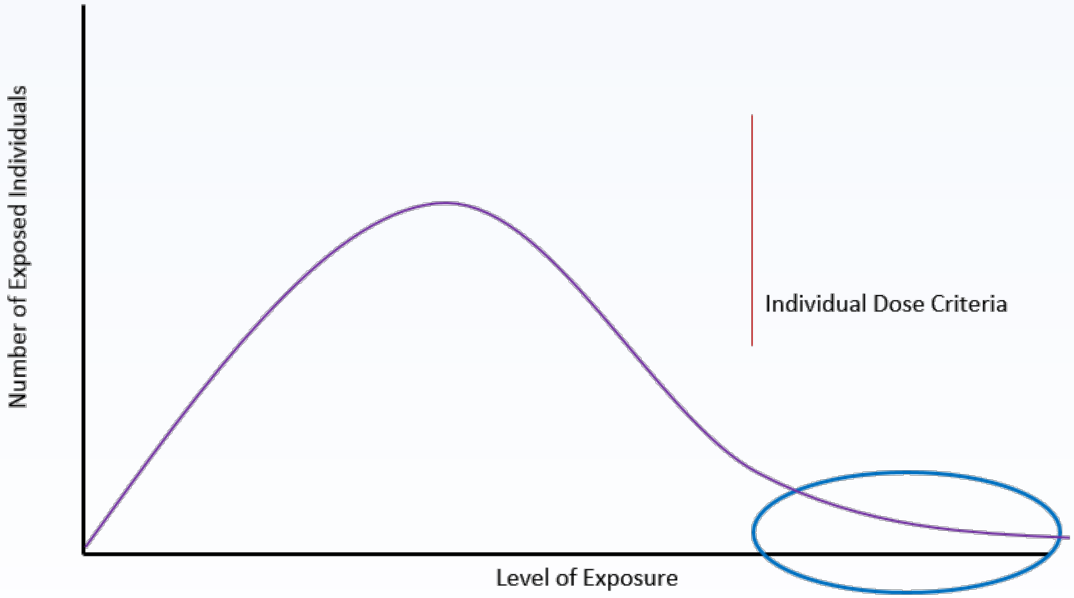
Emergency Exposure Situation

Unified Approach

- Justification for establishing control is necessary
- If justified, exposures are managed by optimisation of protection using restriction on individual doses to reduce inequity, identify exposures which warrant specific attention to reduce their magnitude, and to guide reduction in the entire dose distribution ALARA
- Individual dose Criteria selected in, or below, bands recommended in Publication 103
- Apply accountability, transparency and inclusiveness (stakeholder involvement) commensurate with risks

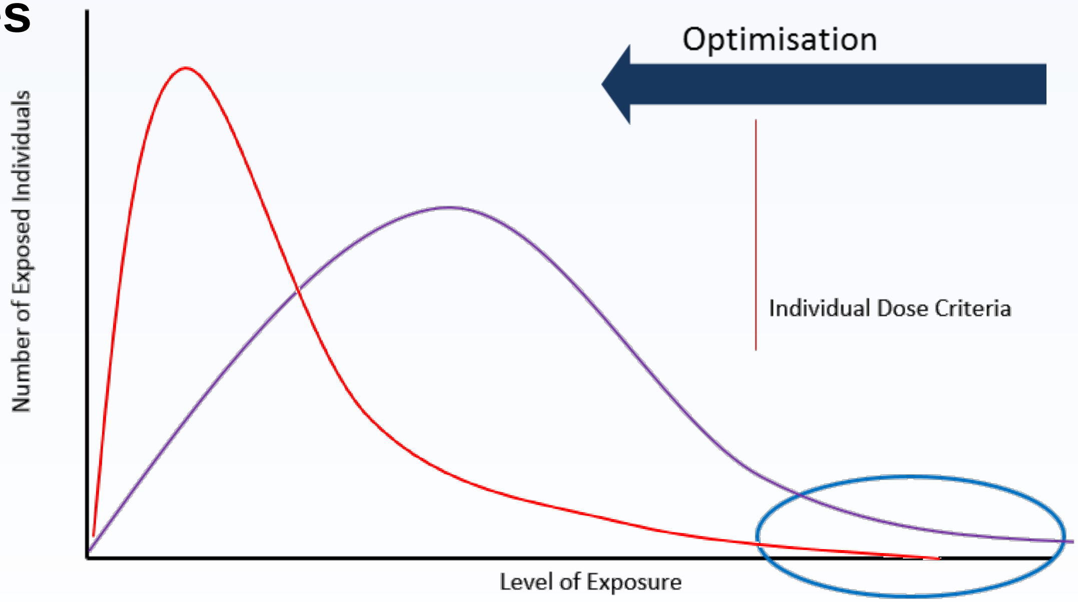
Unified Protection Approach

- Characterize exposures
- Justify taking actions
- Identify exposures which warrant specific attention to reduce their magnitude



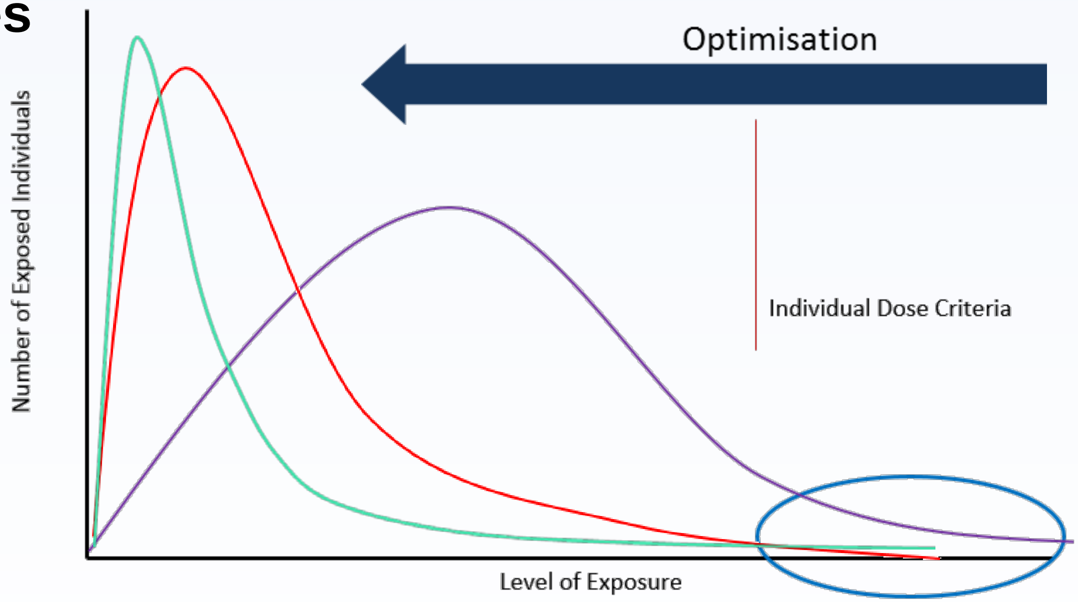
Apply Optimization

- Characterize exposures
- Justify taking actions
- Identify exposures which warrant specific attention to reduce their magnitude
- Influence the entire dose distribution and shift exposures towards lower values



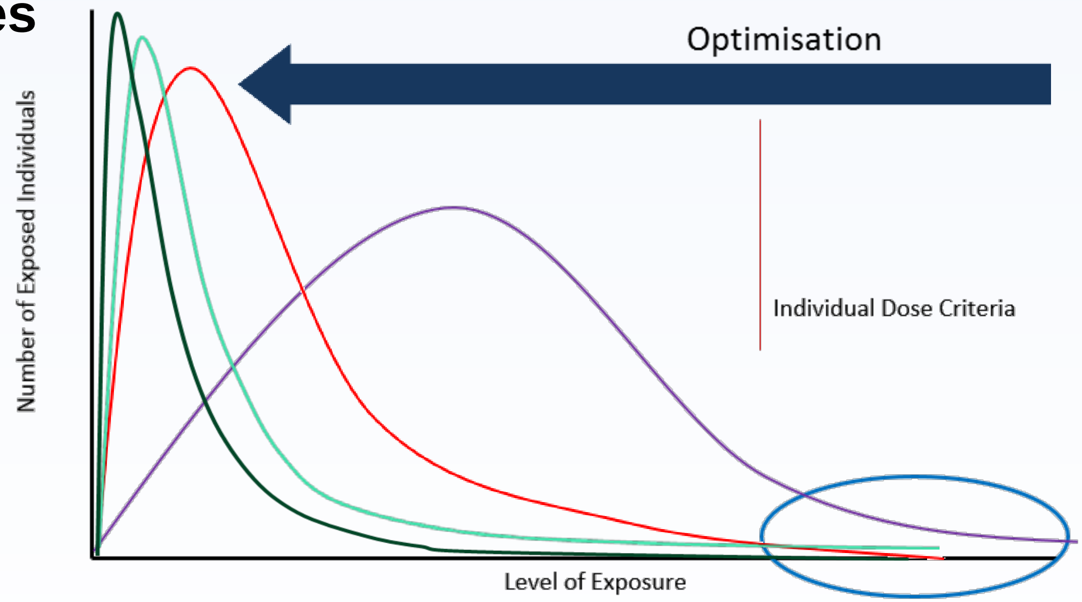
Iterative Process

- Characterize exposures
- Justify taking actions
- Identify exposures which warrant specific attention to reduce their magnitude
- Influence the entire dose distribution and shift exposures towards lower values
- Reduce inequity



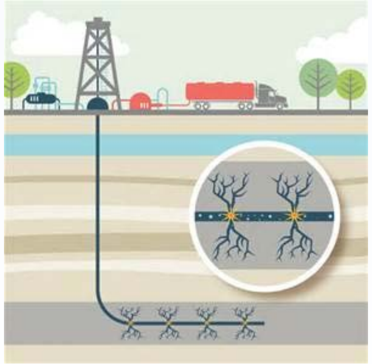
Build Culture of Protection

- Characterize exposures
- Justify taking actions
- Identify exposures which warrant specific attention to reduce their magnitude
- Influence the entire dose distribution and shift exposures towards lower values
- Reduce inequity
- Enable stakeholder engagement and action



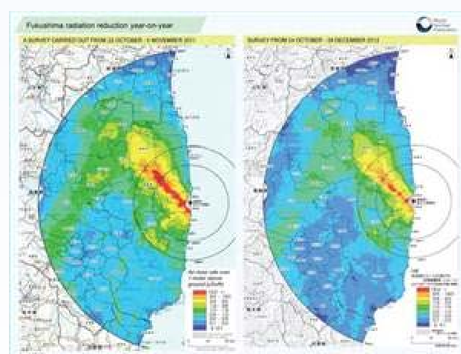
Existing Exposure Situations

- *Publication 126*, Radiological Protection against Radon Exposure, December 2014
- TG 76 on NORM ongoing
- TG 98 on Contaminated Sites started end of 2014



Response to Fukushima

- **TG 93 in process**
  - Update to *Publication 109*, Protection of People in Emergency Exposure Situations
  - Update to *Publication 111*, Protection of People Living in Long-term Contaminated Areas
  - ICRP Dialogue series in Fukushima
  - Draft for public consultation 2017



Foundations of Radiation Protection

- **TG94 Ethical Foundations of the System of Radiological Protection (in process)**
  - IRPA workshops
  - Draft sent to IRPA for distribution to Associate Societies
  - Preliminary consultation at time of IRPA Congress in May, 2016
  - Official Web consultation late 2016

Common values not only grounded in Western Ethical Theories but on a study of the oral and written traditions which have guided people in different cultures over the ages

(Friedo Zoelzer, 2011)

Foundations of Radiation Protection

- **Core Ethical Values**
  - Beneficence – do good
  - Non-maleficence – avoid harm
  - Autonomy
  - Justice
  - Prudence
- **Procedural Aspects**
  - Accountability
  - Transparency
  - Inclusiveness
  - Reasonableness
  - Tolerability

Topical Reports

- *Publication 125*, **Radiological Protection in Security Screening, August 2014**
- *Publication 132*, **Radiological Protection from Cosmic Radiation in Aviation, June 2016**
- **TG 97, Surface and Near Surface Disposal of Solid Radioactive Waste, started end of 2014**
- **Topics invited from organisations in formal relations with ICRP**
  - Mobile High Activity Sources

Challenges

- **How to harmonize and coherently apply RP System to all exposure situations?**
- **What is tolerable, or acceptable, in a particular situation and prevailing circumstance?**
- **How to properly balance social and economic factors?**
- **Who has authority or ability to take actions?**
- **Communication and Engagement of Stakeholders?**

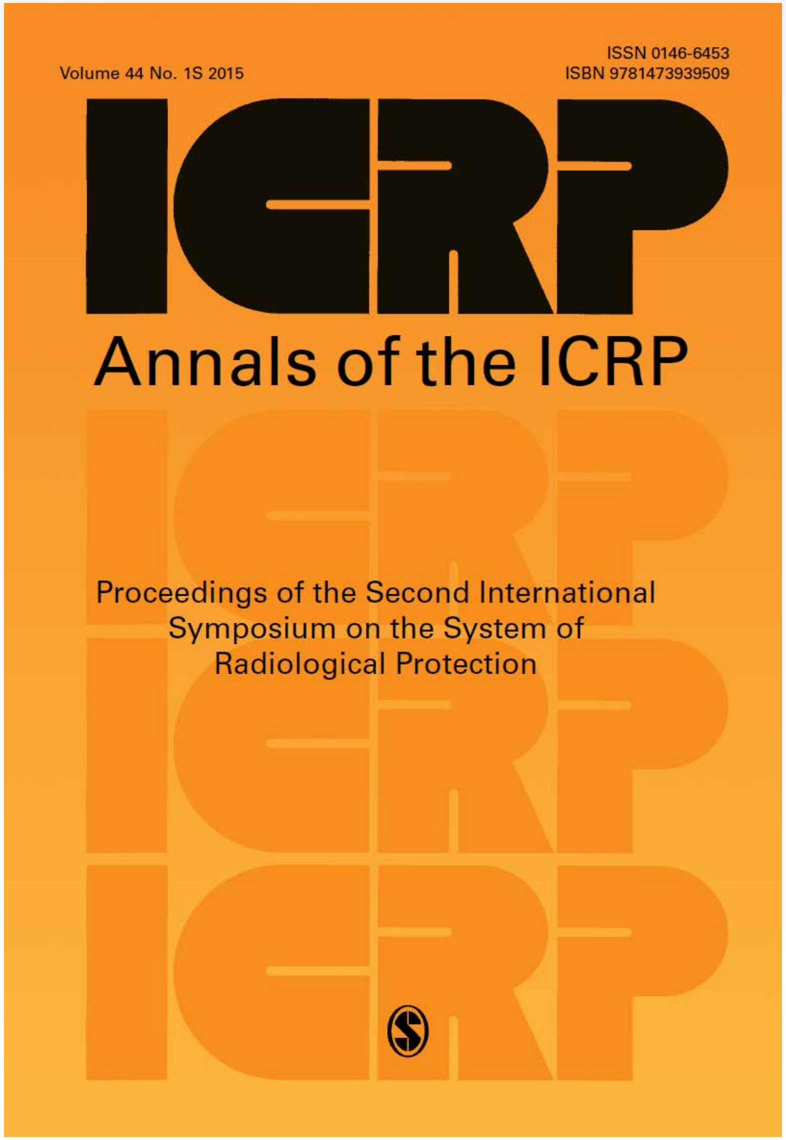
CAUTION

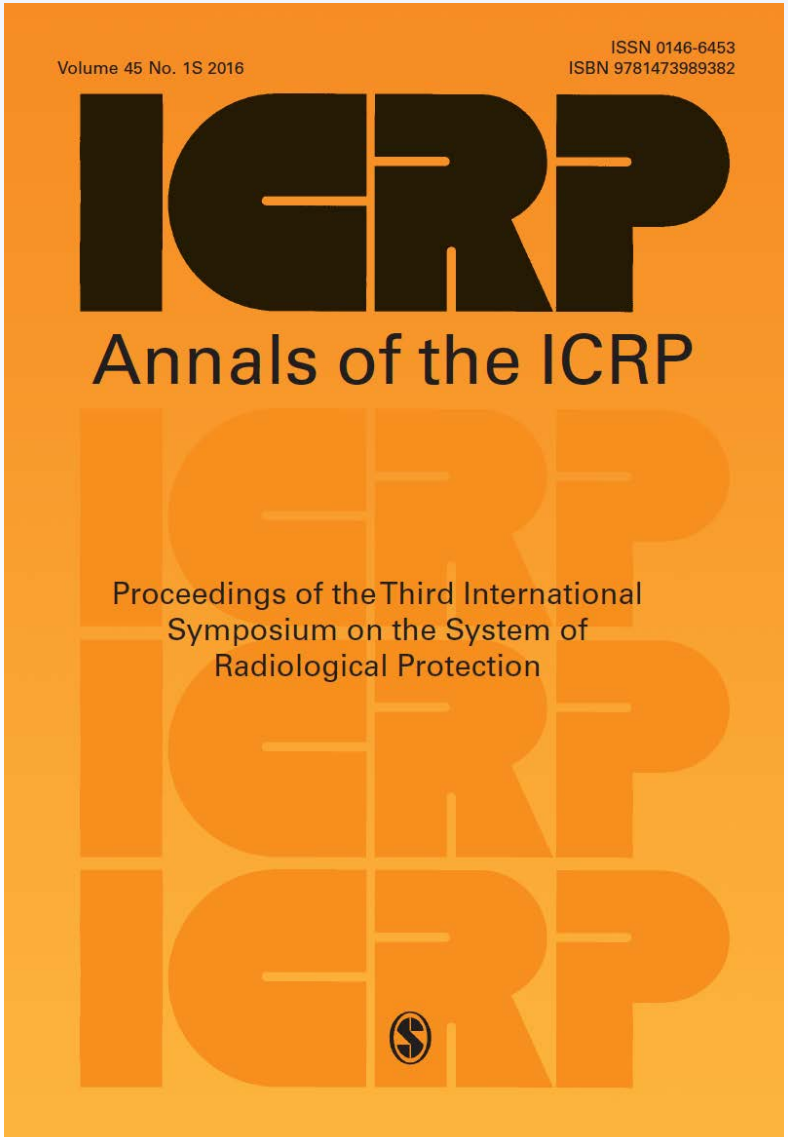
Indiscriminate use of Jargon may be detrimental to your credibility

Future Directions

- **Continue bringing system of protection into a unified framework**
  - Identify and examine foundational issues needed for future recommendations
  - Integrating protection of the environment in the system of protection
- **Focused application in areas such as mobile high activity sources**
- **Application of ethics to practical radiation protection decision-making**

Actas de los Simposios





¡Próxima cita en París!

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- **10-12 Octubre 2017**

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