

The focal role of tolerability and reasonableness in the radiological protection system

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Introduction

- In ICRP Publication 1 (1959) it is already stated that faced with "the existing uncertainty as to the dose-effect relationships for somatic effects" the Commission recommends "that all doses be kept as low as practicable" and recognizing that man could not avoid completely the use of ionizing radiation concludes that in practice it is necessary to limit doses so that the risk "is not unacceptable to the individual and to the population at large".
- It took several decades for the Commission to clarify what was meant by "as low as practicable" and "not unacceptable" and on which criteria to ground the decisions about these intentions.

The search for tolerability (1)

The « acceptability of risk » in Publication 26, 1977

"The aim of radiation protection should be to prevent detrimental non-stochastic effects and to limit the probability of stochastic effects to levels deemed to be acceptable". (§ 9)

For non-stochastic effects:

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"The prevention of non-stochastic effects would be achieved by setting dose-equivalent limits at sufficiently low values so that no threshold dose would be reached, even following exposure for the whole of the lifetime or for the total period of working life". (§ 10)



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Publication 26, 1977 (1)

For occupational exposure:

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"The Commission believes that for the foreseeable future a valid method for judging the acceptability of the level of risk in radiation work is by comparing this risk with that for other occupations recognized as having high standards of safety, which are generally considered to be those in which the average annual mortality due to occupational hazards does not exceed 10⁻⁴." (§ 96)

Publication 26, 1977 (2)

Taking into account the distribution of individual exposures, it is assumed that:

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- "...where the Commission's system of dose limitation has been applied, the resultant annual average dose equivalent is no greater than one-tenth of the annual limit." (§ 99)
- Adoption of an annual dose limit of 50 mSv for occupational exposure
- Assuming to result in an average annual exposure of 5 mSv
- Corresponding to a risk of 5.10⁻⁵ per year for fatal cancers and 2.10⁻⁵ for hereditary effects

Publication 26, 1977 (3)

• For public exposure:

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- "From a review of available information related to risks regularly accepted in everyday life, it can be concluded that the level of acceptability for fatal risks to the general public is an order of magnitude lower than for occupational risks. On this basis, a risk in the range of 10⁻⁶ to 10⁻⁵ per year would be likely to be acceptable to any individual member of the public". (§ 118)
- Based on the detriment of 10⁻² Sv⁻¹, the restriction would correspond to 1 mSv per year
- Adoption of an annual dose limit of 5 mSv for pubic exposure, assuming to result in average dose equivalents of less than 0.5 mSv

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Publication 60, 2007 (1)

Unacceptable risk

• 'The first word is "unacceptable", which is used to indicate that the exposure would, in the Commission's view, not be acceptable on any reasonable basis in the normal operation of any practice of which the use was a matter of choice. Such exposures might have to be accepted in abnormal situations, such as those during accidents'

Tolerable risk

- Exposures that are not unacceptable are then subdivided into those that are "tolerable", meaning that they are not welcome but can reasonably be tolerated [...]'.
- Acceptable risk
 - '[...] and "acceptable", meaning that they can be accepted without further improvement i.e. when the protection has been optimised'.

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Publication 60, 2007 (2)



In the case of workers the Commission relies on considerations about lifetime dose to justify the value of 20mSv/y

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"The Commission has now adopted a more comprehensive approach. The aim is to establish, for a defined set of practices, a level of dose above which the consequences for the individual would be widely regarded as unacceptable. ...Other factors have been considered in the definition of detriment (...). They include the length of life lost due to an attributable death and the incidence of nonfatal conditions." (§ 149)

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Publication 60, 2007 (4)

- In the case of the public the Commission refers to natural exposure to justify the value of 1mSv/y
 - "The approach is to base the judgement on the variations in the existing level of dose from natural sources. This natural background may not be harmless, but it makes only a small contribution to the health detriment which society experiences. It may not be welcome, but the variations from place to place ... can hardly be called unacceptable." (§ 190)

Publication 103, 2007 (1)

"At doses higher than 100 mSv, there is an increased likelihood of deterministic effects and a significant risk of cancer. For this reason the Commission considers that the maximum value for a reference value is 100 mSv incurred either acutely or in a year." (§ 236)

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"For the selection of an appropriate value for the dose constraint or the reference level one should consider the relevant exposure situation in terms of the nature of the exposure, the benefits from the exposure situation to individuals and society,..., and the practicability of reducing or preventing the exposures." (§ 242)

A possible adaptation of the tolerability of risk model to the ICRP 103 framework

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Exposure situations and attitude towards risks

- Quietude/peacefulness: In everyday life we forget the risk if it is well controlled, we have confidence in the arrangements put in place when we trust the institutions and people responsible for the control
- Vigilance: When we are aware that a risk is present around us or we are suspicious that something may go wrong, then we pay attention. If we notice any sign of risk, or that the situation is not well controlled, we take action to try and reduce the risk in order to reassure ourselves that we have done what is reasonably possible
- Reaction: When facing an imminent danger or being involved in a degraded situation we act to protect ourselves and our loved ones and we are in solidarity with others

The tolerability of risk depends on the need for action from the involved individuals

A proposal to combine the tolerability of risk model and the attitude toward risk to the ICRP Pub 103 framework

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The search for reasonableness

- To reduce exposures to the lowest possible level (ICRP, 1955)
- To keep exposures as low as practicable (ICRP, Pub 1, 1959)

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- To keep exposures as low as readily achievable, economic and social considerations being taken into account (ICRP, Pub 9, 1966)
- To keep exposures as low as reasonably achievable, economic and social considerations being taken into account (ICRP, Pub 22, 1973)
- To keep exposures as low as reasonably achievable, economic and social factors being taken into account (ICRP, Pub 26, 1977)
- To keep exposures as low as reasonably achievable, economic and societal factors being taken into account (ICRP, Pub 103, 2007)

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Introduction of the cost-benefit analysis

ICRP Publication 22, 1973

"It is then helpful to express the population dose not only in man-rems, but also in **social and economic terms**, for example, in terms of **detriment or monetary units**, so that the advantage of a **reduction in collective dose** can be **compared directly** with the **detriment or cost** of achieving this reduction." (§ 18)

Economic rationality and cost-benefit analysis



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Example of monetary values adopted by utilities Data from ISOE



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From economic rationality and cost-benefit analysis to stakeholder involvement (1)

 ICRP 37 (1983): Introduction of the "Beta value" in the monetary value

"...in some complex situations it may be desirable to add the costs associated with additional components of detriment to take account of **non-objective features** and of **non-health detriments**" (§ 87)

However, the process to maintain levels of exposure ALARA remains essentially a matter of judgment mixing quantitative and qualitative assessment and field experience.

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From economic rationality and cost-benefit analysis to stakeholder involvement (2)

ICRP 55 (1990): The ALARA process (managerial approach) and multi-attribute analysis

ICRP 101 (2006): Stakeholder involvement

"The basic definition given in Publication 60 (ICRP 1991) remains valid, but the way in which it should be implemented is now viewed as a broader process reflecting the increasing role of individual equity, safety culture, and stakeholder involvement in our modern societies..." (§ 4)

Stakeholder involvement (1)

The "reasonable" can not be defined universally and therefore refers to the specificities of the exposure situation

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- One of the key challenges: to develop evaluation procedures for deliberation among stakeholders on what is reasonable
- Importance of fostering the emergence of citizens / stakeholders informed and advised (radiation protection culture) allowing them to make effective decisions for their own protection and well-being while weighing up the individual and collective dimensions

Stakeholder involvement (2)

Societal considerations and values (according ICRP, Pub 101, 2006)

Equity

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- Ability to control (measurement, health surveillance, etc.)
- Sustainability
- Intergenerational considerations
- Individual benefit
- Social benefit
- Level of information/knowledge held by those exposed
- Social trust

Constituents of reasonableness (1)

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- Related to discernment, judgment, common sense and wisdom
- Requires both the understanding of the situation and the reference to knowledge, experience in the assessment of what is considered acceptable in view of the individual and collective values
- Faculty of thinking allowing to apply judgment to action
- The decision can not be solely driven by theoretical knowledge
- Inseparable from the establishment of a deliberative process to determine what to do based on the situation

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Constituents of reasonableness (2)

Some key points related to reasonableness

- Importance of reciprocity
 - situation or relationship in which two ore more people or groups agree to do something similar for each other
- Developing a reasoning accessible to others
- Promoting a fair cooperation
- Clearly linked to justice and equity

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Constituents of reasonableness (3)

Reasonableness as an expression of wisdom

- A basic definition of wisdom is the quality of having experience, knowledge, and good judgement. (Oxford dictionary)
- As a virtue, wisdom is the disposition to behave and act with the highest degree of adequacy under any given circumstances
- In its popular sense, wisdom is attributed to a person who takes reasonable decisions and act accordingly

Concluding remarks (1)

- Attempts to find in the 70s and 80s rational and objective bases for what is tolerable (risk comparison) and what is reasonable (cost-benefit analysis) have failed to provide clear cut answers
- In practice, searching for tolerability and reasonableness are permanent questioning processes, which depend on the prevailing circumstances, in order to act wisely based on accumulated knowledge and experience
- These processes can be supported by quantitative methods but definitely remain of a deliberative nature
- It is important to keep in mind that finally reasonableness and tolerability are intrinsically related

Concluding remarks (2)

"... the very multi-faceted concept of **reasonableness** should, as relevant, be patently and fully grounded in such synonymous notions as proportionality, balance, fairness, moderateness, consistency, suitability, **tolerableness** and absence of excessiveness."

International Tribunal for the Law of the Sea (2000)



Thank you !