V Congresso de Proteção Contra Radiações da Comunidade dos Países de Língua Portuguesa

Coimbra, 10-12 Março 2016

Organizaçao:

The ICRP System for Radiological Protection. Current Challenges and Trends

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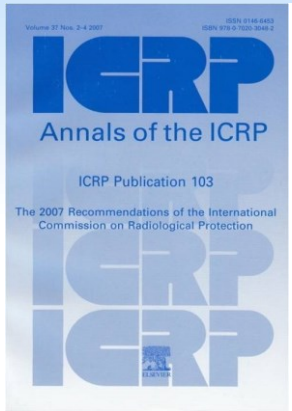
This presentation has neither been approved nor endorsed by ICRP

Contents

- From science to regulations
- Overview of the ICRP System of Radiological Protection for humans:
  - Basic components: Exposure situations; Categories of exposure
  - The principles of Radiological Protection
  - Dose criteria
  - Other basic elements
  - Ethics behind the system
- The ICRP System of Radiological Protection for the environment
- Current challenges and developments
- Conclusions

From science to regulations



Radiological and epidemiological studies

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Assessments by UNSCEAR

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ICRP Recommendations ↔ ICRU and IRPA

↕

Discussions in IAEA, OECD/NEA, other organisations

↙ ↘

International Standards
IAEA/ILO/WHO/PAHO/FAO/NEA

Regional Standards
e.g. Directives of the EC

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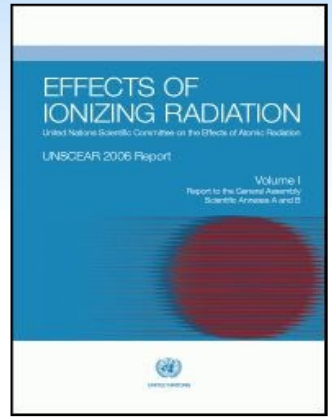
National Legislation for Radiological Protection



IAEA Safety Standards
for protecting people and the environment

Radiation Protection and Safety of Radiation Sources: International Basic Safety Standards

Jointly sponsored by
EC, FAO, IAEA, ILO, OECD/NEA, PAHO, UNEP, WHO

General Safety Requirements Part 3
No. GSR Part 3

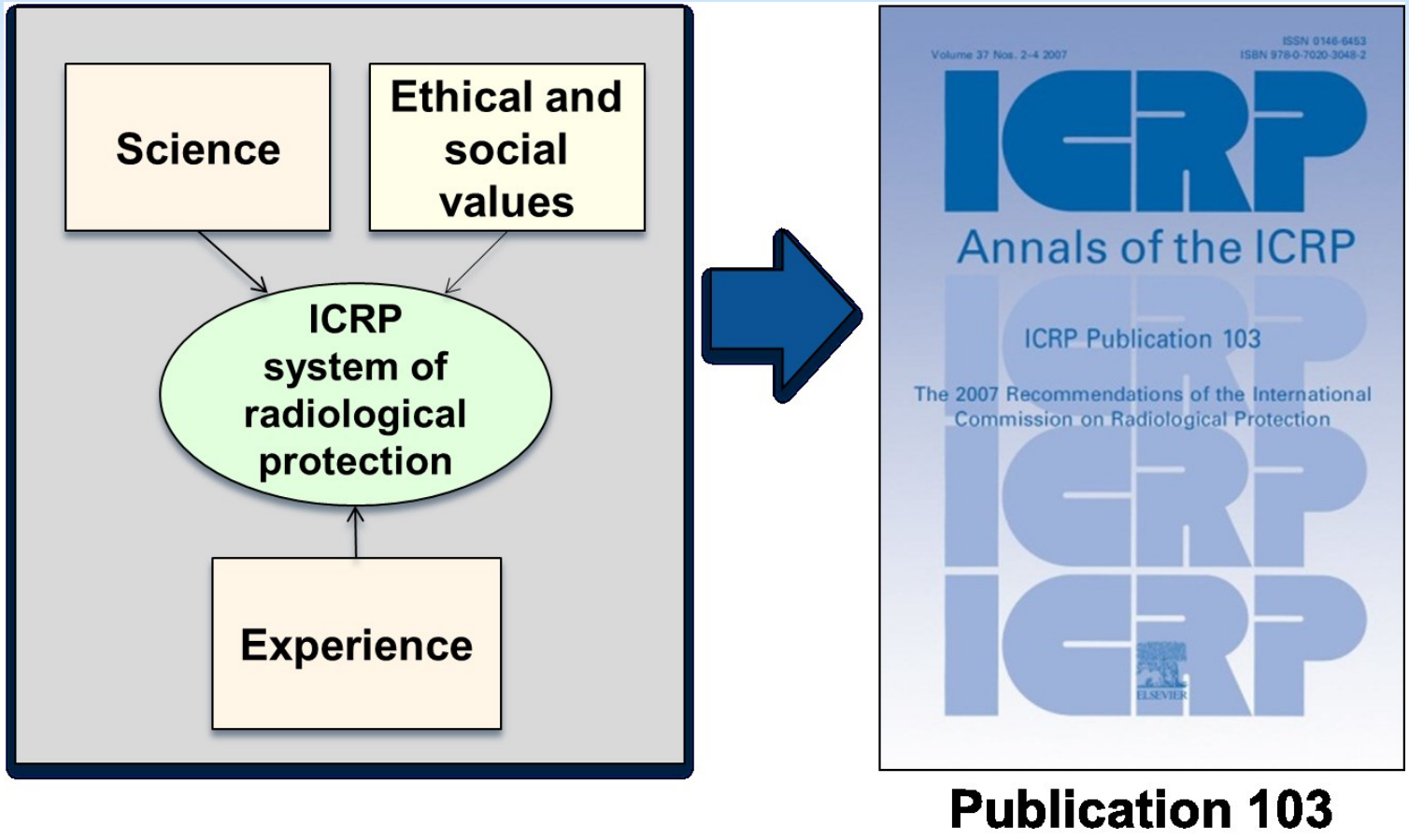
IAEA
International Atomic Energy Agency

Official Journal
of de European Union

L 13
Volume 57
17 January 2014

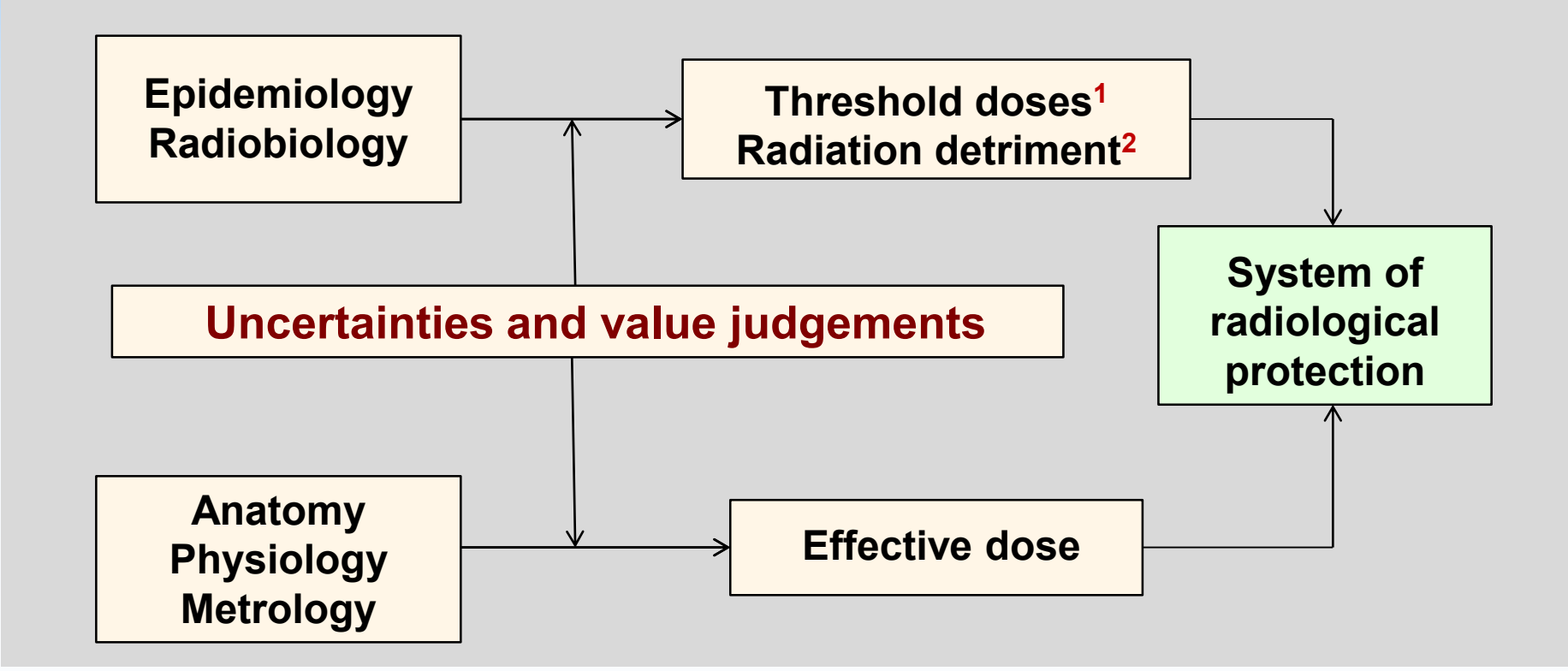
Council Directive 2013/59/Euratom of 5 December 2013 laying down basic safety standards for protection against the dangers arising from exposure to ionising radiation, and repealing Directives 89/618/Euratom, 90/641/Euratom, 96/29/Euratom, 97/43/Euratom and 2003/122/Euratom .

The three pillars of the System of Radiological Protection



Publication 103

The scientific basis of the System of Radiological Protection



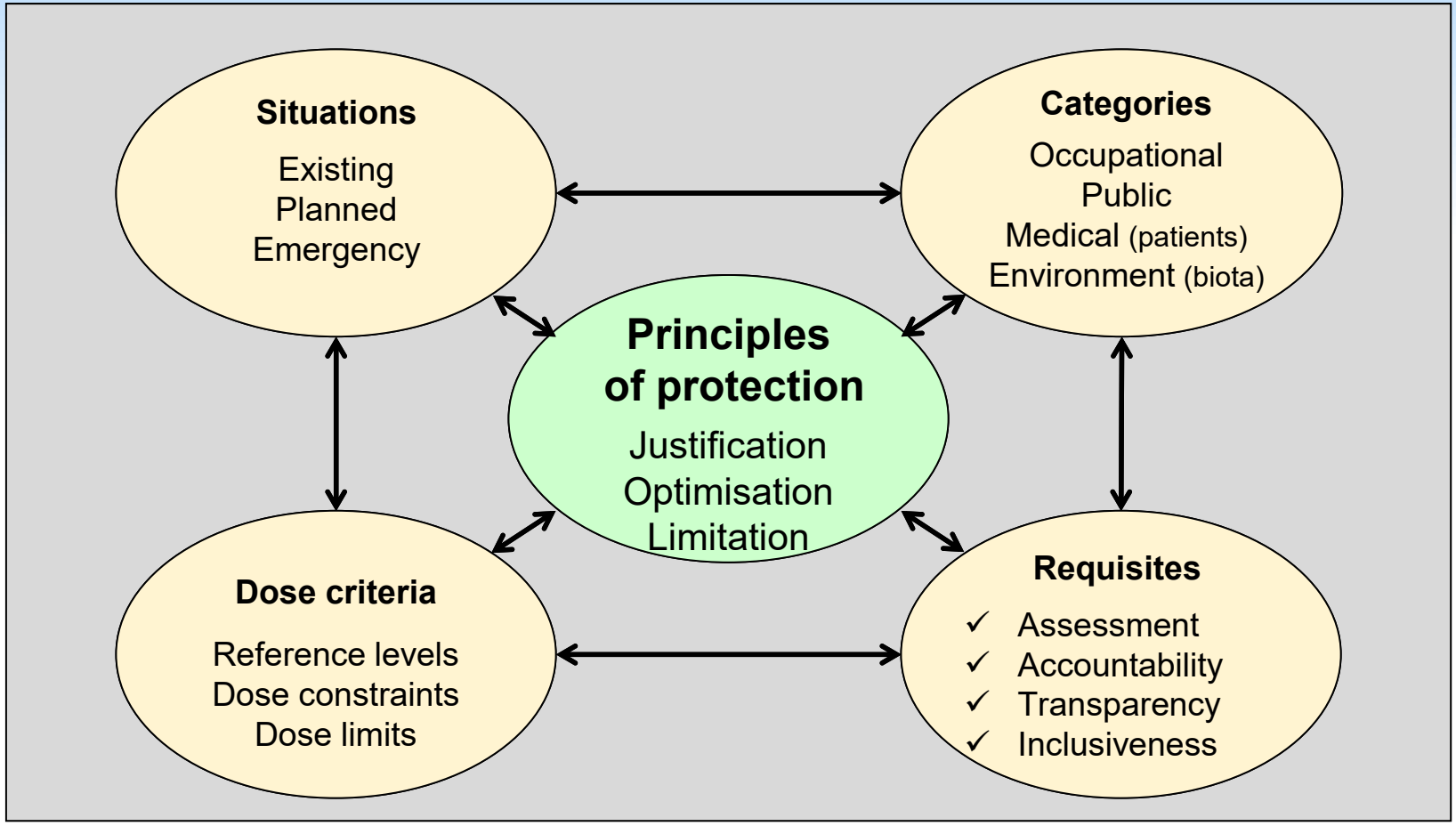
[1] Deterministic effects [2] Stochastic effects

Aims of the ICRP Recommendations

- *"… to contribute to an appropriate level of protection against the **detrimental effects** of ionising radiation exposure without unduly limiting the **benefits** associated with the use of radiation."* ICRP 103, § 26

- *"… to manage and control exposures to ionizing radiation so that **deterministic effects** are **prevented**, and the risks of **stochastic effects** are **reduced** to the extent **reasonably achievable.**"* ICRP 103, § 29

The basic components of the ICRP System of Radiological Protection of humans



Exposure situations

- “The processes causing human exposures from natural and man-made sources.”

- “Protection can be achieved by taking action at the source, or at points in the exposure pathways, and occasionally by modifying the location or characteristics of the exposed individuals.” ICRP103, § 169

The types of exposure situations

- **Existing exposure situations :** when exposures result from **sources that already exist when decisions to control them are taken**. Characterization of exposures is a prerequisite to their control

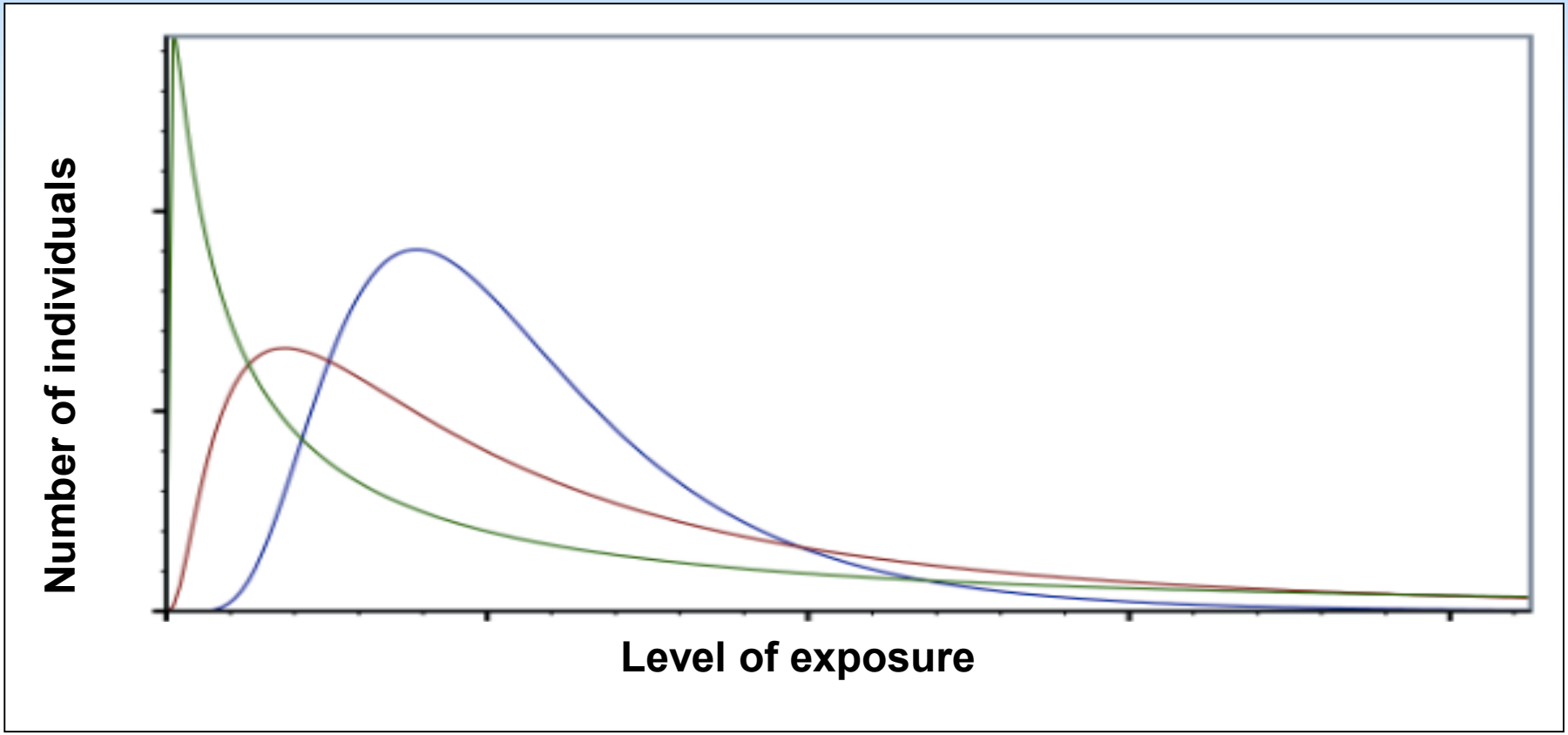
  Remark: the Commission considers long term exposures resulting from a nuclear accident or a malicious act as an existing exposure situation

- **Planned exposure situations :** when exposures result from the **deliberate introduction and operation of sources.** Exposures can be anticipated and fully controlled but may be significantly higher than expected in case of incidents and accidents

- **Emergency exposure situations :** when exposures result from the **loss of control of a source**. These situations require urgent and timely actions in order to mitigate exposures

  Remark: the Commission considers exposures resulting from a malicious act as an emergency exposure situation

Individual dose distributions associated with exposure situations



The categories of exposure

- **Medical exposure:** radiation exposures received by patients in the course of diagnostic, interventional, and therapeutic procedures

- **Occupational exposure:** radiation exposures incurred at work as a result of exposure situations that can **reasonably** be regarded as being the responsibility of the operating management

- **Public exposure:** encompasses all radiation exposures of the public other than occupational and medical exposure

Although individuals may fall into the 3 categories respectively as workers, patients or members of the public, ICRP considers the management of each category **separately**

The principles of radiological protection

- **The principle of justification:** Any decision that alters the radiation exposure situation **should do more good than harm**

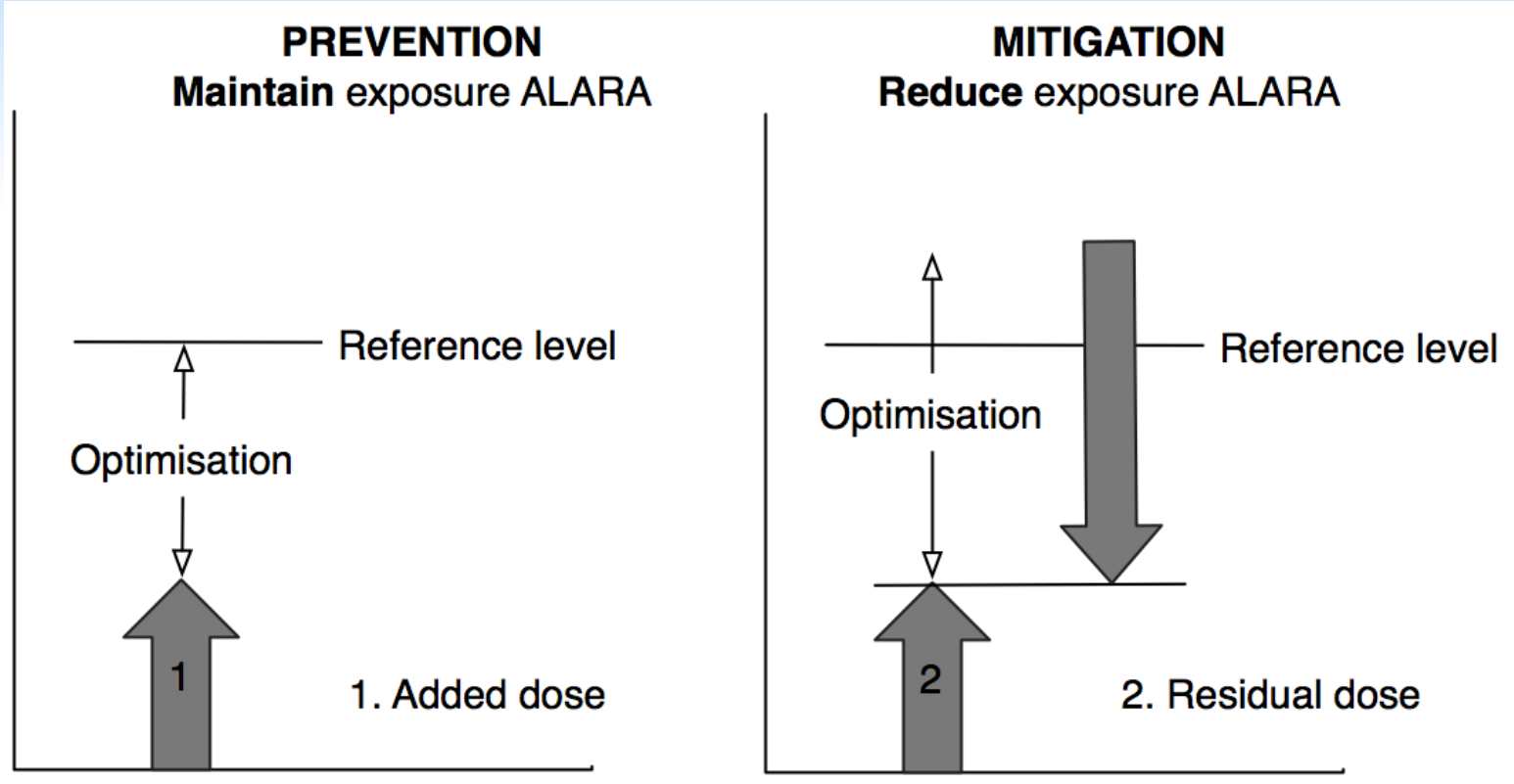
- **The principle of optimisation of protection:** All exposures **should be kept as low as reasonably achievable**, taking into account economic and societal factors **with restrictions** on individual exposures **to reduce inequities** in the dose distribution

- **The principle of application of dose limits:** The total dose to any individual from planned exposure situations other than medical exposure of patients **should not exceed** the appropriate limits recommended by the Commission

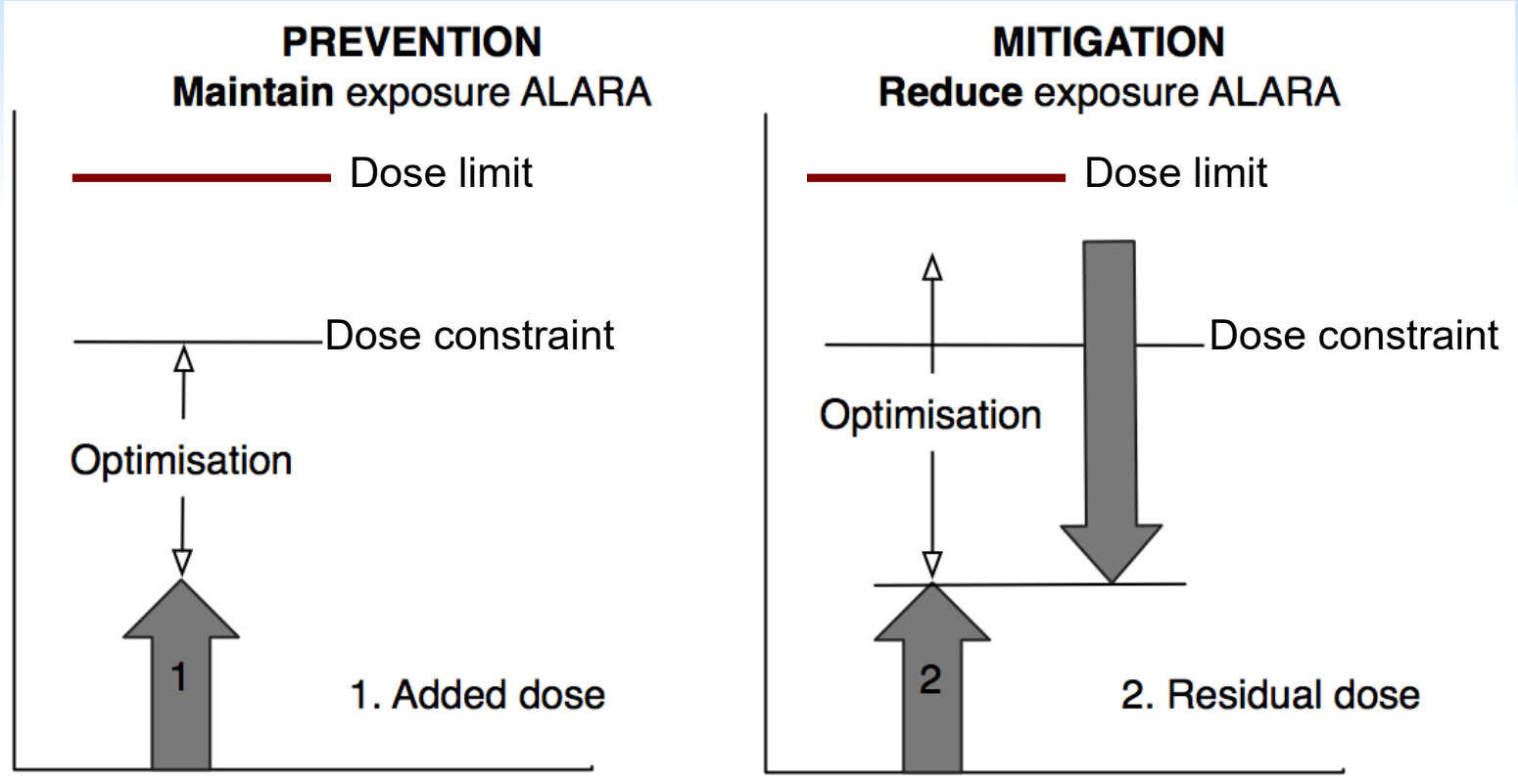
Dose criteria

- **For preventing deterministic effects**
  - **Dose limits** to organs
- **For mitigating the risk of stochastic effects to tolerable levels**
  - Source related restrictions associated with the optimisation principle:
    - **Reference levels** for existing and emergency exposure situations
    - **Dose constraints** for planned exposure situations
  - Individual related restrictions:
    - **Dose limits** applying only to planned situations other than medical exposure

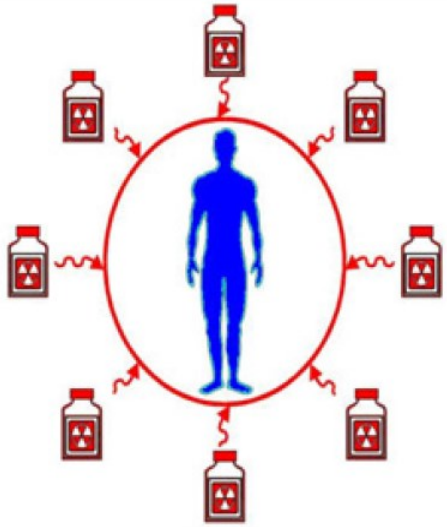
The principle of optimisation
for existing and emergency situations



The principle of optimisation
for planned exposure situations



Dose restrictions and limitation

Dose Limits	Constraints and Reference Levels
Protect individual workers from occupational exposure and the Representative Person from public exposure	
	
From all regulated sources in planned exposure situations	From a source in all exposure situations

Individual related

Source related

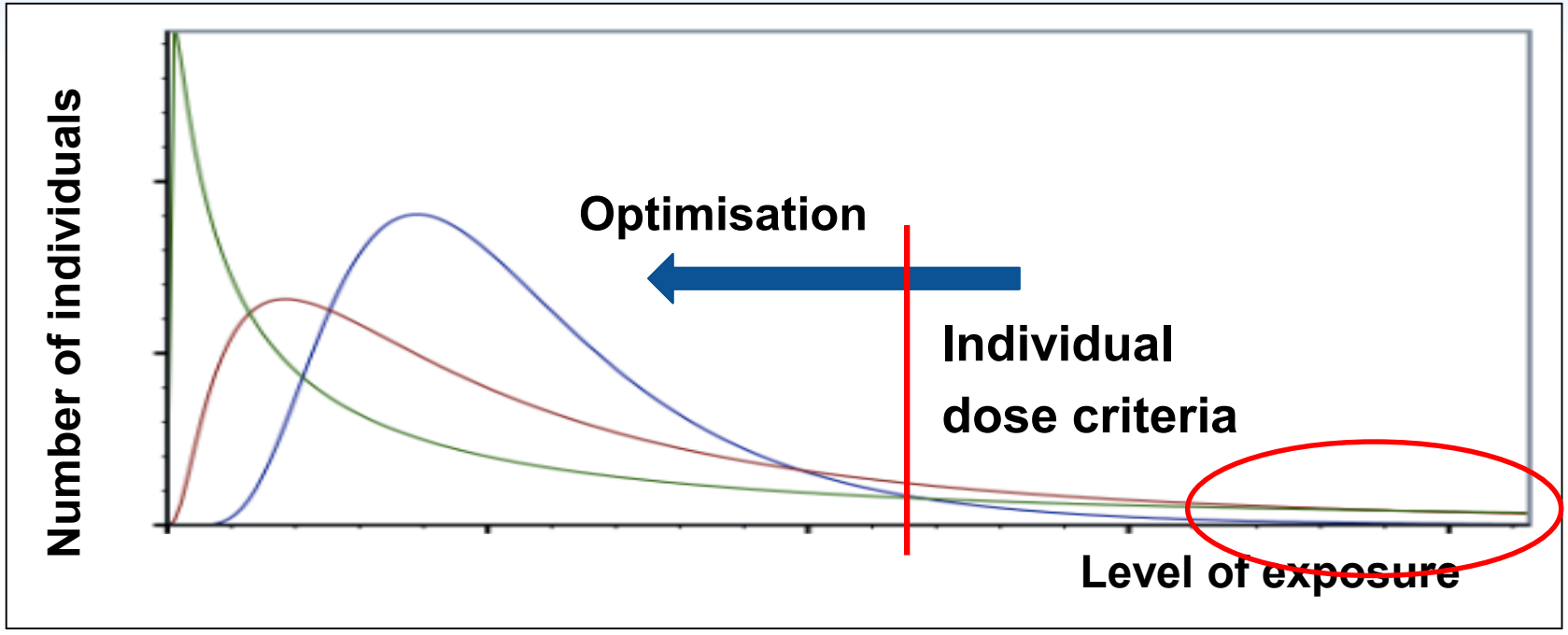
Reference levels for existing and emergency exposure situations

Dose constraints for planned exposure situations

(ICRP 103. Fig. 3.)

Individual dose restrictions and optimisation

- Dose constraints in planned exposure situations and reference levels in emergency and existing exposure situations allow to restrict inequity in individual dose distributions and to focus attention on the higher levels of exposure



Framework for setting DOSE REFERENCE LEVELS

BANDS OF PROJECTED DOSE [Effective dose and/or organ dose]	CHARACTERISTICS AND REQUIREMENTS
20 - 100 mSv	Exceptional situations. Benefit on a case-by-case basis. Information, training and individual monitoring of workers, assessment of public doses.
1 - 20 mSv	Individual direct or indirect benefit. Information, training and either individual monitoring or assessment.
0.01 - 1 mSv	Societal benefit (not individual). No information, training or individual monitoring. Assessment of doses for compliance.

Individual dose restrictions

- For the selection of an appropriate value for the dose restrictions one should consider the relevant exposure situation in terms of the nature of the exposure, the **benefits from the exposure situation to individuals and society**,…, and the **practicability** of reducing or preventing the exposures (ICRP 103, § 242)

- *"At doses higher than 100 mSv, there is an increased likelihood of deterministic effects and a significant risk of cancer. For this reason the Commission considers that the **maximum value for a reference value is 100 mSv** incurred either acutely or in a year.* Exposures above 100 mSv incurred either acutely or in a year would be justified only under extreme circumstances, either because the exposure is unavoidable or in exceptional situations such as the saving of life or the prevention of a serious disaster. No other individual or societal benefit would compensate for such high exposures*" (ICRP 103, § 236)*

Dose criteria

	Medical exposure	Occupational exposure	Public exposure
Existing exposure situations	NA	RL ≤20	RL≤ 20*
Planned exposure situations	DRLs	DC ≤ 20 DL= 20	DC ≤ 1 DL= 1
Emergency exposure situations	-	RL≤ 20–100	RL≤ 20–100

NA = non applicable

RL = reference level ; DC= dose constraint ; DL = dose limit

* RL = 10 mSv/y for radon and lower part of the 1-20 mSv/y band with long term objective of 1 mSv/y for long term contaminated territories

Basic requirements

- Information
- Education/training
- Radiation assessment and monitoring
- Classification of areas
- Medical surveillance

Ethical and societal values underlying the RP system

- The ICRP system is founded on the core ethical values of beneficence, non-maleficence, autonomy/dignity, justice, and prudence
- These core values are:
  - Applied using qualifying ethical values of reasonableness and tolerability allowing wisdom to resolve potential conflicts in making decisions that:
    - Do more good than harm
    - Keep exposures ALARA and seek for fair distribution of exposures
    - Control individual exposure within tolerable levels for the prevailing circumstance
    - Treat people with respect
  - Implemented using the procedural ethical values of accountability, transparency and inclusiveness (stakeholder involvement)

Particular case: Geological disposal of radioactive waste (ICRP 122, 2013)

- Work in cooperation with NEA/OECD (CRPPH and RWMC).
- Basic principle that *"Individuals and populations in the future should be afforded at least the same level of protection as the current generation"*
- 3 periods of oversight (watching care) directly affecting the capability to control the source and to avoid or reduce exposures: direct oversight, indirect oversight and loss of oversight
- Optimisation with dose constraints :
  - 0.3 mSv/y for the public,
  - 20 mSv/y or 100 mSv in 5y for occupationally exposed workers
- Considerations about emergency and existing exposure situations in the long term in case of severe disruptive events

RP of the environment

- … aim is … preventing and reducing the frequency of deleterious radiation effects to a level where they would have negligible impact on the maintenance of **biological diversity**, the **conservation of species**, or the health and status of **natural habitats**, **communities** and **ecosystems**. (ICRP 103, § 30)

- ... Reference Animals and Plants..... (ICRP 103, § 366)

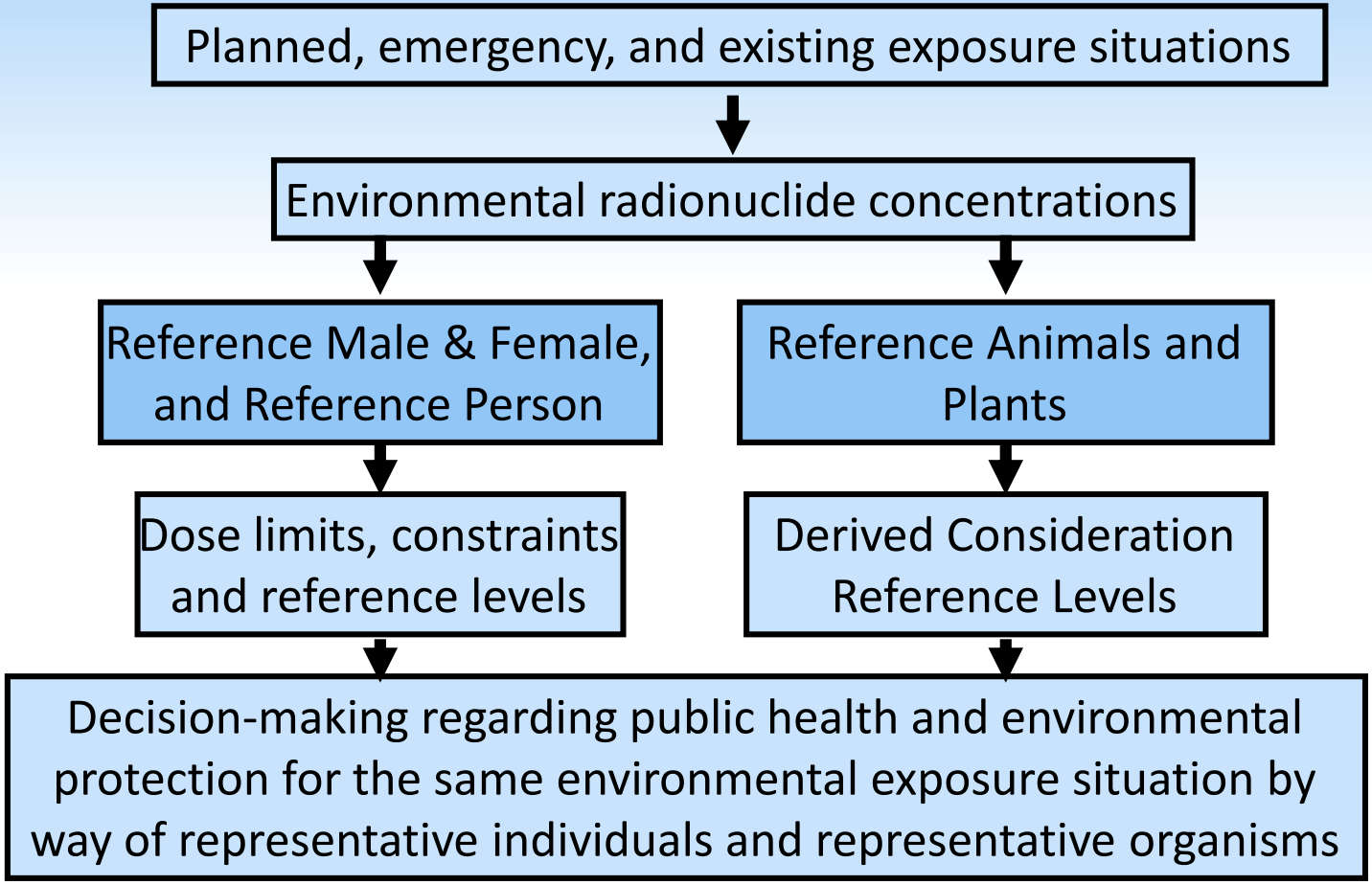
- **Committee 5:** to ensure that the development and application of approaches to environmental protection are compatible with those for radiological protection of man, and with those for protection of the environment from other hazards

ICRP 91 (2003): A Framework for Assessing the Impact of Ionising Radiation on Non-human Species

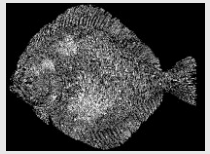
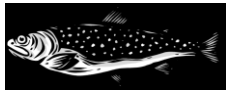
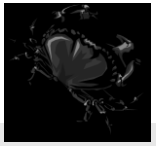
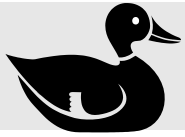
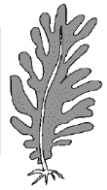
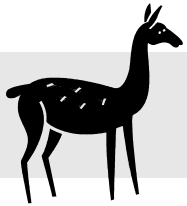
Review of ethics and principles, recommending that the System for Environmental Protection should

- *focus on biota;*
- *consider **adequate protection** on the basis of understanding of effects;*
- *identify **reference animals and plants (RAPs)**; and*
- *let the RAPs guide the derivation of*
  - *exposure scenarios (CFs and DCFs)*
  - *effects data*
  - *dose rates benchmarks*

Evolution of two parallel pathways



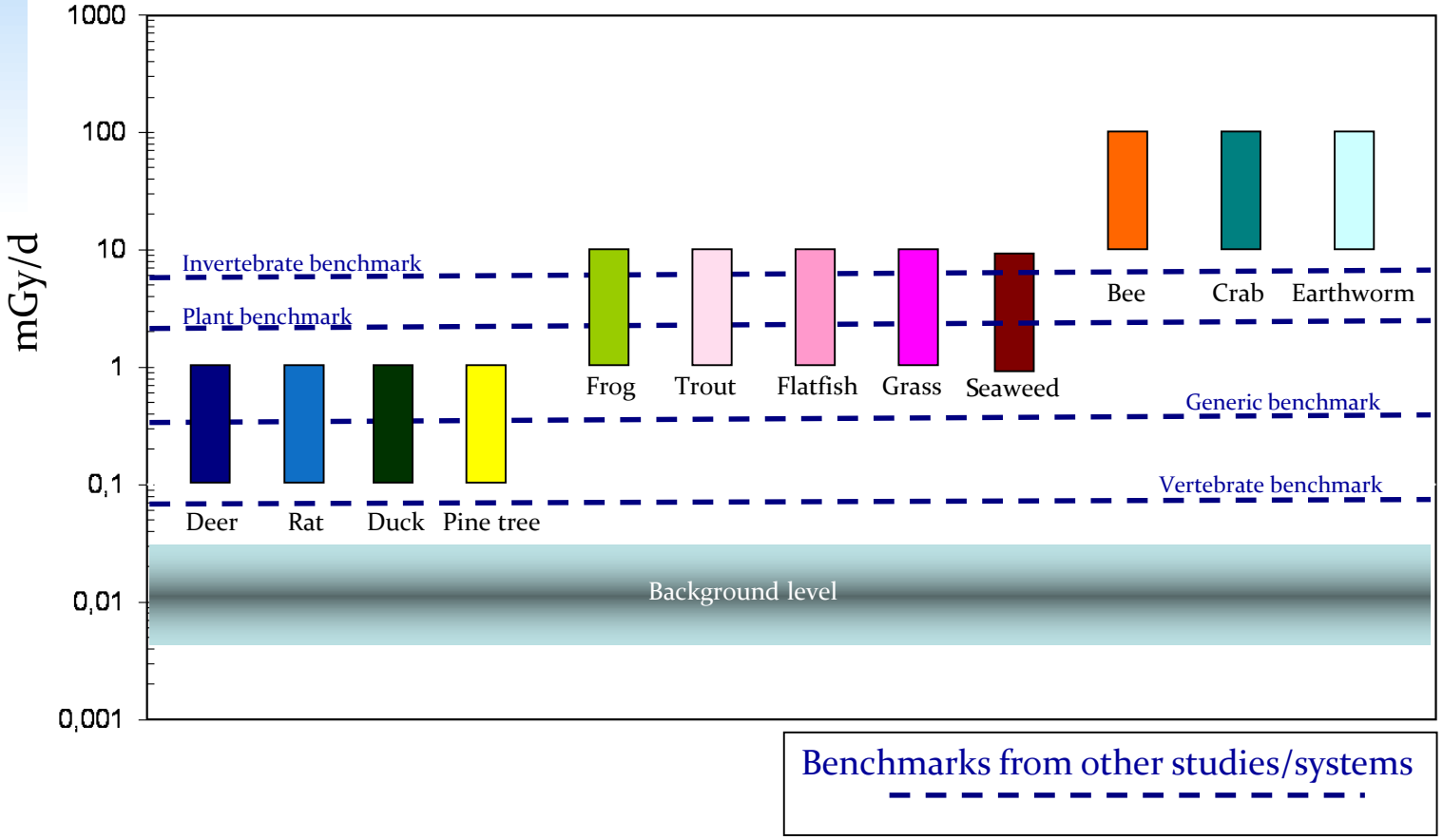
ICRP 108 (2009). Reference Animals and Plants

Terrestrial	Freshwater	Marine
Pine tree 	Frog (adult, egg, egg mass, tadpole) 	Flatfish (egg, adult) 
Bee (adult, colony) 	Trout (adult, egg) 	Crab (adult, egg mass, larvae) 
Earthworm (egg, adult) 	Duck (adult, eggs) 	Seaweed 
Grass (meristem, grass spike) 		
Deer (calf, adult) 		
Rat 		

ICRP 108 reviews biological characteristics

- *Occurrence*
- *Life cycle and life span*
- *Physiology*
- *.....other factors.....*
- *Taxonomy*
- *Reproductive strategy*
- *Ecology*

ICRP 108 (2008)
Derived Consideration Reference Levels, DCRLs



RP of the environment. Further developments.

ICRP 114 (2009). **Environmental Protection: Transfer Parameters for Reference Animals and Plants**

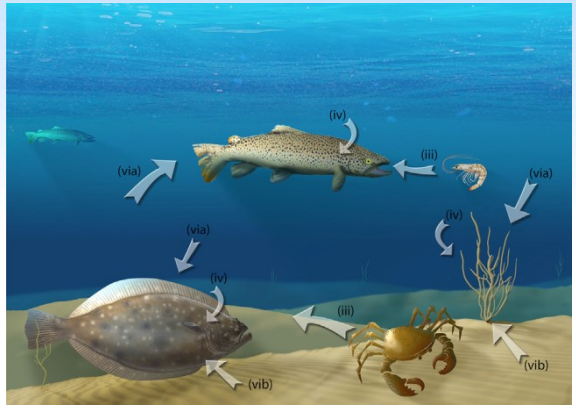
ICRP 124 (2014). **Protection of the Environment under Different Exposure Situations**

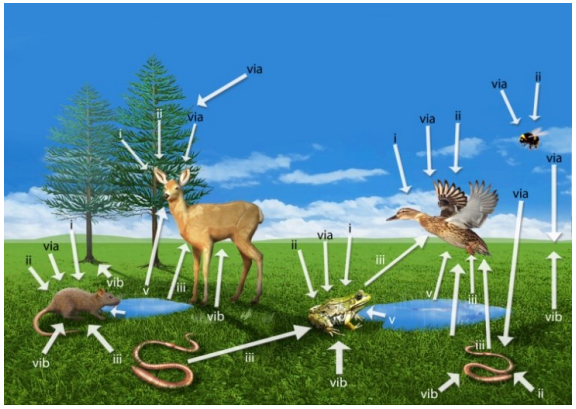
TG72: **RBE**

TG 74: **Improved dosimetry**

TG 99: **monographs**

Focus on application: software and guidance





Current challenges and developments

- **Review of the RP System to start in 2016.** Last Recommendations took about 10 years to be developed…
- **Scientific challenges**
- **RP in Medicine:** focus on individual techniques. Justification. Dosimetry. Use of Diagnostic Reference Levels in medical imaging. Protection of staff and patients.
- **Stakeholder involvement in the development of the RP System** through participation in Task Groups by organising open scientific discussions, meetings, joint workshops
- **Working closely with other organizations:** Formal relations with 21 international, regional, and national organizations, including ICRU, UNSCEAR, IAEA, WHO and IRPA
- **Ethical foundations of the RP System**

Scientific challenges and examples of the involvement of stakeholders (1)

TG 91 on Radiation Risk Inference at Low-dose and Low-dose Rate Exposure for Radiological Protection Purposes

- Organisation of an open meeting in Japan in May 2015
- Paper summarizing the discussion published in September 2015: W. Rühm *et al*. Dose and dose-rate effects of ionizing radiation: a discussion in the light of radiological protection. *Radiat. Environ. Biophys*., *54:* online, 2015. DOI 10.1007/s00411-015-0613-6

ICRP Symposium on Radiological Protection Dosimetry. Historical Review and Current Activities. The University of Tokyo, Japan. February 2016. Presentations available at the ICRP website.

The Use of Effective Dose as a Risk-related Radiological Protection Quantity

Scientific challenges and examples of the involvement of stakeholders (2)

TG 93 on the update of Publications 109 (emergency) and 111 (post-emergency)

- Several meetings with representatives of industry and governmental bodies
- Organisation of 12 ICRP Dialogue meetings since November 2011 in Fukushima prefecture with local stakeholders (Supported by ASN, IRSN, NEA, NRPA and local organisations and NGOs)
- International Workshop on the Fukushima Dialogue Initiative entitled “Rehabilitation of Living Conditions after the Nuclear Accident” held in Date City, Fukushima Prefecture on December 12-13, 2015
- Web documentary on the ICRP Fukushima Dialogue Initiative is available at: http://www.fukushima-dialogues.com

Scientific challenges and examples of the involvement of stakeholders (3)

TG 94 on the ethics of radiological protection

- 8 workshops and meetings on ***'The ethical dimensions of the radiological protection system'*** have been organized in Asia, Europe and North America in cooperation with IRPA Associate Societies, the Open Project for European Radiation Research Area (OPERRA), and the Fukushima Medical University (FMU).
- These events have shown that the core ethical values underlying the RP system - beneficence/non-maleficence, prudence, justice and dignity - are largely shared worldwide
- TG94 report, in draft, will be provided to IRPA and the IRPA Associate Societies for comment and discussion at the upcoming Congress in Cape Town

Conclusions

- The ICRP System of radiological protection is based on well established scientific evidences but also on universally shared ethical values: prudence, beneficence/non-maleficence, justice and dignity. It is the basis for international and national regulations and standards, which incorporate the needed elements for its due practical implementation
- It addresses the main exposure situations –Planned; Existing; Emergency– and the main categories of exposure for people –as Public, Workers or Patients–
- The System is globally well structured and coherent, with the principle of optimisation being the cornerstone and reasonableness and tolerability the core elements
- For non-human biota, a robust system has evolved that is compatible with the RP system for man and the environmental protection system developed for other hazards
- The involvement of relevant stakeholders and organisations in its development is contributing to enrich the System.

Acknowledgement

Many slides of this presentation are based on those prepared for by:

- Jacques Lochard. Vice-President ICRP
- Carl-Magnus Larsson, past-Chairman of ICRP Committee 5
- Donald Cool, Chairman of ICRP Committee 4

Muito obrigado pela sua atenção!