ICRP Framework for Radiological Protection

Requirements for a System of Radiological Protection

- Does more good than harm
- Leads to protection arrangements that maximize the net benefit
- Limits inequity that may arise from the conflict of interest between individuals and society as a whole

Practices and Interventions

- Human activities leading to overall increases in exposure are "practices"
- Human activities leading to overall decreases in exposure are "interventions"
- Examples?

Categories of Exposure

- Occupational
- Medical
- Public
- How different?

System of Protection in Practices

- Justification
- Optimization
- Dose (and Risk) Limits

System of Protection in Intervention

- Proposed intervention must do more good than harm
- Form, scale and duration of the intervention should be optimized

System of Protection for Occupational Exposures

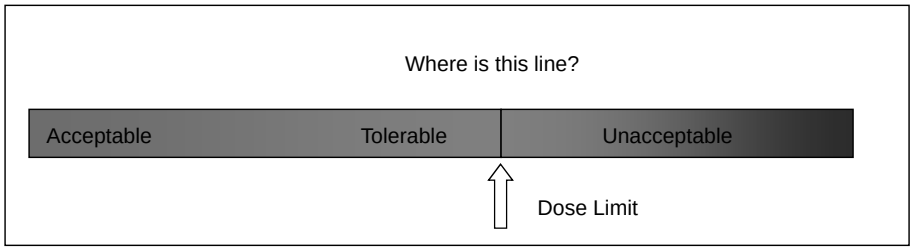
- Dose Constraints – source based limits
- Dose Limits – individual based limits

Occupational Dose Limit

How would you choose it?

Choice of Occupational Dose Limit

- Must preclude deterministic Effects
- Must maintain risk of stochastic effects at "adequate" level
- Previously chosen on the basis of comparing average fatal cancer risk to fatality rate in safe industries
  - Has limitations
  - No longer considered acceptable



Choice of Dose Limit

Table 5. Attributes of detriment due to exposure of the working population[1]

Annual effective dose (mSv)	10	20	30	50	50 (1977 data)
Approximate lifetime dose (Sv)	0.5	1.0	1.4	2.4	2.4
Probability of attributable death (%)	1.8	3.6	5.3	8.6	2.9
Weighted contribution from non-fatal cancer (%)[2]	0.4	0.7	1.1	1.7	—
Weighted contribution from hereditary effects (%)[2]	0.4	0.7	1.1	1.7	1.2
Aggregated detriment (%)[3]	2.5	5	7.5	12	
Time lost due to an attributable death given that it occurs (y)	13	13	13	13	10–15
Mean loss of life expectancy at age 18 years (y)	0.2	0.5	0.7	1.1	0.3–0.5

[1] The values are all derived from Annex C (see paragraph 155); in Annex B, which deals with a wider range of populations, a somewhat higher estimate is given for the time lost due to an attributable death.
[2] Weighted for severity and loss of lifetime.
[3] The sum of the probability of attributable fatal cancer or equivalent detriment (rounded).

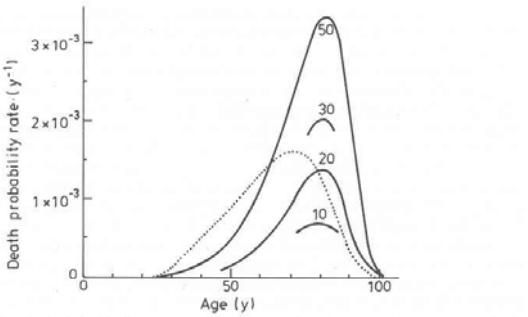


Fig. 2. The unconditional death probability rate (the attributable death age probability density normalised for lifetime risk) for exposure from age 18 to age 65 y. The curves are for females and for present risk estimates.
····· Additive risk projection model (50 mSv y⁻¹)
—— Multiplicative risk projection model (showing various annual doses in mSv)

Selected Occupational Dose Limits – ICRP 60

Table 6. Recommended dose limits[1]

Application	Dose limit Occupational	Public
Effective dose	20 mSv per year, averaged over defined periods of 5 years[2]	1 mSv in a year[3]
Annual equivalent dose in		
the lens of the eye	150 mSv	15 mSv
the skin[4]	500 mSv	50 mSv
the hands and feet	500 mSv	–

[1] The limits apply to the sum of the relevant doses from external exposure in the specified period and the 50-year committed dose (to age 70 years for children) from intakes in the same period (see paragraph 143).
[2] With the further provision that the effective dose should not exceed 50 mSv in any single year. Additional restrictions apply to the occupational exposure of pregnant women, which is discussed in Section 5.3.3.
[3] In special circumstances, a higher value of effective dose could be allowed in a single year, provided that the average over 5 years does not exceed 1 mSv per year.
[4] The limitation on the effective dose provides sufficient protection for the skin against stochastic effects. An additional limit is needed for localised exposures in order to prevent deterministic effects (see paragraphs 173 and 194).

Risk Comparison

Conservative estimate is that an adult worker's risk of developing a fatal cancer is 0.04% for every 1 rem of effective dose.

- 4 in 10 000 per 10 mSv (1 rem)
- 4 in 100 000 per 1 mSv (100 mrem)
- 4 in 1 000 000 per 0.1 mSv (10 mrem)
- 1 in 1 000 000 per 25 μSv (2.5 mrem)

Estimated Loss of Life Expectancy Due to Various Causes

Cause	LLE
Being unmarried - male	9.6 years
Living in poverty	9.6 years
Being male rather than female	7.7 years
Cigarette smoking - male	6.3 years
Heart disease	5.8 years
Being unmarried - female	4.4 years
Cigarette smoking - female	2.2 years
All accidents	1.2 years
Motor vehicle accidents	180 days
Drug abuse	100 days
Average job	74 days
Safest job	30 days
NEW (200 mrem/y for 25 years)	17 days
Living entire life at boundary of a nuclear power plant	1 day
Chest x-ray	2.6 min

Industry Risks

Industry	Hours of Work for 1 in a Million Risk	LLE (days)
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

Medical Exposures

- Subject to justification and optimization – but not dose limits
- Inherently beneficial to the patient – imposing dose limits may be detrimental

Public Exposures

- Subject to justification and optimization and dose limits
- Source based dose constraints should protect public
- Limit for protection when more than one source of exposure and to set upper bound on constraints.