

## The 2007 ICRP Recommendations – What's New?

Dr Jack Valentin, Scientific Secretary, ICRP

- **International Commission on Radiological Protection**  
*ICRP: Who, why, what?*
- **The 2007 Recommendations**  
*Justification (political) – optimisation – limits & constraints*  
*The exposure situation*  
*Include non-human species*

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## About ICRP

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## ICRP, an Independent Registered Charity

**Established to advance for the public benefit the science of Radiological Protection,**

**in particular by providing recommendations and guidance on all aspects of protection against ionising radiation.**

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## Structure of ICRP, 2005 – 2009

**Main Commission**

*Chair: Dr L-E Holm, SE*  
*12 other members*



**Scientific Secretariat**  
*Dr J Valentin, SE*

**C1- Radiation Effects** *Dr R J Preston, US*

**C2- Doses from Radiation Exposure** *Dr H Menzel, CH*

**C3- Protection in Medicine** *Dr C Cousins, UK*

**Task Groups** **C4- Application of ICRP Recommendations** *Dr A Sugier, FR*

**Working Parties** **C5-Prot. of the Environment** *Prof J Pentreath, UK*

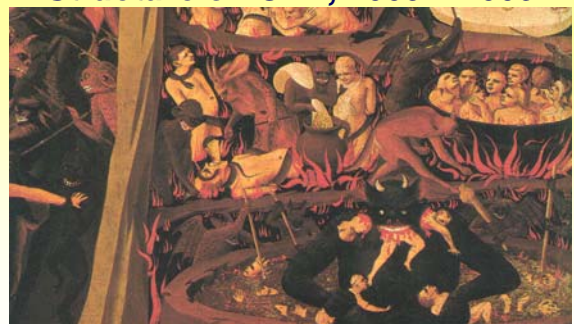
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## Structure of ICRP, 2005 – 2009



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## Structure of ICRP, 2005 – 2009



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## The 2007 Recommendations of ICRP

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## Why Are We Updating...

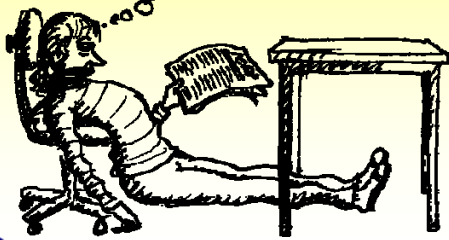
- New biological & physical information  
*Validity of the LNT model? (Linear, No Threshold)*
- Increasing use of radiation in medicine  
*Increase professional awareness*
- Post-Chernobyl issues, inclusion of natural exposures  
*Coherent, consistent, and modification of ICRP Publication 60?*
- Protection of the environment  
*Scientific proof of biological protection*



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## ICRP 1990 Rec's: Logical But Complex

YAWN... PERHAPS I'LL  
READ THIS TOMORROW...



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## Aims of the Revision

- Take account of new science
- Feed back experience of current radiation safety standards
- Improve & streamline the presentation
- Use an open, transparent process
- Maintain as much stability as is consistent with the new information

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## To Get the Recommendations...

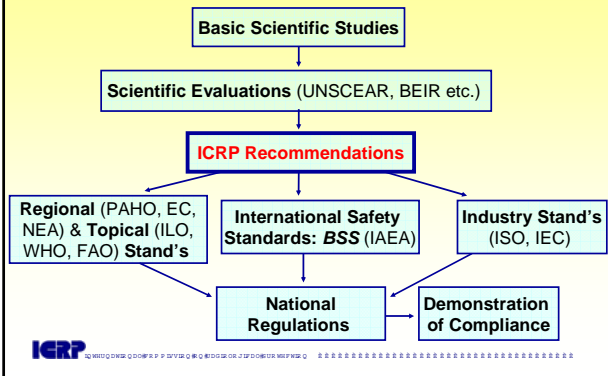
- Buy printed or electronic copies  
*IRPA Ass.Soc. discount available to NSFS!*
- Developing countries: free download at HINARI
- Junior staff: coming summary in JRP
- For all of this, see [www.icrp.org](http://www.icrp.org)
- Or translate them

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## Chapter 1: History, development, structure

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## ICRP In The Cosmic Scheme



## Chapter 2: Aims and scope

## Primary Aim of Our Recommendations

To contribute to an appropriate level of protection for people

and the environment

without unduly limiting the desirable human activities that may be associated with radiation exposure

## The Principles of Protection

Source-related, in all exposure situations:

- **Justification**  
*More benefit than detriment*
- **Optimisation of protection**  
*Dose and risk constraints to*  
*(a) increase equity,*  
*(b) consider multiple sources*

Individual-related, in planned exposure situations

- **Dose limits**  
*Except medical exposure of patients*

## ICRP Value Judgements - Constraints & Equity

<b>Utilitarian ethics</b> <i>Judge actions by the consequences</i>	
<b>Justification</b> <i>Do more good than harm</i>	
<b>Optimisation</b> <i>Maximise good &gt; harm</i>	

## ICRP Value Judgements - Constraints & Equity

<b>Utilitarian ethics</b> <i>Judge actions by the consequences</i>	<b>Deontological ethics</b> <i>Some duties are imperative</i>
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<b>Optimisation</b> <i>Maximise good &gt; harm</i>	<b>Dose constraints</b> <i>Increased equity = emphasise the individual</i>



## ICRP Value Judgements - Constraints & Equity



## Limits, Levels – Constraints & Multiple Sources

DOSE LIMITS	DOSE CONSTRAINTS / REFERENCE LEVELS
Protect individuals from PUBLIC and OCCUPATIONAL exposure...	
from ALL regulated sources, in PLANNED exposure situations	
	

## Limits, Levels – Constraints & Multiple Sources

DOSE LIMITS	DOSE CONSTRAINTS / REFERENCE LEVELS
Protect individuals from PUBLIC and OCCUPATIONAL exposure...	
from ALL regulated sources, in PLANNED exposure situations	from a source, in ALL exposure situations
	

## Chapter 3: Biology

## Females and Males

Buzzfeed.com

- Nominal risk estimates for protection  
*Individual retrospective assessments require specific information*
- The average achieves adequate protection for both sexes  
*A value judgement, based on science*
- Thus, no need for sex-specific protection criteria  
*Excludes discrimination*



## Deterministic and Stochastic Effects

These words will still be the default terms!

- **Deterministic**  
Harmful, mostly late, tissue reactions  
New data on eye will be considered when available
- **Stochastic**  
Cancer and heritable disease  
LNT: Scientifically plausible but not unambiguous  
DDREF: 2 a broad average judgement

## Some Observations

- **Probability of heritable risk was over-estimated in 1990**  
Particularly for multifactorial diseases
- **Nominal probability coeff/s: 2 generations only**  
Based on UNSCEAR 2001, agrees with BEIR VII  
1990 calculation to equilibrium – assumptions not sustainable  
Risk after 2 generations small, no substantial difference –10 generations  
Thus, no significant underestimation of genetic risk
- **Genomic instability, bystander effects, adaptive response, non-cancer disease: uncertainties**  
Non-LNT? But epidemiology includes total effect  
Insufficient knowledge for protection purposes

## Nominal Probability Coefficients (% Sv<sup>-1</sup>)

For practical protection purposes, 2007  
the overall risk coefficient of ~5% is still appropriate

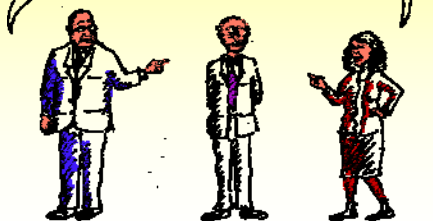
Exposed population	Cancer		Heritable effects		Total
Whole	6.0	5.5	1.3	0.2	7.3
Adult	4.8	4.1	0.8	0.1	5.6

## A Reminder:

$$1 = 2$$

## Does ICRP Over- Or Underestimate Risk?

B...y extremist!!



## Chapter 4: Physical quantities

## Radiation Weighting Factors, $w_R$

Type and energy range	Publication 60	2007
Photons, all energies	1	1
Electrons and muons, all energies	1	1
Protons	5	2
Alpha particles, fission fragments, heavy nuclei	20	20
Neutrons	Stepwise function	Continuous function

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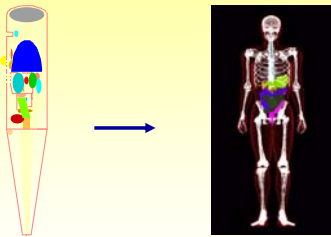
## Tissue Weighting Factors, $w_T$

Tissue	$w_T$	$\sum w_T$
Bone-marrow, <b>breast</b> , colon, lung, stomach, remainder tissues (13/14)	0.12	0.72
<b>Gonads</b>	0.08	0.08
Bladder, oesophagus, liver, thyroid	0.04	0.16
Bone surface, <b>brain</b> , <b>salivary glands</b> , skin	0.01	0.04

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## New Reference Phantoms

MIRD Phantom      Voxel Male and Female Phantoms



New dose coefficients in 2008 😊

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## The Use of Effective Dose (E)

- For compliance and prospective planning
- *Not for detailed retrospective dose and risk assessments after exposure of individuals*  
*particularly not for patients (old, unhealthy population)*
- *Not for epidemiological studies (at least not for risk assessment)*

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## The Use of Collective Dose (S)

- For optimisation
- For comparing technologies and protection options
- *Not for epidemiologic risk assessment*  
*Inappropriate to use it in risk projections based on epidemiology*
- *Not for predicting number of cancer deaths due to trivial exposures to large populations*  
*An unreasonable, unintended, incorrect use of collective dose*

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## Collective Dose: Logical, But Is It Right?

Equates many small doses to few large doses...

Are 500 road traffic casualties just as bad as 500 plane crash victims?



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## Chapter 5: System of protection, man

### In 1990, a Process-Based Approach

<p><b>Practice</b> <i>increases exposure or risk</i></p>	<p><b>Intervention</b> <i>reduces exposure</i></p>
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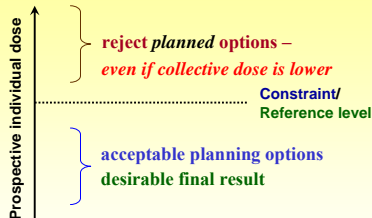
### In 1990, a Process-Based Approach

<p><b>Practice</b> <i>increases exposure or risk</i></p> <p>———— Dose limit</p> <p>----- Dose constraint</p> <p style="text-align: center;">↓</p> <p style="text-align: center;">Protection optimised</p>	<p><b>Intervention</b> <i>reduces exposure</i></p>
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### 2007, Exposure Situation: Planned / Emergency / Existing



Inappropriate to plan to allow higher exposures

### The Collective Dose in Optimisation

- Useful, but we usually also need to know
  - average dose, number exposed, range, etc
  - ...
- Perhaps give more weight to
  - a few large doses than to many small doses
  - doses now than to doses in the far future

## Dose Limits for Planned Exposure Situations

- They remain the same as in 1990!

PUBLIC	OCCUPATIONAL
1 mSv in a year	20 mSv per year, averaged over defined 5-year periods
In special circumstances, an average of 1 mSv per year averaged over defined 5-year periods	100 mSv in 5 years, and less than 50 mSv in one year

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## Chapter 6: Implementation

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## How to Set Constraints

- **Bands of constraints**  
 *$\leq 1$  mSv,  $>1 - 20$ ,  $>20 - 100$*
- **Occupational exposure**  
*Constraint usually set by operator*
- **Public exposure**  
*Constraints usually set by regulator*  
*About 0.3 mSv in a year appropriate*  
*0.1 mSv in a year if prolonged exposure*

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## Regulatory Philosophy



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## Chapter 7: Medical exposure of patients

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## Special Features of the System of Protection

- **Justification in medicine**  
*Benefit and risk apply to the same person (patient)*
- **Optimisation in medicine**  
*Diagnostic Reference Levels, not constraints*  
*Radiation therapy, maximise PTV but minimise other dose*
- **Dose limits**  
*Do not apply to patients*

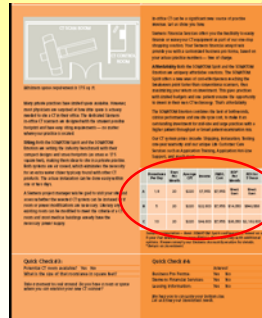
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## Justification or Indiscriminate Referral



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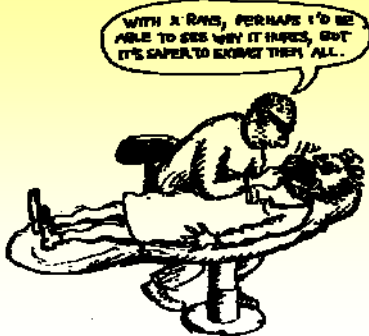
## 'Buy Our CT, Earn \$ 2,163,000 in 5 Years'



Procedures Per Day	Days Per Month	Average CPT	Income	FMVL Cost	ROI* Per Month	ROI for 5 Years	
A	1.8	20	\$220	\$7,950	Break Even	Break Even	
B	5	20	\$220	\$22,000	\$7,950	\$14,050	\$843,000
C	10	20	\$220	\$44,000	\$7,950	\$36,050	\$2,163,000

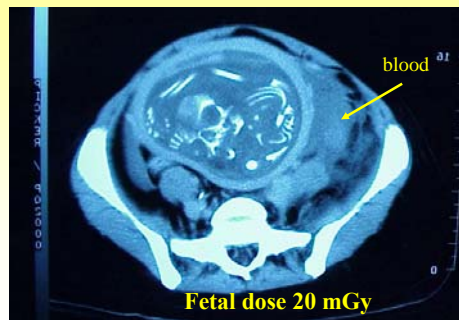
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## Is It Justified?



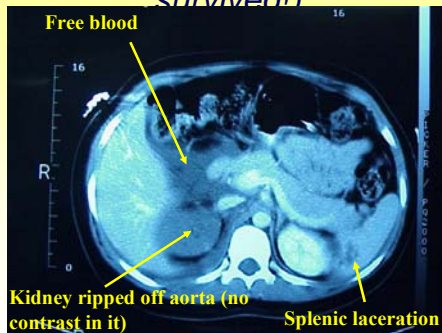
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## Justification in Medicine...



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## ...3 Min. Exam, Then OR (both survived!)



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## Some Medical Is Justified –



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## Chapter 8: Protection of the environment

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## Why Protect Other Species?



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## Why Protect Other Species?

- **NOT** driven by concerns of existing radiation hazards
- Fills a conceptual gap  
*Science to show if the environment is adequately protected  
- and methods to improve protection if required*
- Further guidance will be provided

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## Now, What Was the Take-Home Message...?

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## To Summarise, ICRP is...

- Retaining the fundamental principles of protection
- Clarifying how they apply to sources and the individual
- Changing focus from process (*practice/intervention*) to exposure situation (*planned/emergency/ existing*)
- Extending the concept of source-related constraints to all situations
- Updating weighting factors and detriment
- Maintaining the current dose limits

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## 2007 Recommendations



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