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CENTRE D'ÉTUDE SUR L'ÉVALUATION DE LA PROTECTION DANS LE DOMAINE NUCLÉAIRE

Science and Values in Radiological Protection: Historial Perspective and Present Challenges

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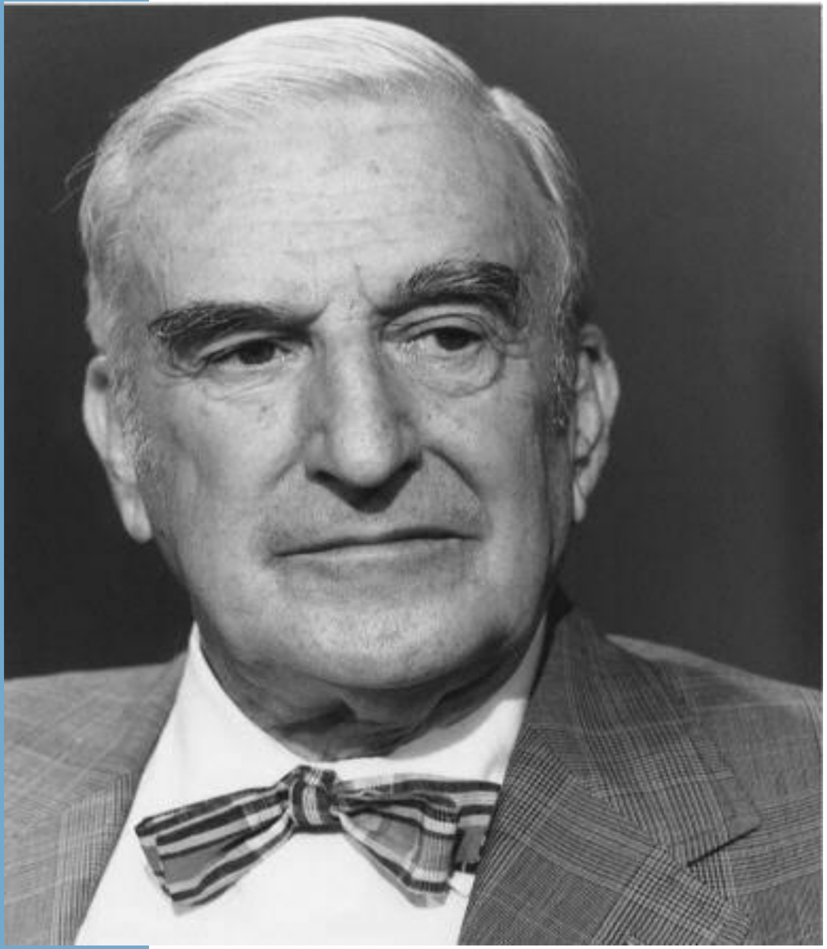
Lauriston S. Taylor (1902 - 2004)



"Radiation protection is not only a matter for science. It is a problem of philosophy, and morality, and the utmost wisdom."

The Philosophy Underlying Radiation Protection

Am. J. Roent. Vol. 77, N° 5, 914-919, 1957
From address on 7 Nov. 1956

Rolf M. Sievert (1896 - 1966)

"The establishment of maximum permissible radiation levels is a non scientific task, which must be based primarily on scientific knowledge and judgement."

The Work of the International Commission on Radiological Protection

United Nations International Conference on The Peaceful Uses of Atomic Energy, Geneva, 1-13 September 1958, Vol. 21, Session 5a pp. 3-7

Overview of the evolution of the radiation protection system

30 40 50 60 70 80 90 00

Deterministic effects
Threshold model

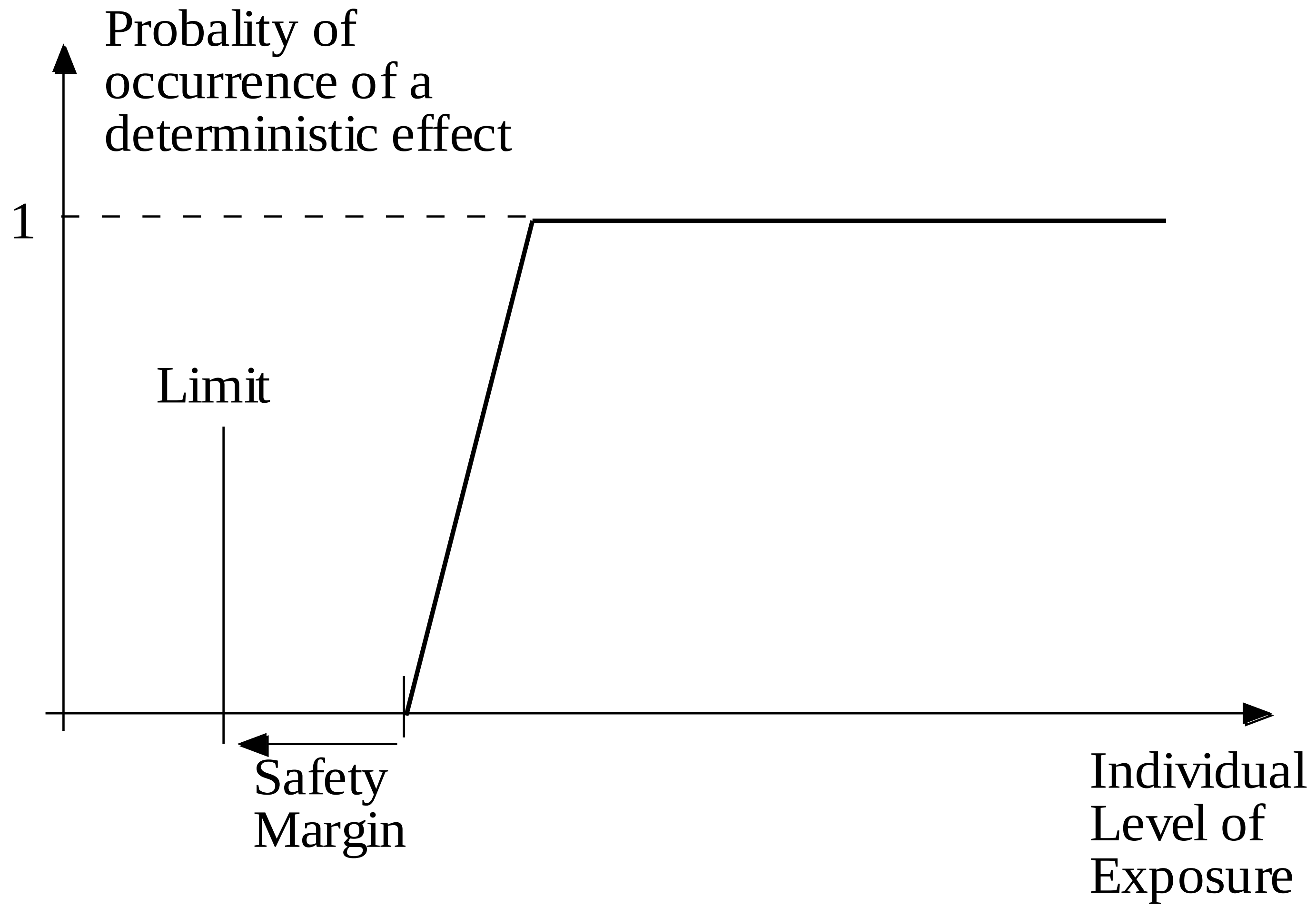
Skin, lens,hands and feet limits →

Stochastic effects
Linear non threshold model

- ***Justification*** →
- ***ALAP*** —— ***ALARA*** →
- ***Limitation*** →

Workers and public

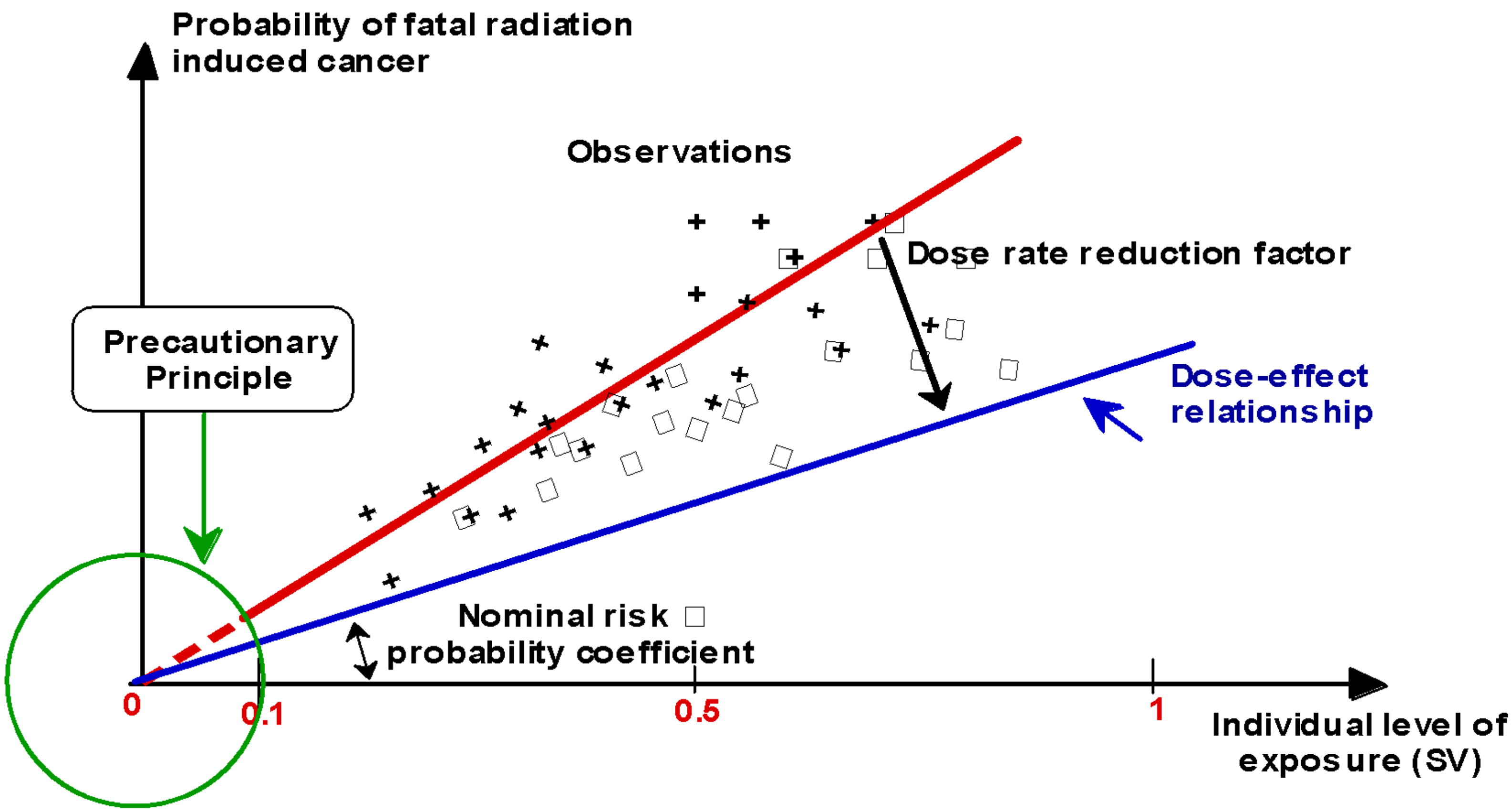
The threshold model for deterministic effects



The management of deterministic effects

- Dose-effect relationships are well quantified
- Existence of threshold doses under which no deterministic effects are observed
- The limit is an individual guarantee that deterministic effects will not occur
- Application of the "prevention" principle
- Easy to translate into regulation

The linear non-threshold model for stochastic effects



The construction of risk for stochastic effects

Biology → **Experts Committee UNSCEAR, BEIR, ICRP…** ← **Epidemiology**

Experts Committee UNSCEAR, BEIR, ICRP… → **Consensus** → **Risk coefficient**

"Microscopic approach"
Description and understanding of basic mechanisms

- *Apoptosis*
- *Repair mechanisms*
- *DNA mutation*
- *Non targeted effects*
- *Delayed effects*
- *Adaptative response*
- *Genomic instability*

"Macroscopic approach"
Risk assessment

- *Cancers*
- *Hereditary effects*
- *Non cancer effects*
    - *Cardiovascular*
    - *others…*

Some characteristics of the LNT model

- Prudent approach : application of the precautionary principle
- Population approach
  - Linear no-threshold hypothesis for all cancers considered as a group but not necessarily individually
  - Average risk combining sex, age, time following exposure…
- Applicable to any exposed population (projection)
- Remaining uncertainties

The basic principle of radiation protection for stochastic effects

- Justification of activities - Complex political process involving considerations about the benefits and the risks associated to the activities as well as ethical and social values

- Optimisation of radiation protection : looking for all types of exposure for the best level of protection under the prevailing circumstances (taking into account economical and social factors)
- Limitation of individual risk for workers and the public - Based on the social "tolerability" of the risk (value judgement, reference…)

The optimisation principle

- Uncertainties, prudent attitude, ALAP (1950)
- The limit is not anymore a guarantee of the absence of risk
- If an activity is justified, how far to reduce the risk without endanger the activity, ALARA (1958)
- Attempt to found the "Reasonably" on science: the cost-benefit model (1973)
- Pragmatism and stakeholder involvement (1988, 1999, 2007)

The limitation principle

$$\underset{\text{[mSv/year]}}{\textbf{Annual dose limit}} = \frac{\overset{\text{[\%/year]}}{\textbf{Tolerable annual risk level}}}{\underset{\text{[\%/mSv]}}{\textbf{Dose risk coefficient}}}$$

Evolution of the annual dose limits for stochastic effects

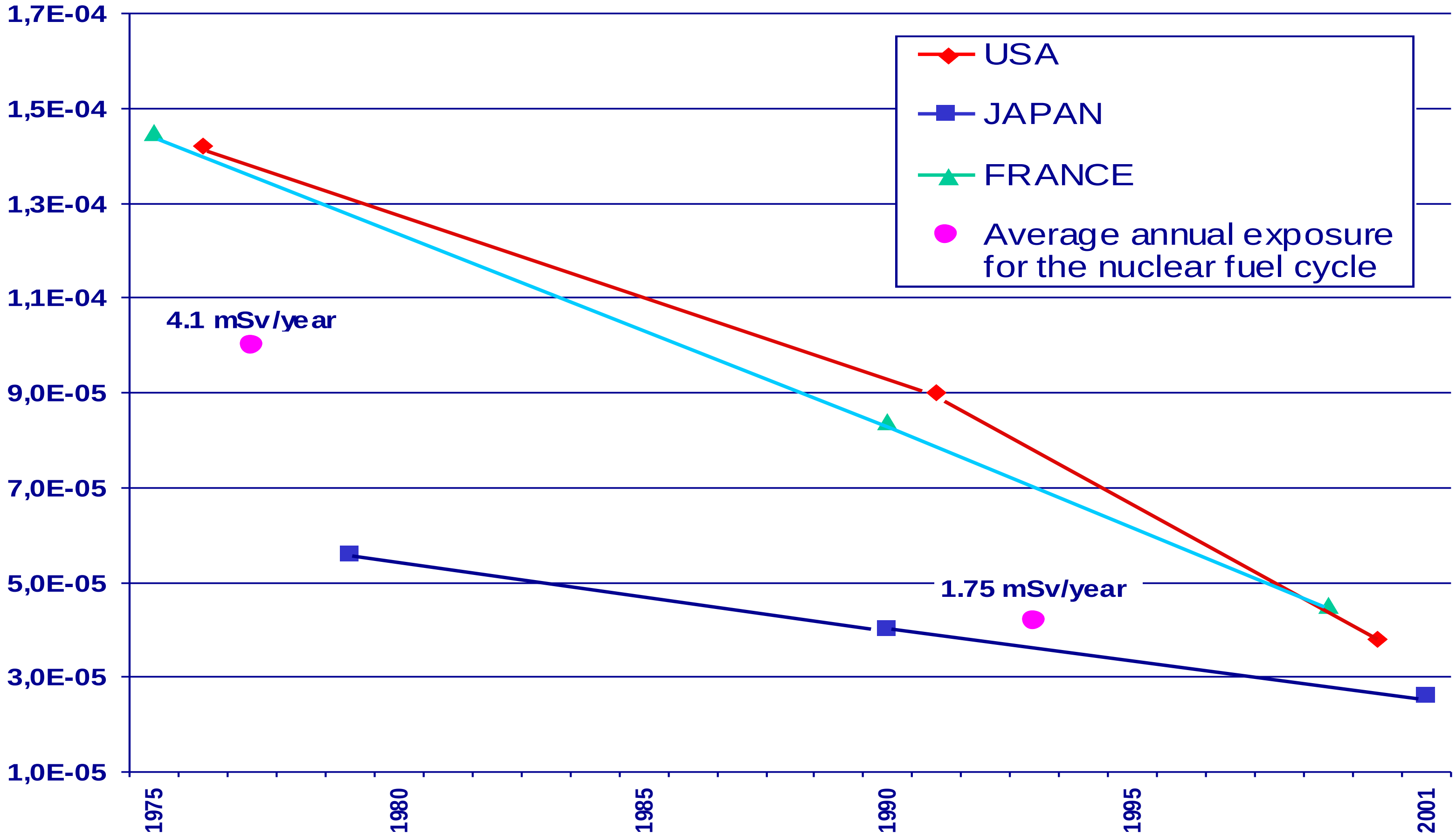
- 1956 : 50 mSv for workers and 5 mSv for the public
  Value judgement

- 1976 : Same values. Average doses comparable to safe activities

- 1990 : 20 mSv for workers and 1 mSv for the public
  Revision of the nominal probability coefficient.

- 2007 : Same values

Evolution of the average annual risk of fatal injuries associated with economic activity and exposure to ionizing radiation

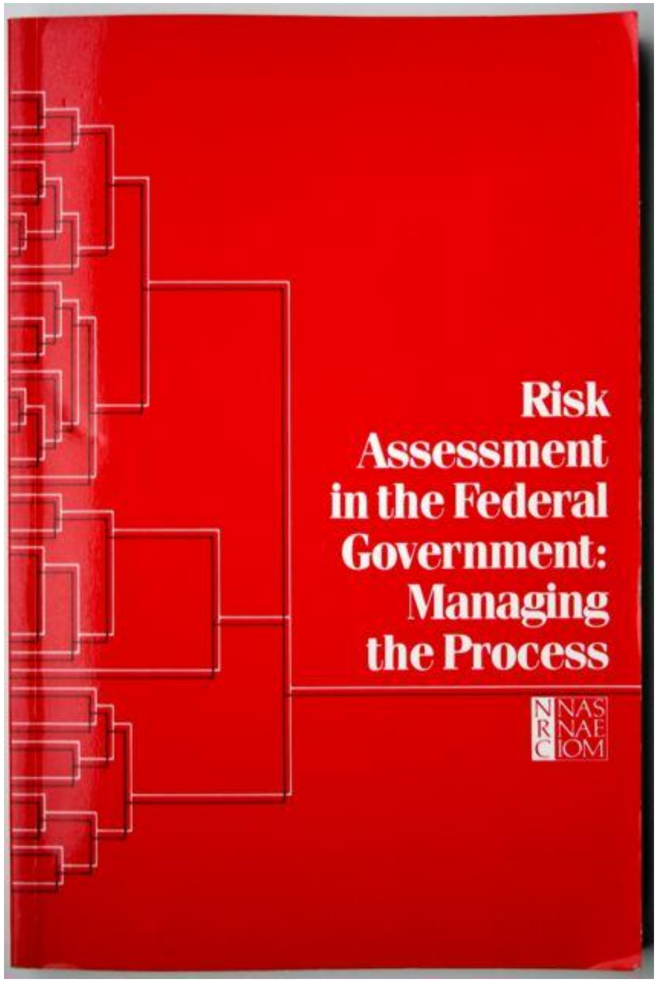


Sources : NSC (USA) ; Ministry of Labour (Japan) ; CNAMTS (France) ; ILO

Conclusion

- The present system of radiation protection is science based, promoting responsibility and vigilance among all concerned parties through a permanent questioning:
  - Are the activities justified?
  - Is any individual exposed to a risk which is considered as not acceptable?
  - Are the exposures maintained as low as reasonable under the prevailing circumstances?
- However, there is a need to improve the understanding of the articulation between science and values in radiation protection

Toward a framework for organizing and analyzing scientific knowledge and values for managing radiological risk (1)



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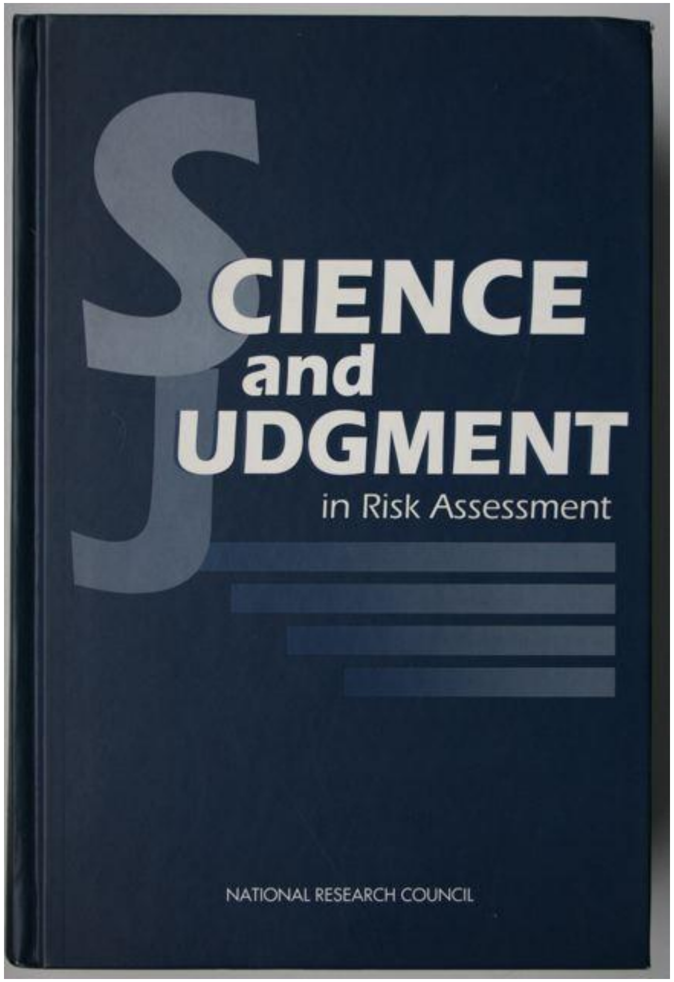

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Toward a framework for organizing and analyzing scientific knowledge and values for managing radiological risk (2)

- Improve the understanding by concerned parties of the science and the value judgements underlying the radiation protection system
- Develop a methodological corpus for facilitating the transmission to the next generation of scientists, decision makers…
- Identify research needs to improve the robustness and quality of the system
- Improve the transparency of the system to facilitate dialogue between all stakeholders
- Anticipate and analyse prospectively potential implications of scientific and social evolution

A topical issue

- The possible implications of radiation protection science evolution to radiation protection regulation was discussed at an Expert Meeting held in Tokyo on December 12, 2007 at the occasion of the 4th Asian Regional Conference on the Evolution of the System of Radiological Protection, December 13-14, 2007, Tokyo - Japan.
- The participants emphasized the need to extend knowledge in :
  - The better understanding of low dose and low dose rate science
  - The articulation of science and values in policy decision