

The 2007 Recommendations of ICRP

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

About ICRP

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.**

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*



INTERNATIONAL COMMISSION ON RADIOLOGICAL PROTECTION

The 2007 Recommendations of ICRP

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 lessons; inclusion of natural exposures**
Coherent, consistent implementation of ICRP Publication 60?
- **Protection of the environment**
Scientific proof of adequate protection?



ICRP 1990 Rec's: Logical But Complex



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 (9 years gestation!)**
- **Maintain as much stability as is consistent with the new information**

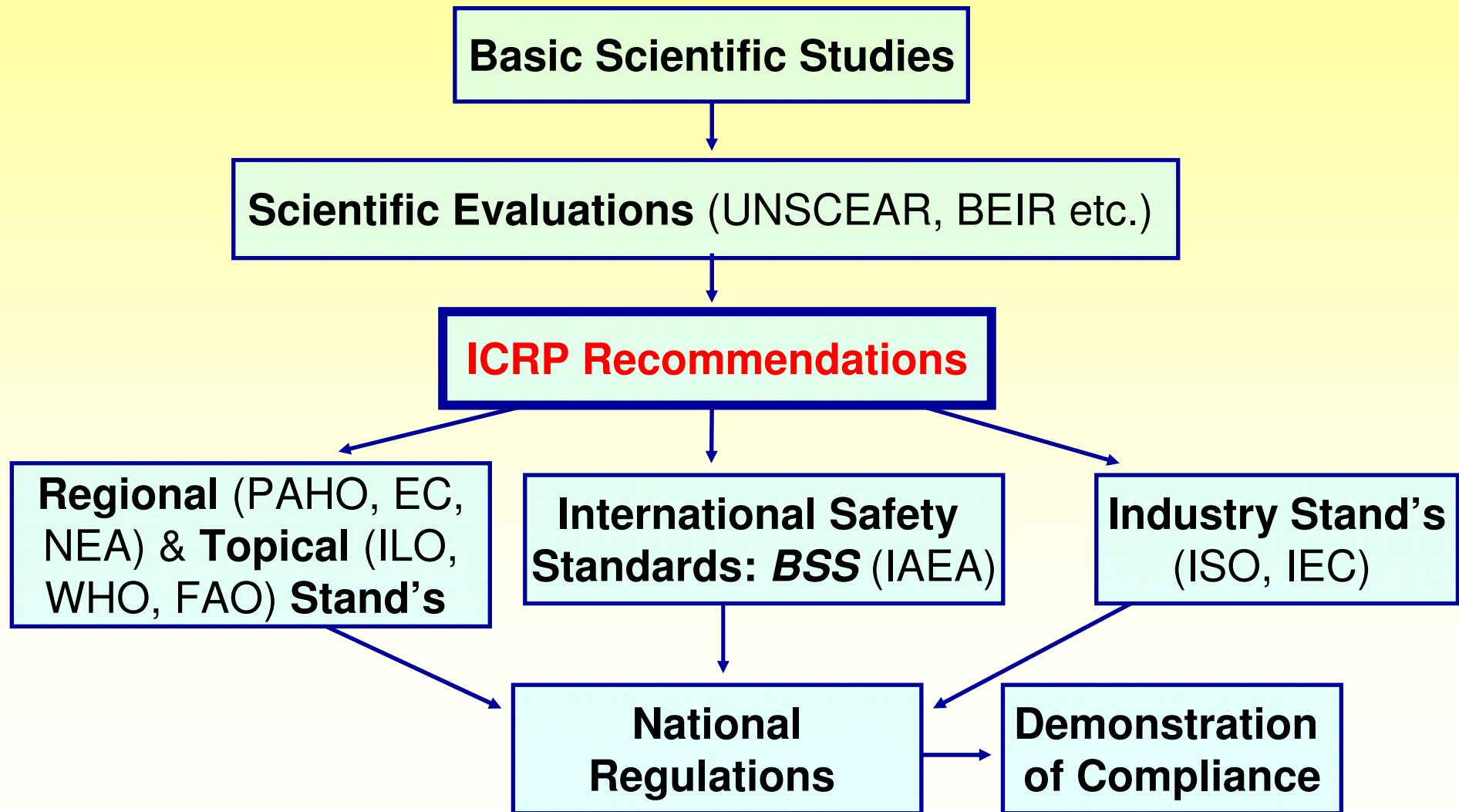
To Get the Recommendations...

- **Buy printed or electronic copies**
IRPA Associated Societies are eligible for a discount
- **Developing countries: free download at HINARI**
- **Junior staff: coming summary in JRP**
- **For all of this, see www.icrp.org**
- **Or translate them (an Italian version is ready!)**

Chapter 1:

History, development, structure

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***

- **Application of dose limits**
Except medical exposure of patients

ICRP Value Judgements - Constraints & Equity

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

ICRP Value Judgements - Constraints & Equity

Utilitarian ethics <i>Judge actions by the consequences</i>	Deontological ethics <i>Some duties are imperative</i>
<i>Justification</i> <i>Do more good than harm</i>	<i>Limitation</i> <i>No individual unduly harmed</i>
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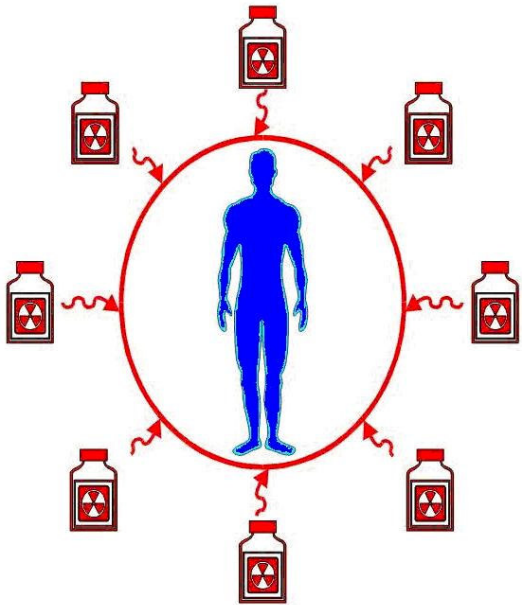
ICRP Value Judgements - Constraints & Equity

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<i>Optimisation</i> <i>Maximise good > harm</i>	<i>Dose constraints</i> <i>Increased equity = emphasise the individual</i>

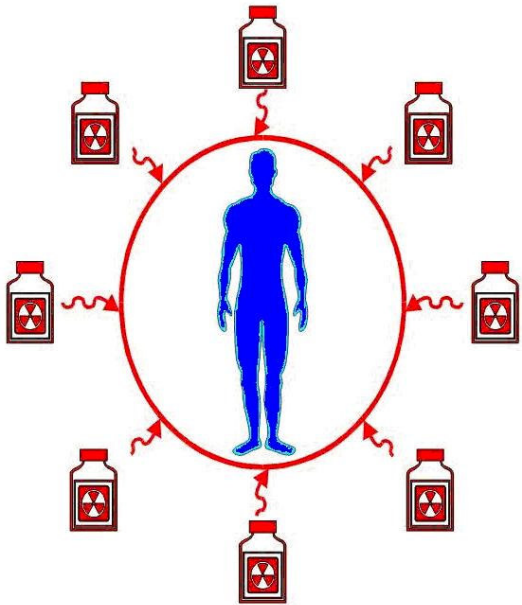
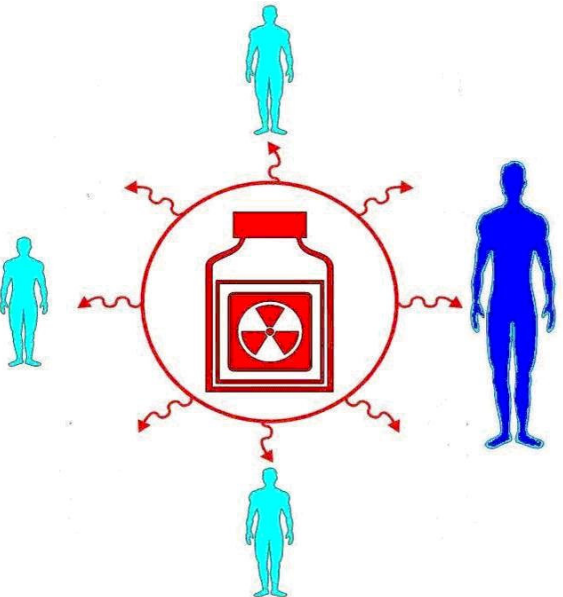
ICRP Value Judgements - Constraints & Equity



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	
 A diagram illustrating multiple sources of radiation exposure. A central blue silhouette of a human figure is enclosed within a red circle. Surrounding this central figure are eight red rectangular boxes, each containing a white radiation warning symbol (a black trefoil on a white background). Red wavy arrows point from each of these boxes towards the central human figure, representing the path of radiation exposure from multiple sources.	

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

Deterministic and Stochastic Effects

These words will still be the default terms!

- **Deterministic**

Harmful, mostly late, tissue reactions

- **Stochastic**

Cancer and heritable disease

Cancer probability now based on incidence, not mortality

LNT: Scientifically plausible but not unambiguous (cf. Central Limit Theorem, i.e., valid at the population level)

Heritable Disease

- **Induced mutation rates: based on mouse studies**
Induced genetic effects not demonstrable in man!
Human spontaneous mutation rates used to estimate Doubling Dose
- **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 2 – 10 generations
Thus, no significant underestimation of genetic risk

Epigenetic Responses to Radiation

- **Genomic instability: Damage expressed after several cell generations**

Why and how does it happen?

Does it really affect normal cells?

If it does, does it change the total risk assessed epidemiologically?

- **Bystander signalling: Damage to non-irradiated cells in an irradiated cell population**

Why and how does it happen?

Does it change the total risk assessed epidemiologically?

- **Important for understanding - currently no way to assess effect on risk – major effect unlikely**

Adaptive Response to Radiation

- **A priming dose sometimes confers increased resistance against a second dose**

Not a universal feature

Considerable variation, usually transient

Mechanistic knowledge fragmentary

Not evident at 'protection' doses

No consistent evidence of reduction of adverse health effects

- **Thus, scientifically important but at present not relevant for radiological protection**

Females and Males

- **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**

Precludes discrimination



Nominal Probability Coefficients (% Sv⁻¹)

Exposed population	Cancer		Heritable effects		Total
	Publ 60	2007	Publ 60	2007	Publ 60
Whole	6.0	5.5	1.3	0.2	7.3
Adult	4.8	4.1	0.8	0.1	5.6

For practical protection purposes, 2007

the overall risk coefficient of ~5%
is still appropriate

5.7

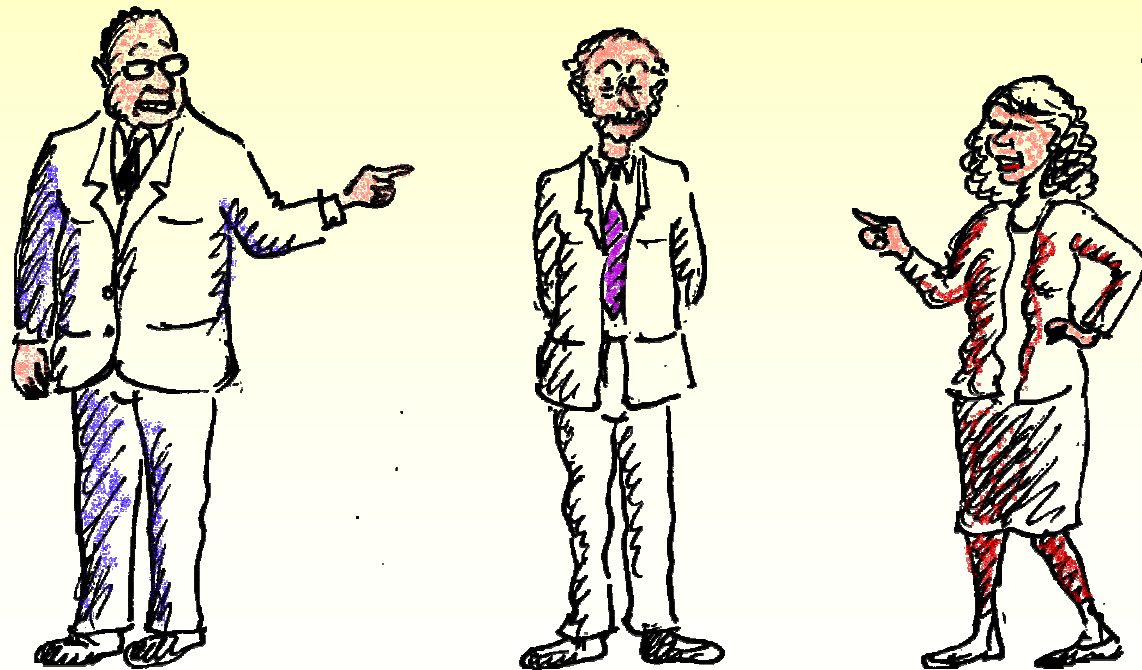
4.2

A Reminder:

$$1 = 2$$

*Does ICRP Over- Or **Under**estimate Risk?*

B....y extremist!!



Chapter 4:

Physical quantities

Radiation Weighting Factors, w_R

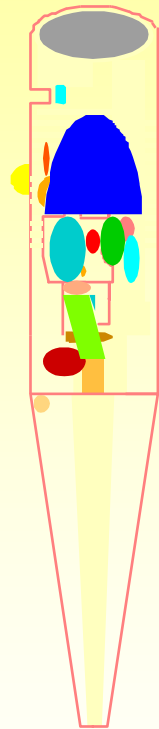
Type and energy range	Publication 60	2007
Photons, all energies	1	1
Electrons and muons, all energies	1	1
Protons	5	2
Alpha particles, fission fragments, heavy nuclei	20	20
Neutrons	Stepwise function	Continuous function <10 keV, 2.5

Tissue Weighting Factors, w_T

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

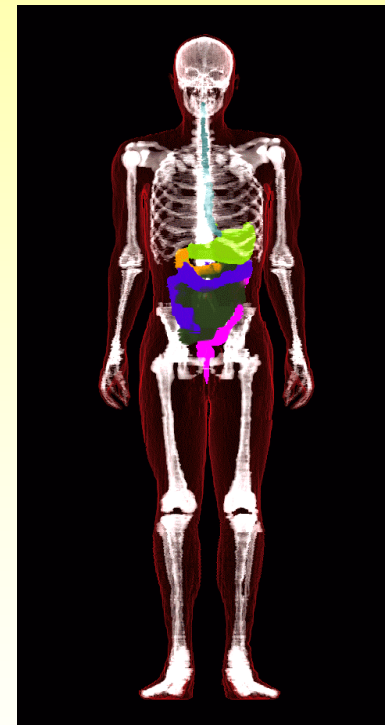
New Reference Phantoms

MIRD Phantom



Voxel Male and Female Phantoms

Fetus; child: in preparation



New dose coefficients in 2008 ☺

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)**

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

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?**



Chapter 5:

System of protection, man

In 1990, a Process-Based Approach

Practice

increases exposure or risk

Intervention

reduces exposure or risk

In 1990, a Process-Based Approach

Practice

increases exposure or risk

———— Dose limit

- - - - - Dose constraint



Protection
optimised

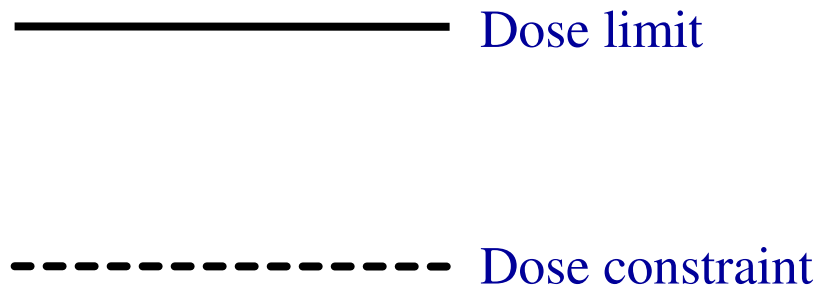
Intervention

reduces exposure or risk

In 1990, a Process-Based Approach

Practice

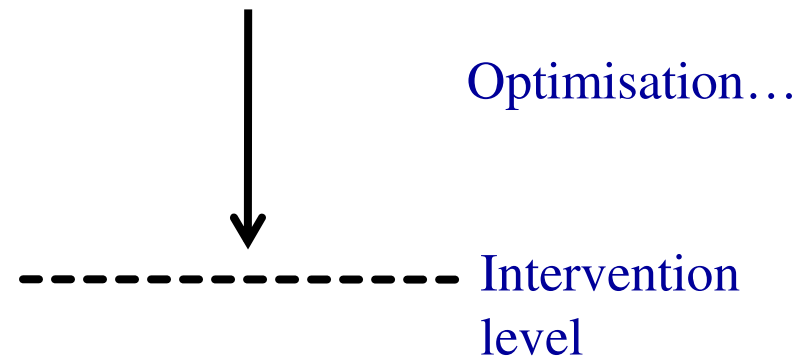
increases exposure or risk



↓
Protection
optimised

Intervention

reduces exposure or risk



...but what happens here?

2007, Exposure Situation: Planned / Emergency / Existing



Inappropriate to *plan to allow* higher exposures

How to Select Constraints / Reference Levels

- **100 – 20 mSv**

Direct benefit. Information, training, dose monitoring.

Example: Radiological emergencies

- **20 – 1 mSv**

Direct or indirect benefit. Information, training, dose monitoring or assessment.

Examples: Occupational exposures in planned situations, radon in dwellings

- **Less than 1 mSv**

Societal benefit. Dose assessment.

Example: Public exposures in planned situations

The Collective Dose in Optimisation

- **A key parameter (at least in occupational protection), 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

Chapter 6: Implementation

Planned Exposure Situations

- **Occupational exposure**

Constraint usually set by operator

(small operators may need guidance)

Transient/itinerant workers need special attention

- **Public exposure**

Constraints usually set by regulator

About 0.3 mSv in a year appropriate

0.1 mSv in a year if prolonged exposure

Potential Exposures

- Workplace accidents

Number of people affected is small

Detriment = health risk to those directly exposed

- Large disasters

Number of people affected can be large

Detriment also includes contaminated land, food restrictions, etc

- Exposures in the far future, e.g. from waste repositories

Considerable uncertainties

Dose calculations useful to compare protection options but not to project detriment



Assessment of Potential Exposures

- **Everybody is responsible for safety, incl. security**
Particularly important to remember outside the nuclear fuel cycle
- **Risk constraints: guide optimisation of protection**
 - **against risk (probability of death) =**
 *$\text{Prob (accident)} * \text{Prob (death | accident dose)}$*
- **ICRP continues to recommend established generic constraints:**
 - *Potential exposure of workers: $2 \cdot 10^{-4}$ per year*
 - *Potential exposure of the public: $1 \cdot 10^{-5}$ per year*

Existing Exposure Situations: Radon

- **Upper level of dose: 10 mSv (radon/progeny equilibrium)**

Upper level of activity conc. retained for continuity

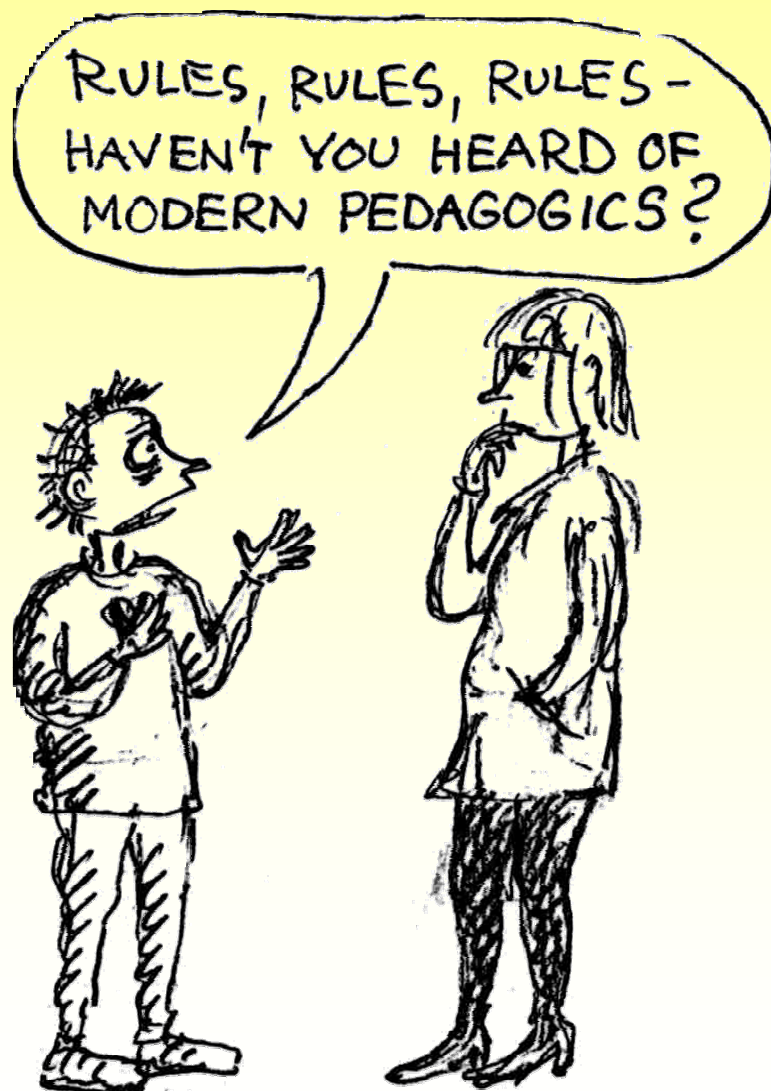
National regulators can [should] set lower constraints

‘There is now evidence for what we thought all the time’

No real difference UNSCEAR-ICRP; an ICRP TG statement in preparation

Situation	Reference level
Domestic dwellings	600 Bq m ⁻³
Workplaces	1500 Bq m ⁻³

Regulatory Philosophy



Chapter 7:

Medical exposure of patients

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

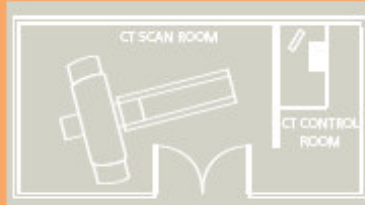
- **Dose limits**

Do not apply to patients

Justification or Indiscriminate Referral



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



Minimum space requirement is 77.5 sq. ft.

Many private practices have limited space available. However, most physicians are surprised at how little space is actually needed to site a CT in their office. The dedicated Siemens in-office CT scanners are designed with the smallest possible footprint and have easy siting requirements—no matter where your practice is located.

Siting Both the SOMATOM Spirit and the SOMATOM Emotion are setting the industry benchmark with their compact designs and small footprints (as small as 17.5 square feet), making them ideal to site in a private practice. Both systems are air cooled, which eliminates the necessity for an extra water chiller typically found with other CT products. The actual installation can be done easily within one or two days.

A Siemens project manager will be glad to visit your site and assess whether the selected CT system can be installed. No room or power modifications are necessary. Literally any existing room can be modified to meet the criteria of a CT room and most medical buildings already have the necessary power supply.

Quick Check #3:

Potential CT room available? Yes No
What is the size of that room/area in square feet?

Take a moment to look around. Do you have a room or space where you can envision your new CT scanner?

In-office CT can be a significant new source of practice revenue. Let us show you how.

Siemens Financial Services offers you the flexibility to easily finance or lease your CT equipment as part of our one-stop shopping solution. Your Siemens financial analyst will provide you with a customized business pro forma, based on your actual practice numbers—free of charge.

Affordability Both the SOMATOM Spirit and the SOMATOM Emotion are uniquely affordable solutions. The SOMATOM Spirit offers a new level of cost-effectiveness in achieving the break-even point faster than conventional scanners, thus maximizing your return on investment. This gives practices with limited budgets and low patient volume the opportunity to invest in their own CT technology. That's affordability.

The SOMATOM Emotion combines the best of both worlds, clinical performance and low life cycle cost, to make it an outstanding investment for mid-size and large practices with a higher patient throughput or broad patient examination mix.

Our CT system prices include: Shipping, Installation, Testing, one-year warranty and our unique Life Customer Care Services such as Application Training, Application Hot-Line Support, and much more.

	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	\$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

Source: computation - Base SOMATOM Spirit configuration, based on a 5-year Pay Model, Finance Lease (PML), 3% interest rate, with additional options. Please consult your Siemens Account Executive for details.
*Return on investment.

Quick Check #4:

Business Pro Forma: Interest
Siemens Financial Services: Yes No
Leasing Information: Yes No

We help you to calculate your bottom line. Let us know your investment needs.

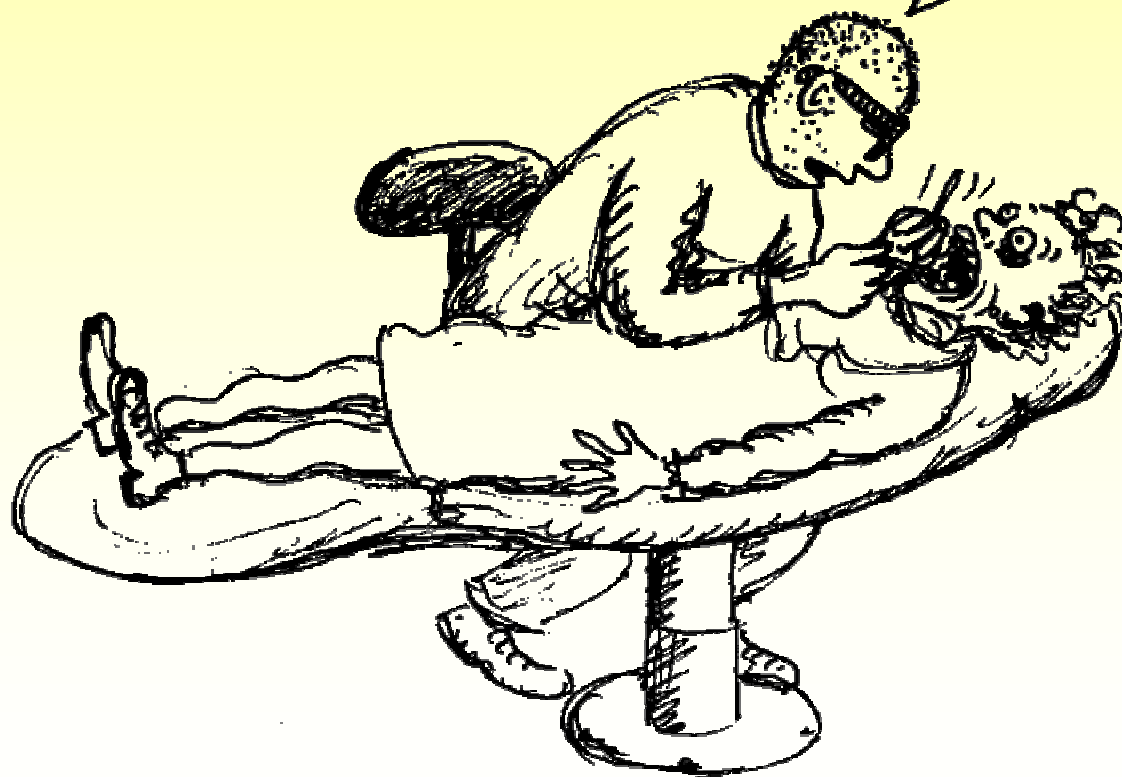
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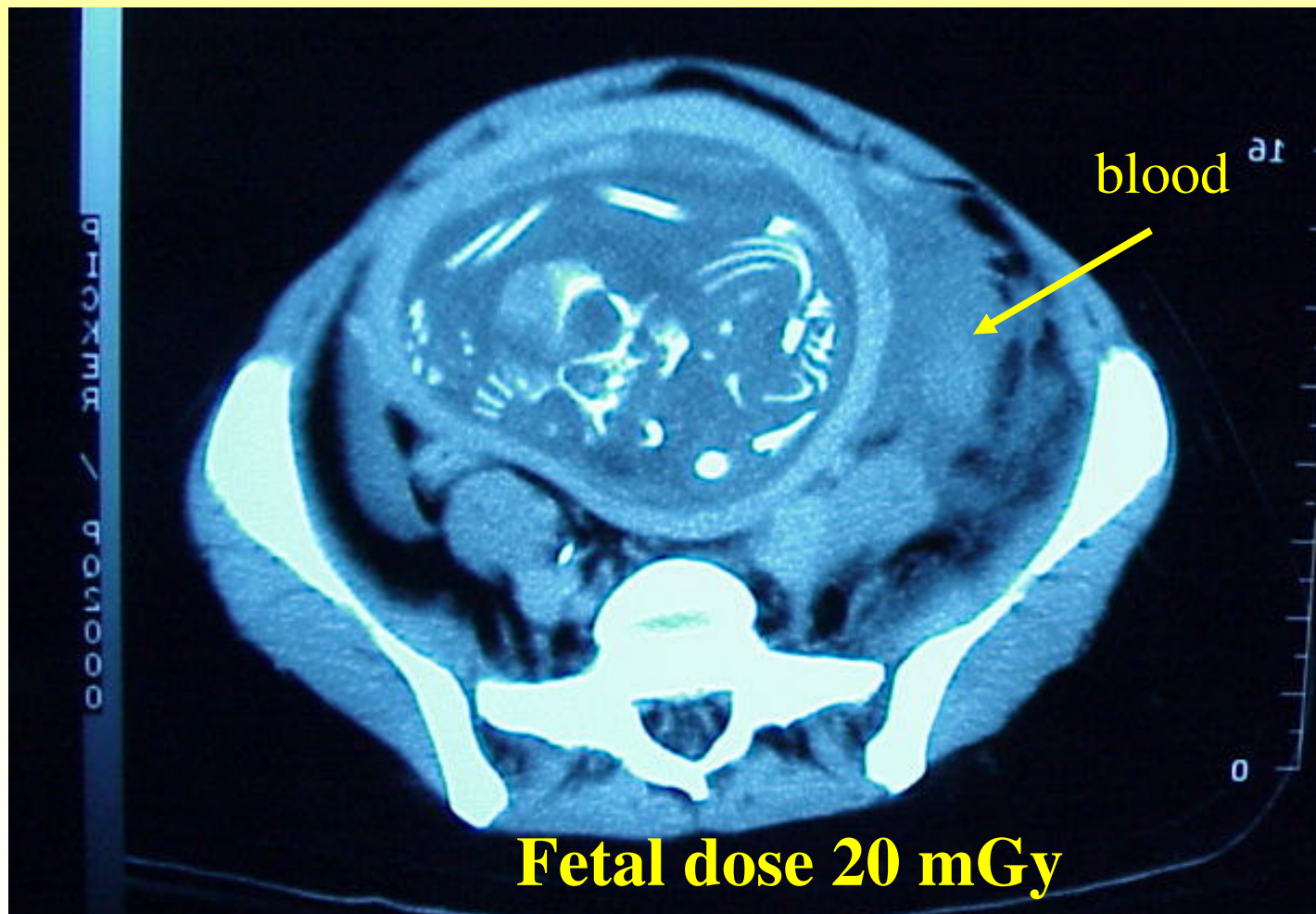
INTERNATIONAL COMMISSION ON RADIOLOGICAL PROTECTION

Is It Justified?

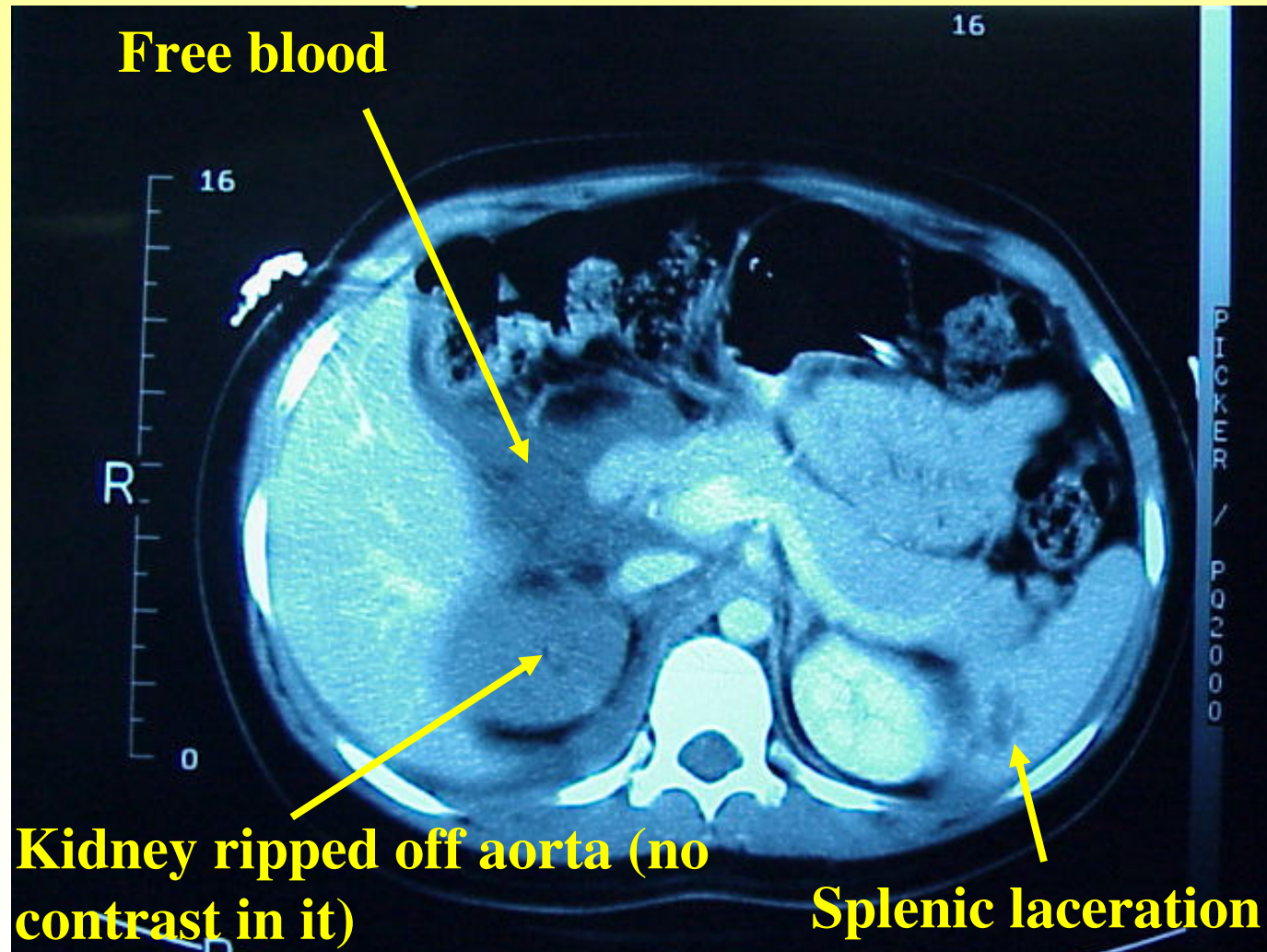
WITH X RAYS, PERHAPS I'D BE
ABLE TO SEE WHY IT HURTS, BUT
IT'S SAFER TO EXTRACT THEM ALL.



Justification in Medicine...



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



Some Medical Is Justified – But...



Chapter 8:

Protection of the environment

Why Protect Other Species?



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**

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**

2007 Recommendations

