The Current And Coming Recommendations From ICRP

Dr Jack Valentin - **Scientific Secretary, ICRP**

- **International Commission on Radiological Protection**
  - *ICRP: Who, why, what?*
- **Sources, doses, dose response**
  - *Linear, no threshold – the best current approximation*
- **ICRP 60**
  - *Justification – optimisation – limits*
  - *Emphasis shifting from society to individual*
- **The next, 2005, Recommendations**
  - *Justification (political) – limits & constraints – optimisation*
  - *Include non-human species*

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.

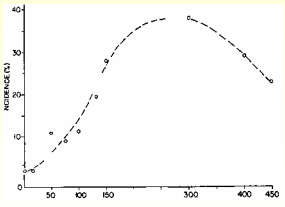
Primary Aim of Our Recommendations

To provide an appropriate standard of protection for man

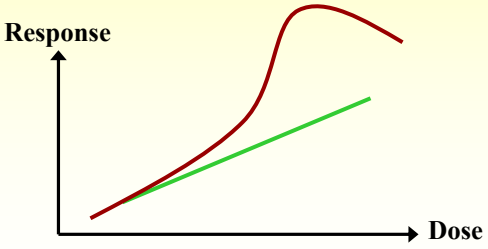
without unduly limiting the beneficial practices giving rise to radiation exposure

Risks: The Basic Assumptions

- **High doses ➔ deterministic harm due to cell killing**
- **Stochastic late harm: cancer, hereditary, other - LNT?**



Mouse leukaemia (Upton 1961)



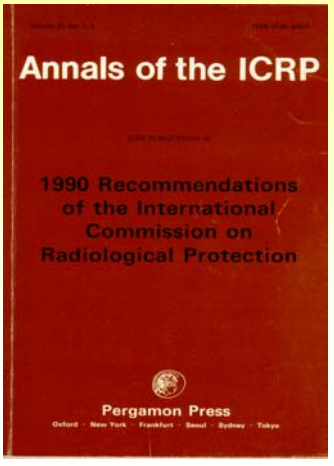
The ICRP Publication 26 System

- **Prevent deterministic, minimise stochastic harm**
- **Justification *by Cost-Effectiveness Analysis***
  More good than harm to society
- **OPTIMISATION *by Cost-Benefit Analysis***
  ALARA; maximise net collective benefit
- **Dose limits**

'How much does it cost; how many lives are saved?'

The ICRP Publication 60 System

- **Prevent deterministic, minimise stochastic harm**
- **Justification**
- **Optimisation: *CBA & other means***
  'Constrained by restrictions on the doses to individuals (Dose Constraints) … so as to limit the inequity likely to result from the inherent economic and social judgements'
- **Dose and risk limits**



Ethical Basis for the ICRP System

Utilitarian ethics *Judge actions by the consequences*	**Deontological ethics** *Some duties are imperative*
Justification *Do more good than harm*	
Optimisation *Maximise good > harm*	
	Limitation *No individual unduly harmed*

Published Recommendations Since 1990

Publ. no.	Title
62	…protection in biomedical research
63	…protection of the public in a radiological emergency
64	…potential exposure: a conceptual framework
65	Protection against Radon-222…
68	Dose coefficients for … workers
75	General principles for radiation protection of workers
76	…potential exposure: …selected radiation sources
77	…policy for the disposal of radioactive waste
81	…disposal of long-lived solid radioactive waste
82	Protection of the public in … prolonged radiation exposure

Dose Levels, Limits, Constraints..

Almost 30 different numerical values, based on

- *Individual annual fatal risk*
- *Multiples/fractions/maximum values of natural background*
- *Formal differential cost-benefit analysis*

Spanning 5 orders of magnitude…

New Basic Recommendations Ahead

- **Revision every ~15 years**
  Due again ~2005
- **Repeat or develop?**
  Logical but overwhelming
  Public dose limit not helpful
  Collective dose often misused
- **Rec's at the beginning of the 21st century**
  Utilitarian → egalitarian
  Anthropocentric → holistic
  Constraints
  Stakeholder optimisation

Dose Limit for the Public

- Sum of contribution from many sources
- Can only be regulated at source
- Does not include the dominant natural background
- Does not apply to interventions
- Does not apply in emergencies

…So, ICRP 60 (1990) Is Still Good, But Will Be Updated In 2005:

- 'Something' is due in 2005
- Biological assumptions need updating
  (relatively minor)
- Unnecessarily complicated; confusing terminology
- Shifting values: emphasising individual over society
- The dose limit for the public is unhelpful
- Focusing on man alone is insufficient
- Existing recommendations need to be consolidated…
- And can surely be simplified from almost 30 values!

Components of The 2005 System : The Basic Recommendations..

Features, draft 2005 Recommendations

- **Quantities in radiological protection**
- **Biological aspects**
- **General system of protection**
- **'Quantitative recommendations'** *(limits, constraints)*
- **Optimisation of protection**
- **Exclusion from the system**
- **Medical exposures**
- **Potential exposures**
- **Radiological protection of the environment**

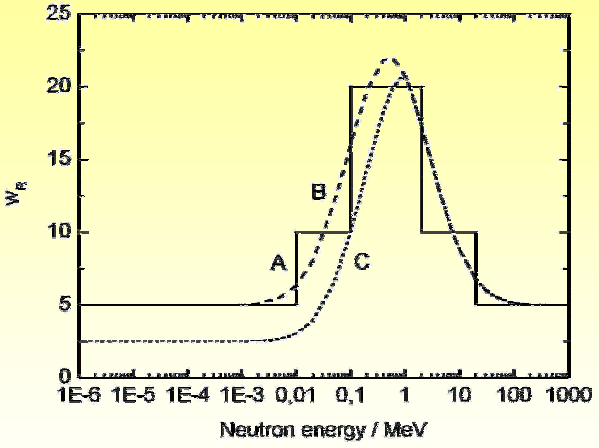
Effective Dose

$$E = \sum_T w_T \sum_R w_R \, D_{T,R}$$

Major changes:

- **New values of w_R are proposed:**
  - *-for protons, reduced from 5 to 2*
  - *-for neutrons < 1 MeV, reduced to ~ ½, continuous curve recommended*
- **New values of w_T are proposed:**
  - *-for gonads, risk is reduced to ~ ¼* (UNSCEAR 2001)

New w_R for Neutrons



A-ICRP 60 histogram

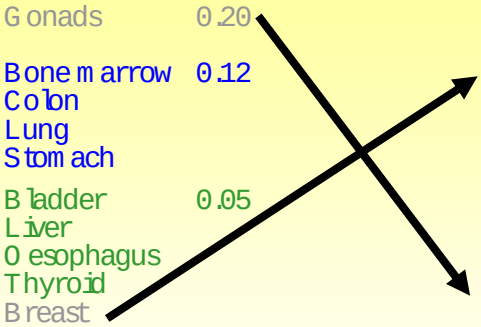
B-ICRP 60 function

C- 2005 Proposed function

$w_R = 2.5 + 18.2 \exp[-(\ln E_n)^2/6]$ ..... for $E_n < 1$ MeV

$= 5.0 + 15.0 \exp[-(\ln 2 E_n)2/6]$ ..... for $E_n > 1$ MeV

Values of w_T



1990		2005	
Gonads	0.20		
		Bone marrow	0.12
Bone marrow	0.12	Breast	
Colon		Colon	
Lung		Lung	
Stomach		Stomach	
Bladder	0.05	Bladder	0.05
Liver		Liver	
Oesophagus		Oesophagus	
Thyroid		Thyroid	
Breast		Gonads	
Skin	0.01	Skin	0.01
Bone surface		Bone surface	
		Brain	
		Kidney	
		Salivary glands	
Remainder	0.05	Remainder	0.1

Biological Aspects

Induction of tissue reactions

RBE-weighted absorbed dose (Gy-Eq?)

Cancer

Mechanisms

Epidemiology

Hereditary effects

Embryo and fetus

Genetic susceptibility

Non-cancer diseases

Detriment Coefficients (% Sv^{-1})

Exposed population	Lethality adjusted cancer risk	Lethality adjusted heritable effects	Detriment 2005	Detriment Pub.60
Whole population	6.2	0.2	6.5	7.3
Adult workers	4.8	0.1	4.9	5.6

The 2005 System of Protection

JUSTIFICATION

QUANTITATIVE RECOMMENDATIONS

OPTIMISATION

Justification

- **Recognise *distribution of responsibilities***
  ***Justification, primarily at the political level* (can be delegated)**
- **Radiological considerations are but one input**
  Important, but rarely overriding
- **Recommendations apply to practices once these are *declared justified***
- **Medical radiation requires separate treatment**
  Justify: Radiation – Procedure – Application to this patient

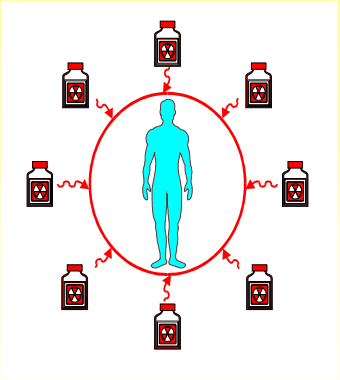
The 2005 System of Protection

JUSTIFICATION

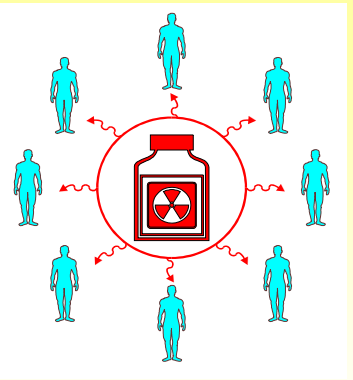
QUANTITATIVE RECOMMENDATIONS

OPTIMISATION

Individual- and Source-Related



INDIVIDUALS are protected from ALL regulated sources by the DOSE LIMITS



INDIVIDUALS are protected from a SINGLE source by the DOSE CONSTRAINT

The 2005 System of Protection

JUSTIFICATION

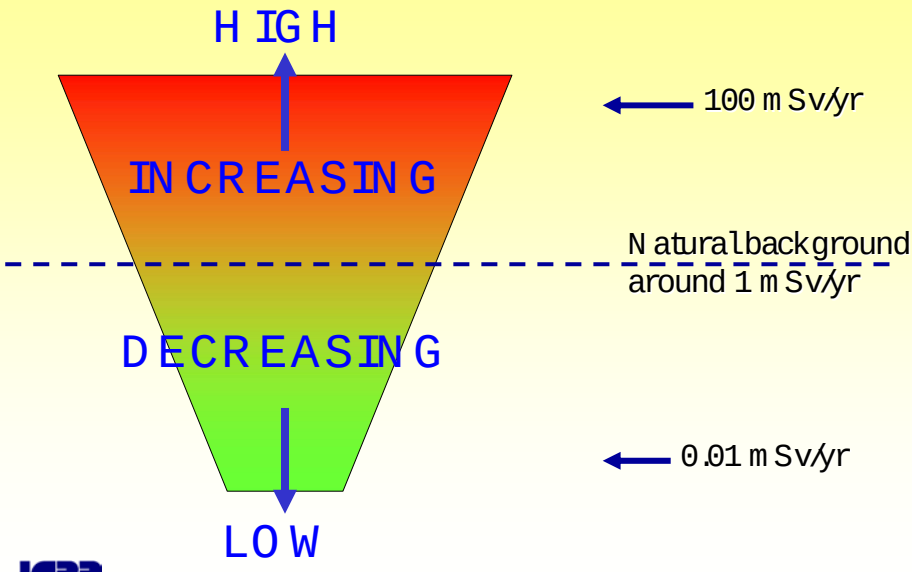
QUANTITATIVE RECOMMENDATIONS

CONSTRAINTS ON SOURCES

Restrictions for the most exposed individuals
-set by ICRP, and by International/National Agencies

OPTIMISATION

ICRP: Need For Action



Maximum Constraints

Effective Dose in a year (mSv)

100	• Emergencies: work; evacuation; relocation • *High* levels of existing controllable exposures • Information, training, monitoring • No individual/societal benefit above this constraint
20	• Emergencies: Sheltering; stable iodine • Normal: Occupational exposure • Existing controllable exposures, e.g. radon • Comforters and carers to patients • Information, training, monitoring or assessment • Direct or indirect benefit to the individual
1	• Normal situations • No information or training, no individual dose assessment • Societal, but no individual direct benefit
0.01	• Minimum value of any constraint

The 2005 System of Protection

JUSTIFICATION

QUANTITATIVE RECOMMENDATIONS

INDIVIDUAL LIMITS

Already exist in Basic Safety Standards
No individual is exposed to unacceptable regulated risk in *normal* situations

OPTIMISATION

ICRP Yardstick for Gauging Limits

- **1928 – 1966: Magnitude of risk(s) unknown**
  Hence choice of limits rather arbitrary
- **1977: Comparison with 'safe' industries**
  'Average' worker – average risk
  Highest exposure – maximum risk
  Public: Divide by 10, factor in 'accepted' road traffic fatalities
- **1990: Workers – multiattribute risk, public –normal variations in natural background**
  Not safe (!!), not welcome, but hardly unacceptable
- **2005/6: Natural background the primary yardstick**

Dose Limits For Practices

PUBLIC	WORKERS
1 mSv in a year	20 mSv per y averaged over 5 y
- exceptionally, 1mSv/yr averaged over 5 years	-100 mSv in 5 years and less than 50 mSv in one year

Organ or tissue	Radiation weighted dose (mSv/yr)	
	Occupational	Public
Lens of the eye	150	15
The skin	500	50
Hands and feet	500	-

The 2005 System of Protection

JUSTIFICATION

QUANTITATIVE RECOMMENDATIONS

OPTIMISATION

A duty: reduce doses to achieve a higher level of protection

-the responsibility of operators and national authorities

AT THE HEART OF SUCCESSFUL PROTECTION

The Protection of Groups

- **Collective Dose:**
  - *the product of mean dose and number exposed*
  - *a legitimate quantity*
  - *but aggregates information excessively*
  - *and therefore, is of limited utility*
- **For making decisions, information should be presented in a matrix**

The Matrix…

- ***Mininmum* information for workers:**
- **Number exposed**
- **Average dose**
- **Dose range?**
- **Task-related dose?**
- **Etc**

Potential Exposures

DOSE CONSTRAINT → RISK CONSTRAINT

'Risk' =
Prob. of receiving dose * Prob. of detriment given that dose
Risk Constraint restricts 'Risk' = prob. of attributable death

Effective Dose > 100 mSv: non-stochastic reactions possible
➔ Conditional prob. of detriment, given dose = 1

'Hot Particles' = Potential Exposures; Risk Constraint applies

Major accidents – more complicated!

YOU are responsible for safety – and outside the nuclear fuel cycle, nobody is there to help you!

Protection of Non-Human Species

- **This is *NOT* driven by concerns of existing radiation hazards**
- **It fills a conceptual gap**
  We need to DEMONSTRATE that the environment is adequately protected
- **Several countries are already implementing environmental radiation standards**

Protection of Non-Human Species

- **A practical, simple policy**
- **Agreed quantities and units**
- **Dose models for reference fauna and flora**
- **Basic knowledge of radiation effects**
- **A means to demonstrate compliance**

Components of The 2005 System : ... And Foundation Documents

Schedule

- 1999 – 2003: Conceptual discussion
- May 2004: Proposal launched at IRPA 11, Madrid
  …and many other fora
- June 2004: Text released for consultation, 6 months
- Mid- 2005: Earliest possible date of ICRP adoption
- 2006: Likely date of printing, 'P100' and 'Foundation documents'
- 2008: 'Son of P30' completed
- 2009: Likely first instances of legal implementation

In Summary...

- New basic ICRP recommendations coming
- Simpler presentation, more egalitarian
- LNT-based, but using matrix rather than collective dose
- Holistic, not anthropocentric
- Justification: primarily societal
- Constraints and limits for basic protection
- Source-related optimisation with stakeholder involvement, a further duty