CHAPTER 4

DOSE LIMITS AND RISK

ICRP

formed in 1928

reorganised and called ICRP in 1950

13 scientists from all over the world on main commission

four committees with specialist scientists

special working groups as required

UNSCEAR

established in 1955

70 - 100 scientists from more than 20 countries

meets annually in Vienna

publishes large scientific review about every 5 years

BEIR

funded by US EPA

17 scientists from universities, hospitals, national labs in the USA

UNSCEAR and BEIR are concerned only with effects; only ICRP makes recommendations

The aim of radiation protection is to prevent detrimental non-stochastic effects and to limit the probability of stochastic effects to levels believed to be acceptable.

STOCHASTIC effects are those for which the probability of an effect occurring, rather than its severity, is regarded as a function of dose, without threshold.

NON-STOCHASTIC effects are those for which the severity of the effect varies with the dose, and for which a threshold may therefore occur.

The main features of the ICRP recommendations are the following:

(a) **No practice shall be adopted unless its introduction produces a positive net benefit.**

(b) **All exposures shall be kept as low as reasonably achievable, economic and social factors being taken into account.**

(c) **The dose to individuals shall not exceed the limits recommended for appropriate circumstances by the Commission.**

LIMITS FOR ATOMIC RADIATION WORKERS

The dose limits apply only to dose received on the job; they do not apply to medical exposure or exposure to background radiation.

LIMITS FOR STOCHASTIC EFFECTS

The whole-body dose limit given in ICRP 26 was 50 mSv a year. This limit has been reduced in ICRP 60, which reads as follows:

> ***"...results indicate that a regular annual dose of 50 mSv, corresponding to a lifetime dose of 2.4 Sv, is probably too high, and would be regarded by many as clearly so."***
>
> ***"...the ICRP has reached the judgement that its dose limit should be set in such a way that the total dose received in a working life would be prevented from exceeding about 1 Sv received moderately uniformly year by year...and that this figure would only rarely be approached."***
>
> ***"...The ICRP recommends a limit on whole-body dose of 20 mSv per year, averaged over 5 years (i.e., 100 mSv in 5 years) with the further provision that the dose should not exceed 50 mSv in any single year."***

External and internal whole-body doses must be added; the total dose must not exceed the limits given above.

TISSUE WEIGHTING FACTORS

Tissue or Organ	Weighting Factor, w_T
Gonads	0.20
Red Bone Marrow	0.12
Colon	0.12
Lung	0.12
Stomach	0.12
Bladder	0.05
Breast	0.05
Liver	0.05
Oesophagus (canal from mouth to stomach)	0.05
Thyroid	0.05
Skin	0.01
Bone Surface	0.01
Remainder	0.05

LIMITS FOR NON-STOCHASTIC EFFECTS

Non-stochastic effects should be prevented. ICRP believes that they will be prevented if we adhere to the H_{WB} limit. There are only three exceptions, i.e., three non-stochastic limits not covered by this scheme:

The lens of the eye:	**150 mSv/y.**
The skin:	**500 mSv/y.**
The extremities:	**500 mSv/y.**

DOSE LIMITS

	ARWs	Non-ARWs
Stochastic Limits (Effective Whole-Body Dose)	20 mSv per year, averaged over a period of 5 years, with no more than 50 mSv in any one year.	1 mSv per year
Non-Stochastic Limits the lens of the eye the skin extremities	 150 mSv 500 mSv 500 mSv	 15 mSv 50 mSv -

1. Limits do not apply to medical exposure, background radiation

2. H_{WB} limit of 20 mSv/y is an average

3. Female ARW is limited to 2 mSv H_{WB} for remainder of pregnancy

PERCEIVED RISKS IN THE US

	Women	Students	Businessmen
1	Nuclear Power	Nuclear Power	Handguns
2	Motor Vehicles	Handguns	Motorcycles
3	Handguns	Smoking	Motor Vehicles
4	Smoking	Pesticides	Smoking
5	Motorcycles	Motor Vehicles	Alcohol
6	Alcohol	Motorcycles	Fire Fighting
7	General Aviation	Alcohol	Police Work
8	Police Work	Police Work	Nuclear Power
9	Pesticides	Contraceptives	Surgery
10	Surgery	Fire Fighting	Hunting
11	Fire Fighting	Surgery	General Aviation
12	Construction	Food Preservatives	Mountain Climbing
13	Hunting	Spray Cans	Construction
14	Spray Cans	Construction	Bicycles
15	Mountain Climbing	General Aviation	Pesticides
16	Bicycles	Airlines	Skiing
17	Airlines	X-Rays	Swimming
18	Electric Power	Hunting	Airlines
19	Swimming	Electric Power	Electric Power
20	Contraceptives	Food Colouring	Railroads
21	Skiing	Antibiotics	Football
22	X-Rays	Mountain Climbing	Contraceptives
23	Football	Railroads	Spray Cans
24	Railroads	Bicycles	X-Rays
25	Food Preservatives	Skiing	Power Mowers
26	Food Colouring	Football	Antibiotics
27	Power Mowers	Home Appliances	Home Appliances
28	Antibiotics	Power Mowers	Food Preservatives
29	Home Appliances	Vaccinations	Vaccinations
30	Vaccinations	Swimming	Food Colouring

Acute Risk vs Chronic Risk

Acute Radiation Risk

Chronic Radiation Risk

Hourly Risk

Lost life Expectancy

ACTUAL ANNUAL LOSS OF LIFE IN THE US

1	Smoking	150,000	inferred
2	Alcohol	100,000	inferred
3	Motor Vehicles	50,000	observed
4	Handguns	17,000	observed
5	Electric Power	14,000	observed
6	Motorcycles	3,000	observed
7	Swimming	3,000	observed
8	Surgery	2,800	observed
9	X-Rays	2,300	calculated
10	Railroads	1,950	observed
11	General Aviation	1,300	observed
12	Construction	1,000	observed
13	Bicycles	1,000	observed
14	Hunting	800	observed
15	Home Appliances	200	observed
16	Fire Fighting	195	observed
17	Police Work	160	observed
18	Contraceptives	150	inferred
19	Airlines	130	observed
20	Nuclear Power	100	calculated
21	Mountain Climbing	30	observed
22	Power Mowers	24	observed
23	College Football	23	observed
24	Skiing	18	observed
25	Vaccinations	10	observed
26	Food Colouring		
27	Food preservatives		
28	Pesticides, PCBs, Dioxins		
29	Prescription Antibiotics		
30	Spray Cans		

RISKS OF CANADIAN INDUSTRIES

Industry	Hours of Work	LLE
Average all	14.0	70
Mining	1.5	660
Forestry	1.7	580
Fishing	2.3	430
Construction	4.9	200
Transport	6.6	150
Public admin.	16.0	62
Manufacturing	17.0	58
Agriculture	37.0	27
Trade	37.0	27
Service	53.0	19
Finance	125.0	8

LLEs in US For Various Risks

Activity or Risk	LLE (Days)
Living in poverty	3500
Being male rather than female	2800
Cigarettes (male)	2300
*Heart Disease	2100
Being single (worse for men)	2000
Working as coal miner	1100
*Cancer	980
*Stroke	520
*All accidents	435
Vietnam army service	400
*Alcohol	230
Motor Vehicle Accidents	180
*Pneumonia and influenza	130
*Drug abuse	100

* means averaged over US population;
others refer only to those exposed

Activity or Risk	LLE (Days)
*Accidents at home	95
*Suicide	95
*Homicide	90
*Average job - accidents at work	74
*AIDS	70
*Drowning	40
*Falls	39
*Radon in homes	35
*Fire	27
*Poison	24
ARW Dose (2 mSv/y)	17
*Air pollution from coal G.S.	12
*Bicycle accidents	5
*Airline crashes	1
*Hurricanes and tornadoes	1
*Struck by lightning	20 h
Living next to Lepreau	20 min

Risks that kill people and risks that piss them off are completely different.

- Voluntary vs Involuntary
- Natural vs Man-Made
- Familiar vs Exotic or Dreaded
- Non-Memorable vs Memorable
- Known vs Unknown
- Control vs Not In Control
- Moral vs Amoral
- Trusted Source vs Not Trusted
- Fair vs Unfair

H_D = Deep Dose

H_S = Shallow Dose

H_X = Extremity Dose

H_T = Tissue Dose

$H_W = H_T w_T$ = Weighted Dose

$H_{WB} = H_D + \sum H_T w_T$

Dose limit applies to this H_{WB}