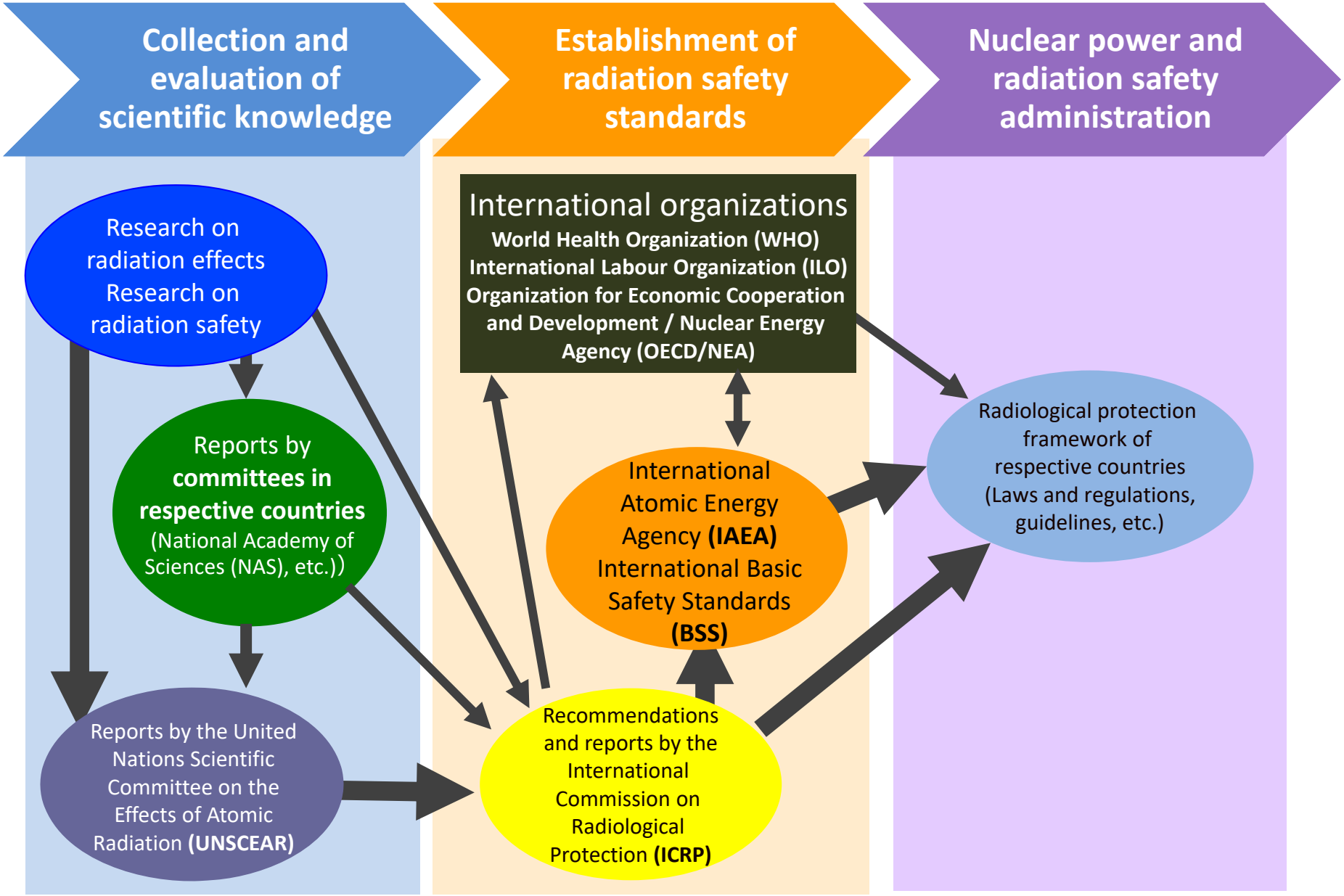
Principles of Radiological Protection

Radiological Protection System



International Commission on Radiological Protection (ICRP)

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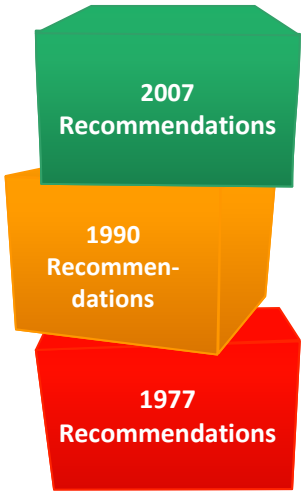
The Commission aims to make recommendations concerning basic frameworks for radiological protection and protection standards. The Commission consists of the Main Commission and five standing Committees (radiation effects, doses from radiation exposures, protection in medicine, application of the Commission's recommendations, and protection of the environment).

(Reference) Dose limits excerpted from ICRP Recommendations

	1977 Recommendations	1990 Recommendations	2007 Recommendations
Dose limits (occupational exposure)	50 mSv/year	100 mSv/5 years and 50 mSv/year	100 mSv/5 years and 50 mSv/year
Dose limits (public exposure)	5 mSv/year	1 mSv/year	1 mSv/year



mSv: millisieverts

Aims of the Recommendations

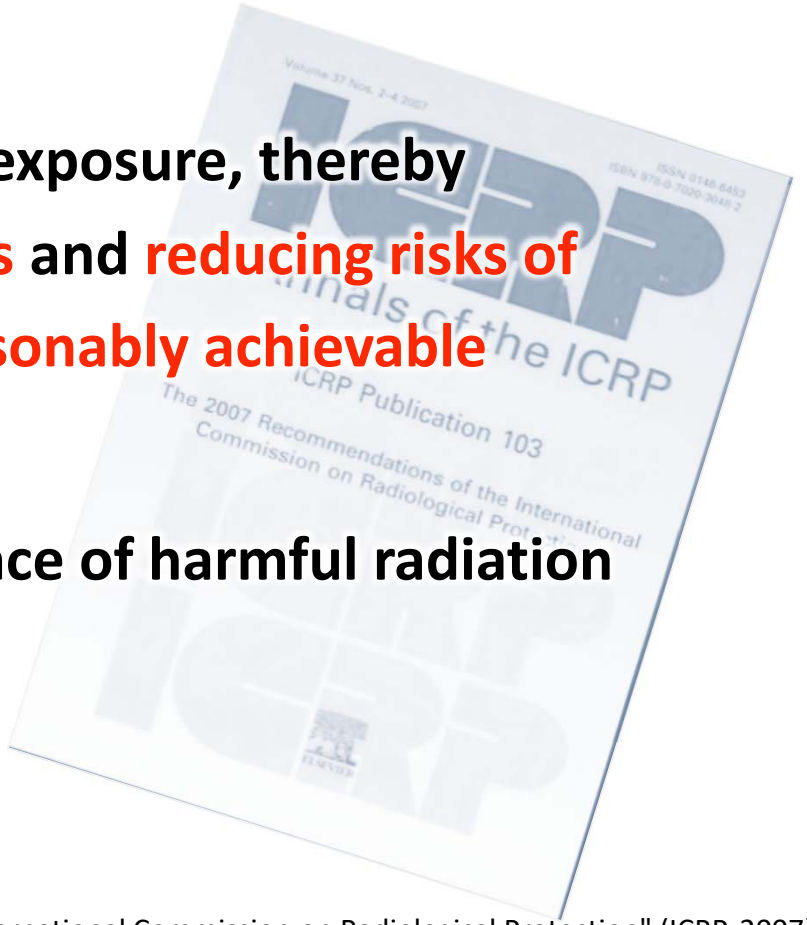
Aims of the Recommendations(2007 Recommendations of the International Commission on Radiological Protection (ICRP))

1) To protect human health

・ Manage and control radiation exposure, thereby **preventing deterministic effects** and **reducing risks of stochastic effects as low as reasonably achievable**

2) To protect the environment

・ Prevent or reduce the occurrence of harmful radiation effects



Source: ICRP Publication 103, "The 2007 Recommendations of the International Commission on Radiological Protection" (ICRP, 2007)

Principles of Radiological Protection

Exposure Situations and Protection Measures

People's exposure to radiation

Planned exposure situations

Situations where protection measures can be planned in advance and the level and range of exposure can be reasonably forecast

Dose limits
(Public exposure) 1 mSv/year
(Occupational exposure)
100 mSv/5 years and
50mSv/year

Measures
Manage disposal of radioactive waste and long-lived radioactive waste

Existing exposure situations

Situations where exposure has already occurred as of the time when a decision on control is made

Reference level
A lower dose range within 1 to 20 mSv/year, with a long-term goal of 1 mSv/year

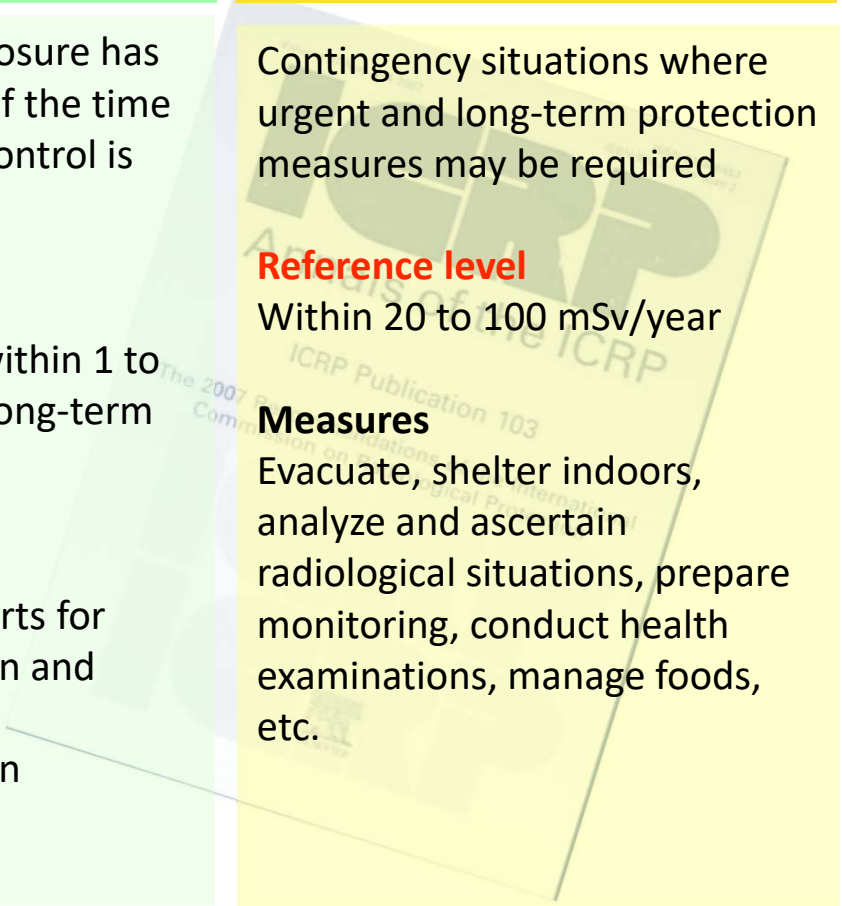
Measures
Ensure voluntary efforts for radiological protection and cultivate a culture for radiological protection

Emergency exposure situations

Contingency situations where urgent and long-term protection measures may be required

Reference level
Within 20 to 100 mSv/year

Measures
Evacuate, shelter indoors, analyze and ascertain radiological situations, prepare monitoring, conduct health examinations, manage foods, etc.



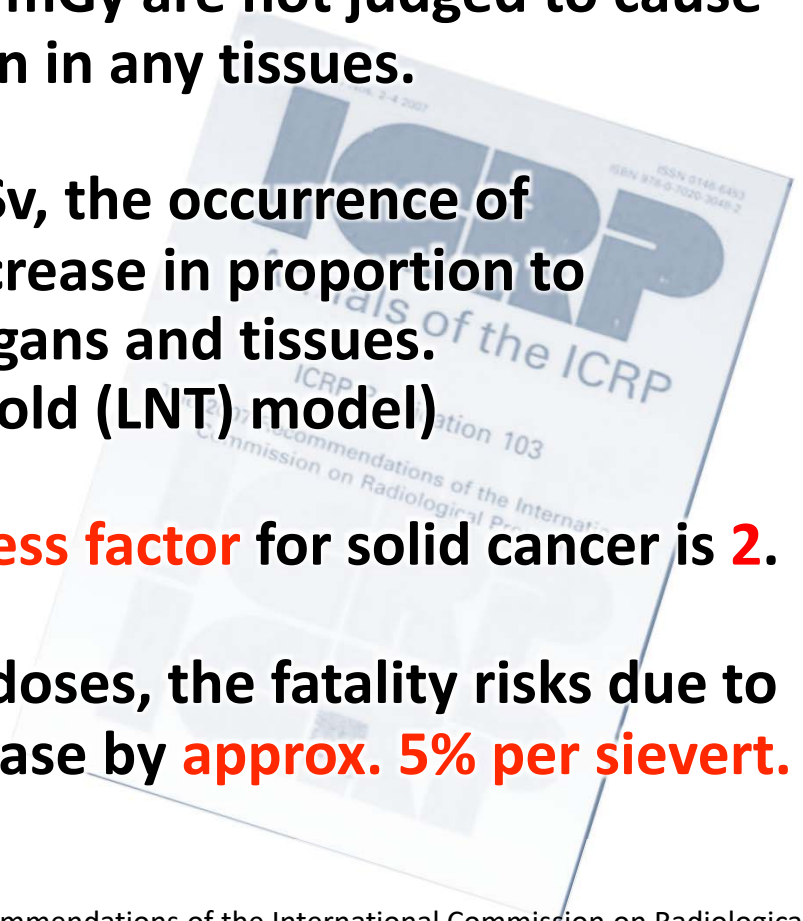
mSv: millisieverts

Source: ICRP Publication 103, "The 2007 Recommendations of the International Commission on Radiological Protection" (ICRP, 2007)

Biological Aspect

Health effects of radiation have deterministic effects and stochastic effects.

- **Absorbed doses up to approx. 100 mGy are not judged to cause any clinically significant dysfunction in any tissues.**
- **In the range below approx. 100 mSv, the occurrence of stochastic effects is assumed to increase in proportion to increases in equivalent doses in organs and tissues. (Adoption of the linear non-threshold (LNT) model)**
- **The dose and dose-rate effectiveness factor for solid cancer is 2.**
- **Assuming a linear reaction at low doses, the fatality risks due to cancer and hereditary effects increase by approx. 5% per sievert.**

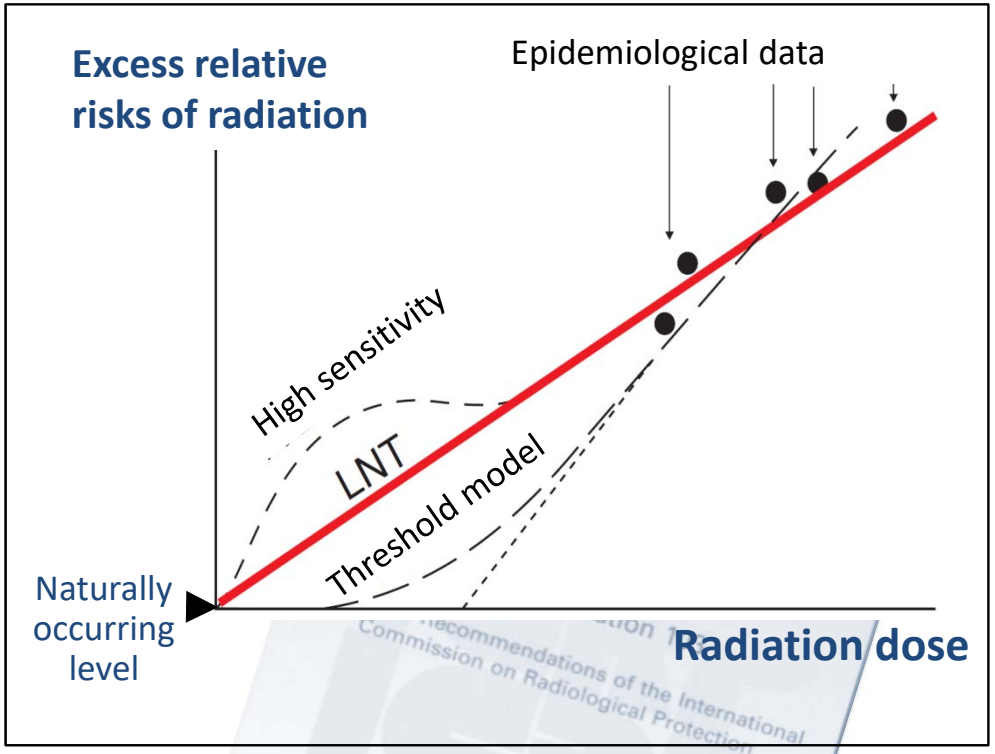


Source: ICRP Publication 103, "The 2007 Recommendations of the International Commission on Radiological Protection" (ICRP, 2007)

Disputes over the LNT Model

◎ Affirmative positions:
National Academy of Sciences (2006)
There is no specific safety dose for radiation exposure.

◎ Critical positions:
Académie de Médecine; Académie de Science (2005)
Exposure to radiation below a certain dose does not actually cause cancer, leukemia, etc. and therefore, the LNT model represents overestimation not suited to the reality.



⇒ **The International Commission on Radiological Protection (ICRP) adopts the linear non-threshold (LNT) model as a simple and reasonable assumption for the purpose of radiological protection.**

Three Fundamental Principles of Radiological Protection

ICRP's three fundamental principles of radiological protection

- **Justification**
- **Optimization**
- **Application of dose limits**

Source: ICRP Publication 103, "The 2007 Recommendations of the International Commission on Radiological Protection" (ICRP, 2007)

Justification of Radiological Protection

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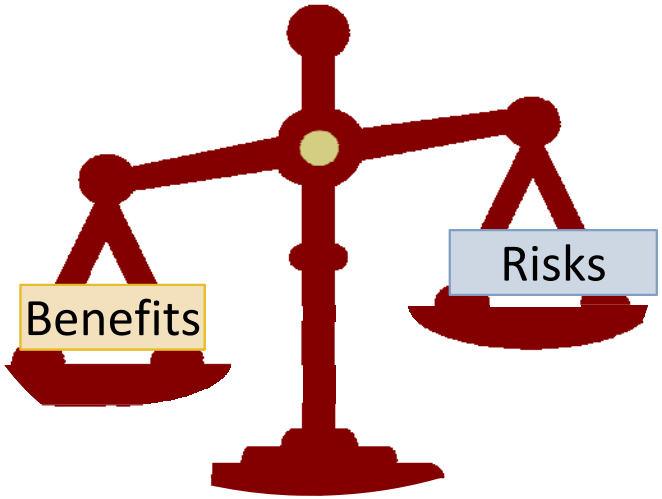
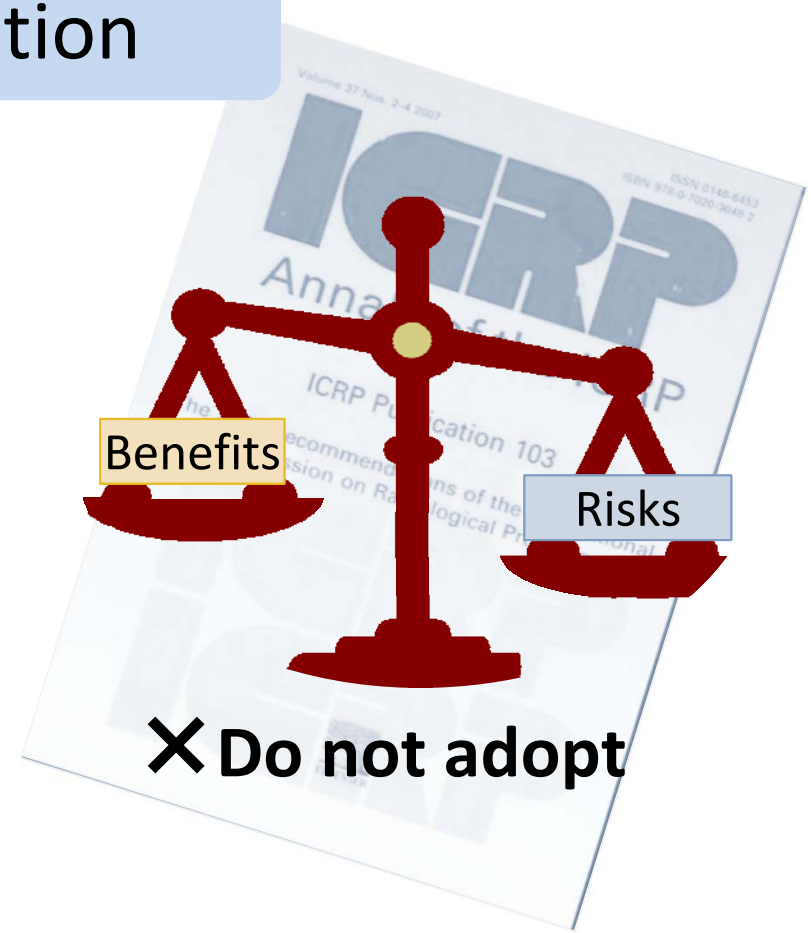
Justification



○ Adopt



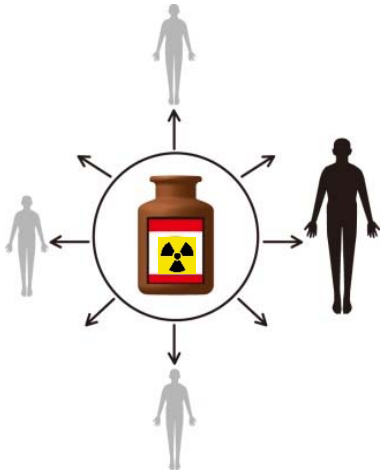
✕ Do not adopt

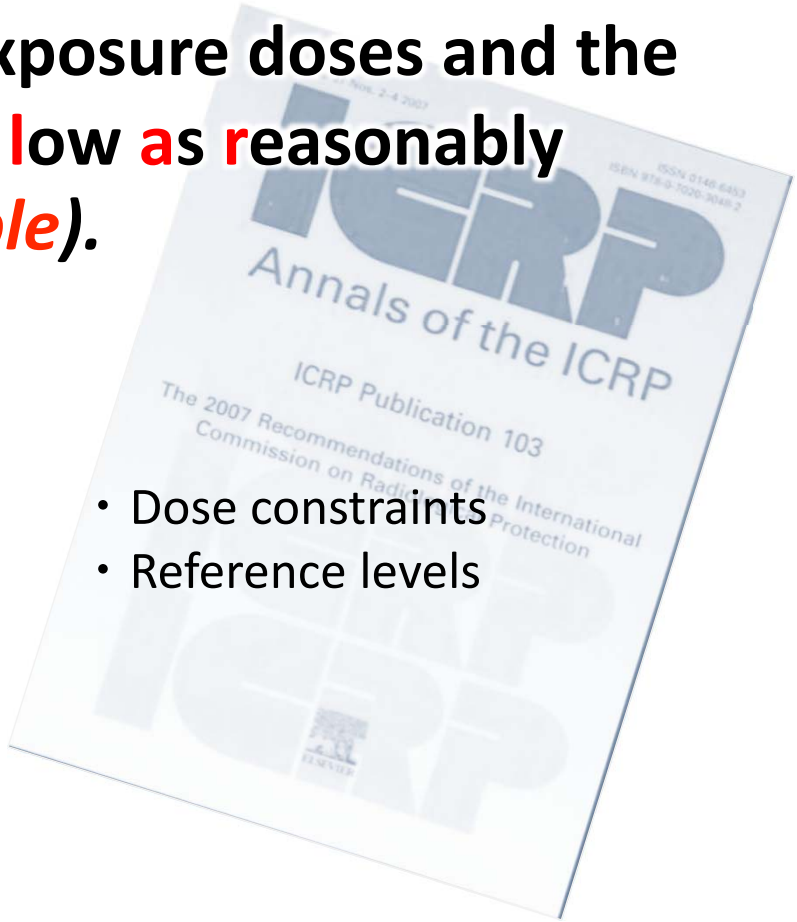
Source: ICRP Publication 103, "The 2007 Recommendations of the International Commission on Radiological Protection" (ICRP, 2007)

Optimization of Radiological Protection

Optimization of Radiological Protection

In consideration of economic and social factors, strive to reduce individuals' exposure doses and the number of exposed people as low as reasonably achievable *(the ALARA principle)*.





- Dose constraints
- Reference levels

Source: ICRP Publication 103, "The 2007 Recommendations of the International Commission on Radiological Protection" (ICRP, 2007)

Reduction of Exposure Doses Using Reference Levels

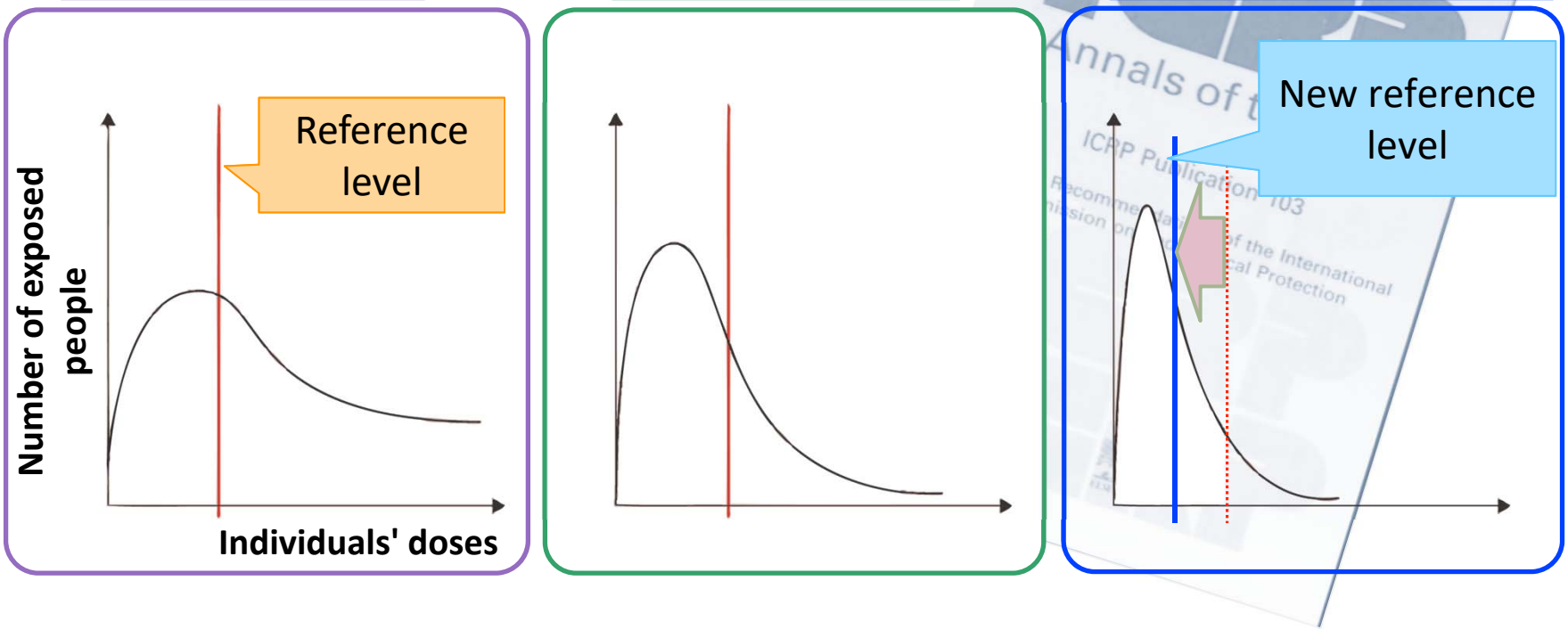
Optimization of radiological protection using reference levels

Initial situation

Setting of a reference level

When doses have decreased

Setting of a new reference level



Source: ICRP Publication 103, "The 2007 Recommendations of the International Commission on Radiological Protection" (ICRP, 2007)

Application of Dose Limits

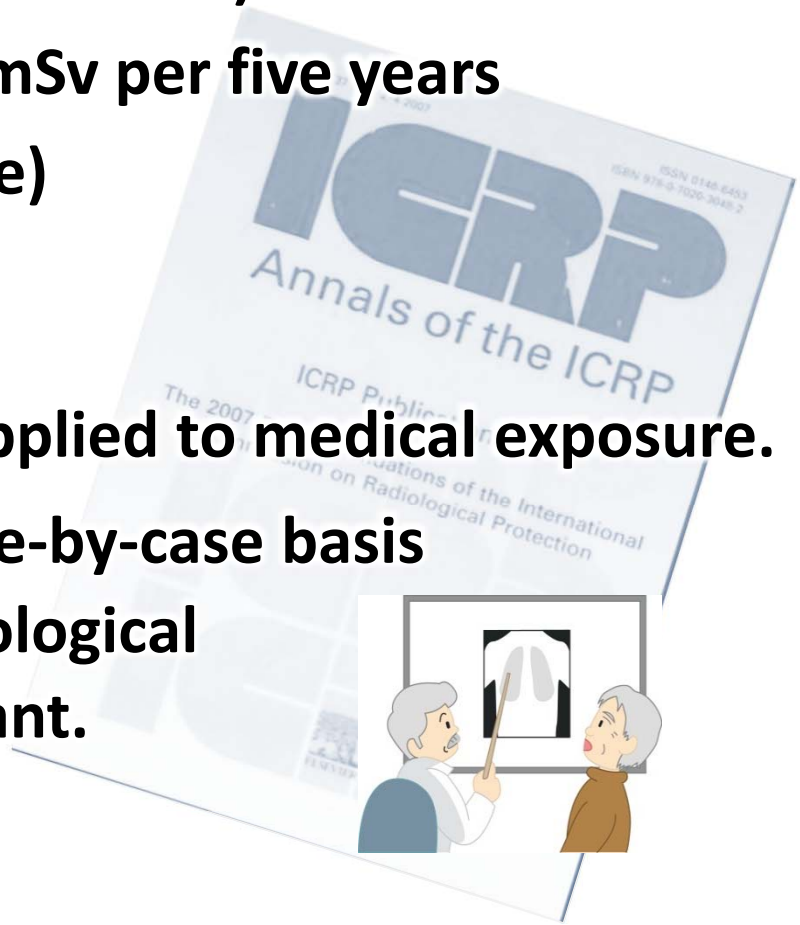
Dose limits are applied under planned exposure situations.

○ **Occupational exposure (effective dose)**

50 mSv per year and 100 mSv per five years

○ **Public exposure (effective dose)**

1 mSv per year



(Exception) Dose limits are not applied to medical exposure.

- **Justification on a case-by-case basis**
- **Optimization of radiological protection is important.**

Source: ICRP Publication 103, "The 2007 Recommendations of the International Commission on Radiological Protection" (ICRP, 2007)