The new ICRP Publication 146 on radiological protection of people and the environment in the event of a large nuclear accident

Jacques Lochard
Professor at Nagasaki University
Visiting Professor at Hiroshima University
ICRP Vice Chair

Phœnix Leader Education Program for Renaissance
(Hiroshima Initiative) from Radiation Disaster
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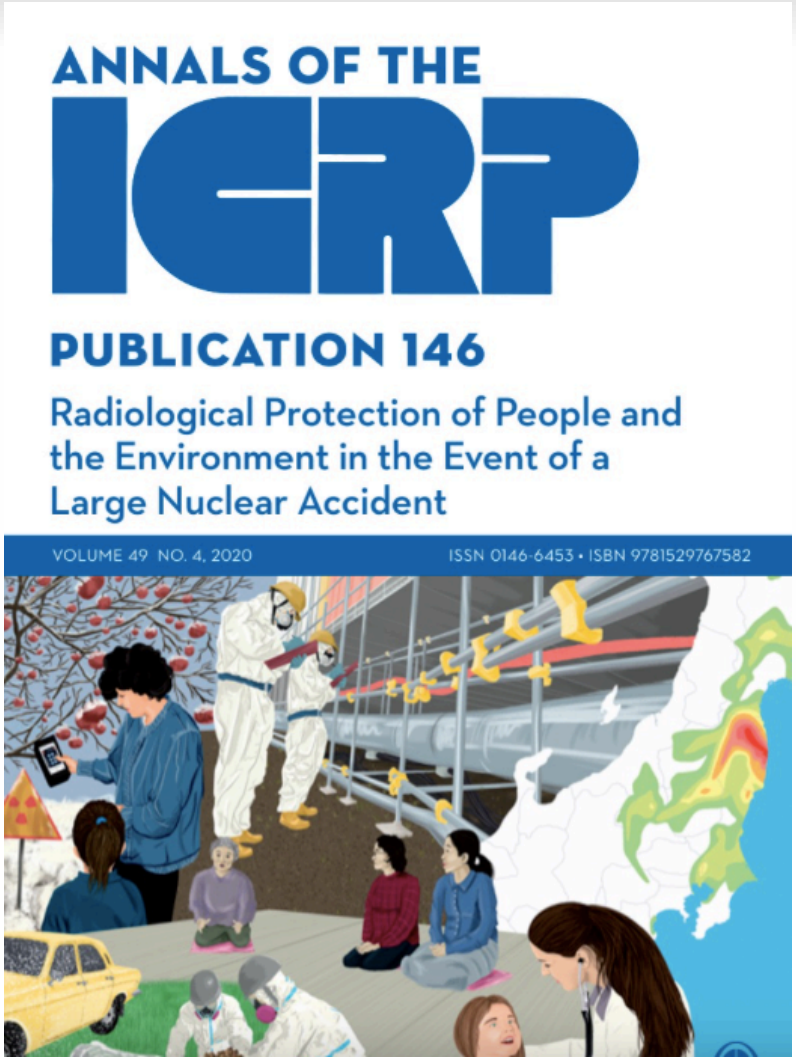
This presentation has neither been approved nor endorsed by ICRP

ATOMIC BOMB DISEASE INSTITUTE, NAGASAKI UNIVERSITY

Background

- First ICRP guidance on managing the radiological protection of people in case of nuclear accidents were published in 1984 (Publication 40) and then revised in 1991 (Publication 82)
- Building on the experience of the management of the Chernobyl accident in Europe, the Commission published in 2009 new guidance in **Publications 109 and 111**. The latter publication presented the first comprehensive ICRP recommendations dealing with **long-term recovery** after a nuclear accident
- Following the Fukushima nuclear accident in March 2011 in Japan ICRP took several initiatives to draw the lessons of the accident and decided late 2013 to create a **Task Group** to develop a new Publication integrating the Chernobyl and Fukushima experience
- The draft report prepared by the Task Group has been adopted by the ICRP Main Commission in July 2020 and published as **ICRP Publication 146** in December 2020



Authors on behalf of ICRP

Michiaki Kai - Japan

Toshimitsu Homma - Japan

Jacques Lochard - France

Thierry Schneider - France

Jean-François Lecomte - France

Anne Nisbet - UK

Sergey Shinkarev - Russia

Viktor Averin - Belarus

Ted Lazo – United States

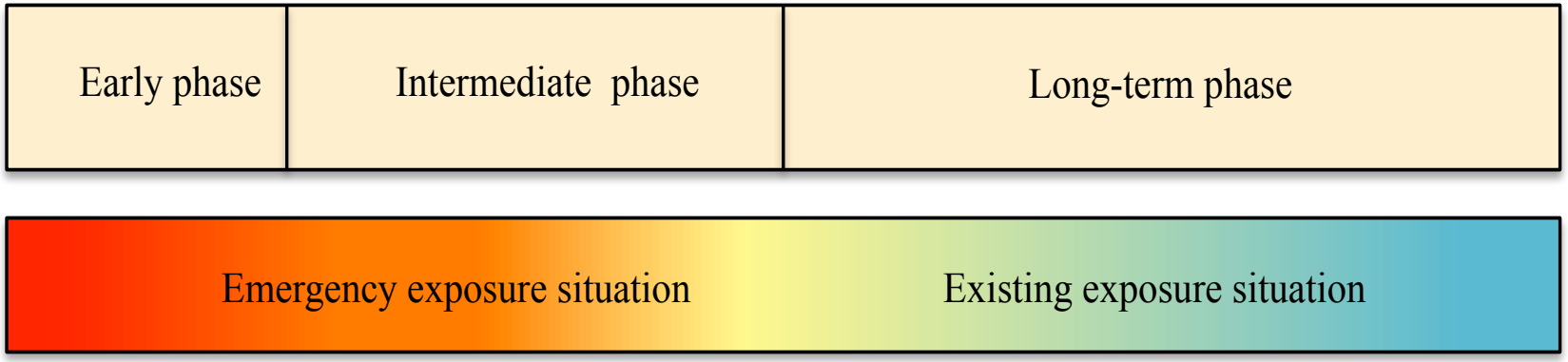
Scope and content of the report

- Publications 109 and 111 were intended to cover all exposure situations resulting from a nuclear accident or a radiation emergency
- Publication 148 focuses only on **large nuclear accidents** i.e. resulting in severe damage to the reactor core and significant releases of radioactive material into the environment, impacting widespread areas
- Content of the report:
  - Chapter 1 introduces the Publication
  - Chapter 2 presents the **timeline of the accident**, its **consequences** and the relevant principles for the **protection of people and the environment**
  - Chapter 3 describes the recommendations that apply to the **early and intermediate phases** of an accident
  - Chapter 4 describes those applying to the **long-term phase**
  - Chapter 5 provides a short overview of **preparedness planning** for large nuclear accident
  - Chapter 6 is a brief conclusion,
  - Annexes A and B provide brief historical overviews of the **Chernobyl** and **Fukushima** nuclear accidents

Timeline for managing a nuclear accident

- For managing a large nuclear accident the Commission distinguishes between the **early,** the **intermediate phases** and the **long-term phase**

- For implementation of the system of radiological protection, the early and intermediate phases are considered as an **emergency exposure situation,** and the long term phase as an **existing exposure situation**



Consequences of a large nuclear accident (1)

- Large nuclear accidents affect **all dimensions of individual and social life** and generate very complex situations
- The main concerns are about the potential health impacts of radiation due to its **unknown character** and **alarming image**
- However, nuclear accidents cannot be managed with radiological protection considerations alone but must take into account the **social, psychological, environmental, educational, cultural, ethical, economic and political factors** associated with the consequences of the accident

Consequences of a large nuclear accident (2)

In Publication 146, the Commission is considering successively the following consequences:

- **Radiation-induced health effects**
  - Tissue reactions (Deterministic effects)
  - Cancer and heritable effects (Stochastic effects)
- **Consequences for fauna and flora**
- **Societal consequences**
- **Economic consequences**
- **Psychological consequences**
- **Health impacts of changes in lifestyle**

Principles for protection of people and the environment (1)

- The objective is **to prevent severe tissue/organ damage**, **to reduce cancer and heritable diseases** to the extent reasonably achievable, and **to prevent or reduce** the frequency of deleterious radiation **effects on biota**

- This objective must be pursued considering to the extent possible, the **health and well-being** of all affected individuals, decent **working conditions** for responders on-site and off-site, the **quality of life** of affected communities off-site, and the **biological diversity** in affected areas

Principles for protection of people and the environment (2)

- For emergency and existing exposure situations, the fundamental protection principles to guide action are:
  - the **justification of decisions**
  - the **optimisation of protection**

- The **principle of individual dose limitation** is not appropriate because the sources of exposures on-site and off-site are **no longer under control.** Under these conditions, it is difficult to predict, with sufficient precision, the doses that will be received by exposed people, and thus to guarantee compliance with dose limits established for planned exposure situations

The justification of protective decisions (1)

- The principle of justification states that **any decision altering a radiation exposure situation should do more good than harm**
- In emergency and existing exposure situations, this principle is applied when deciding whether to take action **to avoid or reduce potential or actual exposures**
- All decisions that aim to reduce the impacts of exposure in the event of a nuclear accident **introduce additional constraints** in working conditions on-site and on daily life in affected areas, which have greater or lesser negative effects on the individuals and communities concerned
- Responsibility for making decisions on the justification of protection is usually the role of **authorities and responsible organisations**

The justification of protective decisions (2)

- In the early phase, justification applies to the decisions on whether or not to take prompt actions to avoid or reduce exposures. In this context, the **evacuation** and **sheltering** of people are the most delicate decisions
- In the intermediate phase, justification applies to decisions on implementing further protective actions with the perspective that these actions **combined together** constitute a coherent **protection strategy**
- Justification also applies to the fundamental decision of authorities concerning **the future of the affected areas**, and marks the beginning of the long-term phase
- ICRP recommends **involving key stakeholders** in public consultation processes for the justification of decisions whenever possible

The optimisation of protection (1)

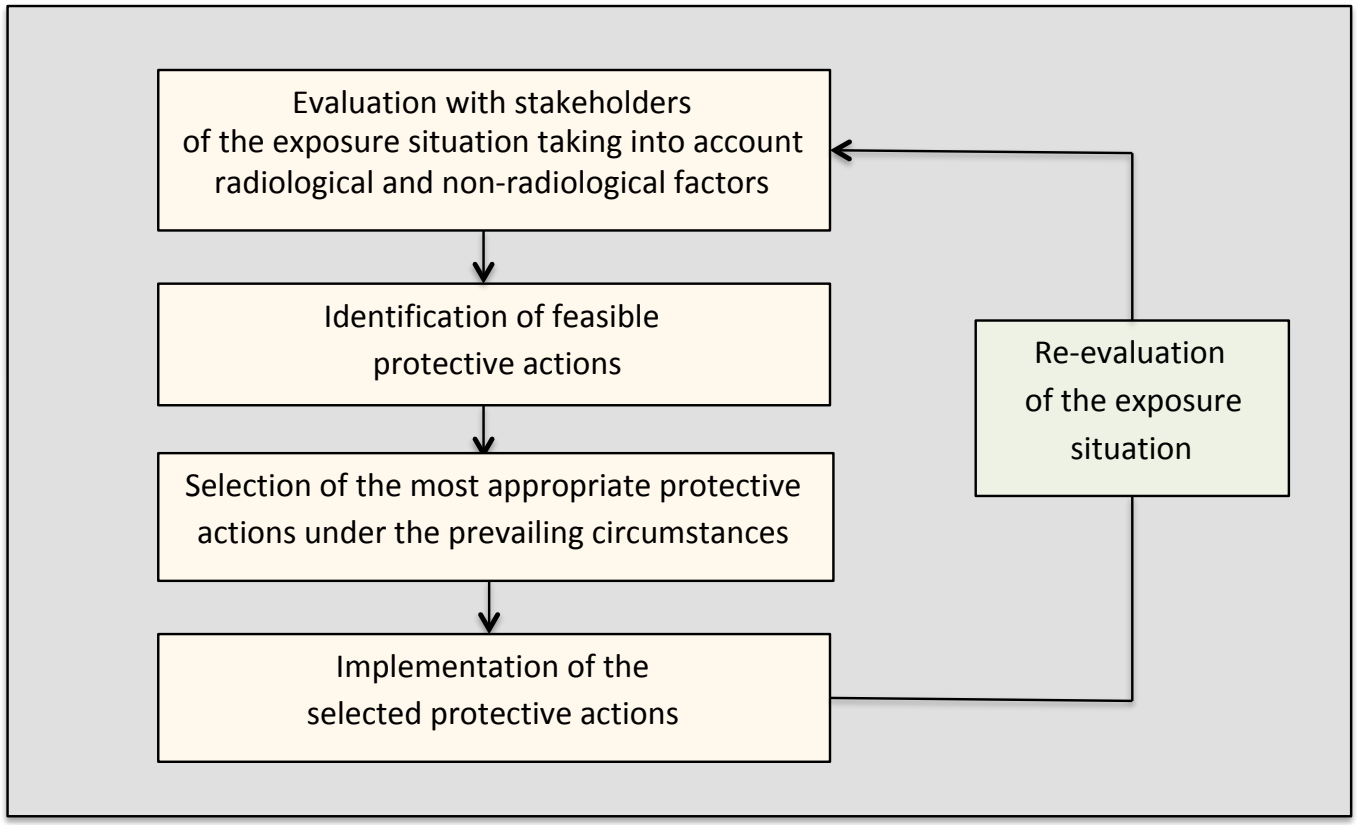
- This central principle of the radiological protection system, means that all individual exposures should be kept **as low as reasonably achievable,** taking into account **societal, environmental and economic** factors

- This should be done with the objective to avoid unnecessary exposure (**prudence**), fair distribution of exposure among exposed individuals (**justice**), and treating people with respect (**dignity**)

- Optimisation should consider the radiological and environmental characteristics of the exposure situation, as reflected by the **views and concerns of stakeholders**, and the **ethical values that govern radiological protection**

The optimisation of protection (2)

- Implementing the optimisation principle is a **step-by-step process** that aims to select the best protective actions given the characteristics of the exposure situation



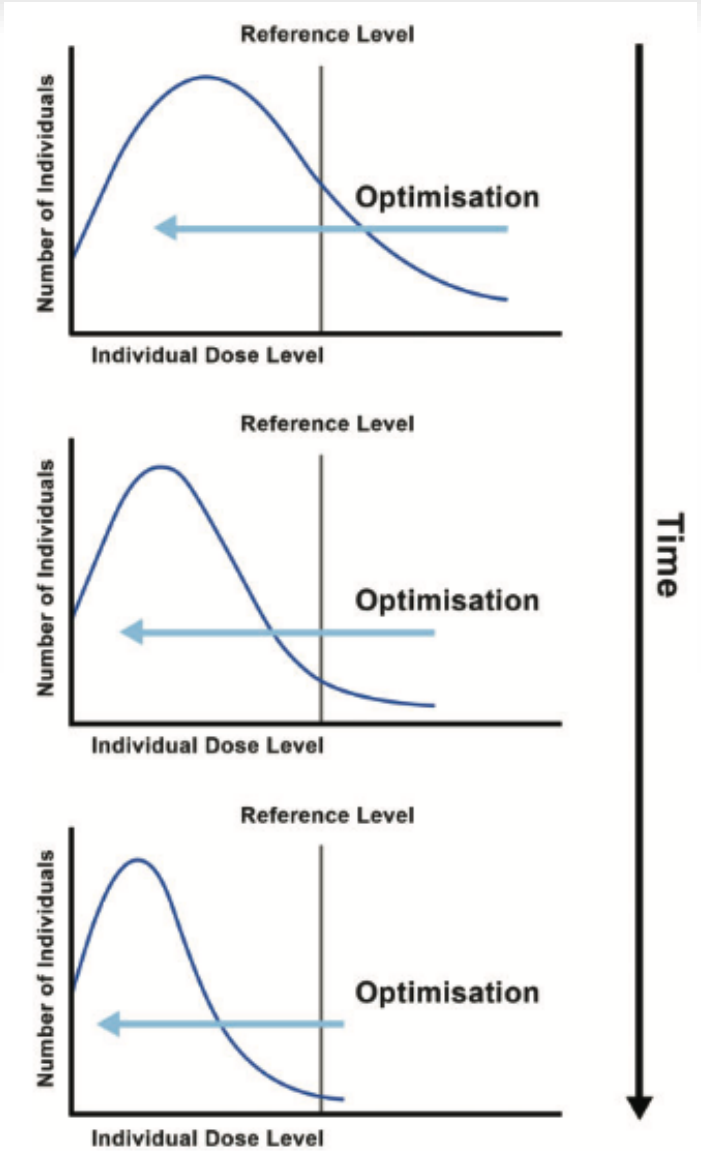
The optimisation of protection (3)

- The optimisation process inevitably has to cope with **conflicts of interest among stakeholders** and must seek to reconcile their different expectations and needs
- ICRP pays particular attention to **equity in the distribution of exposure** within the groups of affected people, and recommends that optimisation of protection should be implemented with the aim of reducing the exposure of the most exposed individuals as a priority
- ICRP considers the implementation of '**self-help protective actions**' to be an integral part of the optimisation process that should be **encouraged and supported** by the authorities and experts
- The Commission recommends that authorities **involve stakeholders** in the decision making process related to the selection and implementation of the protective actions

Optimisation and the use of reference levels (1)

- ICRP recommends using **reference levels** to **restrain inequity** in the distribution of exposures and to **guide** optimisation
- Reference levels are generally expressed in terms of **annual individual effective dose (mSv/year)** and they reflect the level of exposure above which it is considered inappropriate for exposure to occur
- Reference levels are not **prescriptive regulatory limits** that should not be exceeded. In practice, reference levels may well be exceeded by some individuals at the start of, or during the optimisation process, without this constituting any regulatory violation

Optimisation and the use of reference levels (2)



- When the optimisation process starts, a fraction of the exposures may be above the selected reference level according to the ambition of the public authorities
- The priority is then to identify the **most exposed people** and reduce their exposure
- Thus, over time, the number of people receiving exposure above the reference level should decrease, and only a few people with typical behaviours are likely to receive exposure exceeding the reference value
- Eventually, the dose distribution will be very narrow and the average exposure will be well below the reference value

The early and intermediate phases

- ICRP recommends managing the early and intermediate phases of an accident in accordance with the radiological protection principles that apply to **emergency exposure situations**
- Emergency exposure situations arising from large nuclear accidents result in exposure of **on-site personnel** within the facility, as well as **off-site exposure of members of the public**
- During the early phase, it is necessary **to act promptly** to reduce the impact of radiation.
- The Commission recommends that **affected people should be informed by all available channels**, including radio, television, text messages, emails, and social media
- During the intermediate phase **environmental and individual monitoring** should be undertaken in order to **characterize** the radiological situation
- The objective is to know **where, when, and how** people are exposed and will be exposed in the future in order to take actions.

Protection of responders (1)

- Individuals involved in the early and intermediate phases are diverse in terms of status: **emergency teams** (e.g. firefighters, police officers, medical personnel), **workers** (occupationally exposed or not), **professionals and authorities, military personnel, and citizens who volunteer to help**. ICRP considers that the term **'responder'** is appropriate to refer to all of these individuals

- ICRP to manage exposures of responders **as closely as possible** to that of exposed workers in normal operation **but in a specific way** to take into account the fact that the source of exposure is no longer under control and that the working conditions are unusual

- Given the unpredictability of the situation resulting from an accident, this approach should be **sufficiently flexible, while remaining cautious**, to be effective

Protection of responders (2)

- For the protection of responders ICRP recommends applying the principle of **optimisation of protection using reference levels** for managing individual doses
- The total exposure of responders from all activities should be guided by a reference level of **100 mSv for the duration of the early and intermediate phases.**
- For life saving or to regain control of the installations, particularly during the early phase, a very **limited number** of responders may receive exposures above 100 mSv
- The exposures of off-site responders are likely to receive **may be high, but less than on-site**
- As responders work in difficult and **stressful conditions**, specific attention has to be devoted to ensuring that they have **decent working and housing conditions**

Protection of the public

- The Commission presents and give recommendations about the following protective actions

- **Early phase**
  - Evacuation
  - Sheltering
  - Iodine thyroid blocking
  - Personal decontamination
  - Restrictions of food stuffs

- **Intermediate phase**
  - Temporary relocation
  - Foodstuff management

    (Introduction of radiological criteria)
  - Decontamination of the environment
  - Management of business activities

- For the protection of the public the Commission recommends applying the principle of **optimisation of protection using reference** a reference level of **100 mSv or below** for the entire duration of both the early and the intermediate phases

The co-expertise process

- ICRP recommends adopting the '**co-expertise process**' in affected areas as early as the **intermediate phase** of an accident

The long-term phase

- ICRP recommends managing the long term phase of an accident in accordance with the radiological protection principles that apply to **existing exposure situations**
- The long-term phase begins on-site when the authorities in charge of the intermediate phase consider that the damaged facility is **secured**
- Off-site, the long-term phase begins when the authorities have made their **decisions concerning the future of affected areas**, and have decided to allow residents, who wish to do so, to stay permanently in these areas
- Experiences from **Chernobyl** and **Fukushima** have shown that beyond the consideration of radiological aspects, recovery after a large nuclear accident is a **complex process** in which all dimensions of individual and community life are involved and interlinked

Protection of responders

- During the long-term phase on-site, the objective is to **dismantle the damaged installation**, including management of the corresponding waste
- The exposure situation is characterized and the source is **mostly under control**, although unforeseen situations may occur at any time
- For responders on-site, the Commission recommends setting a reference level not above **20 mSv per year**, and applying the requisites for occupational exposure, as relevant
- Off-site, it recommends to use a reference level **less than 20 mSv per year.** When protective actions are implemented in areas with low levels of exposure the reference level generally not needs to exceed **10 mSv per year**

Protection of the public

- Protection of the public in the long-term phase relies on a set of protective actions that **continue and complement** actions implemented during the early and intermediate phases like d**econtamination (including waste management), radiation monitoring, foodstuffs management, health surveillance**
- Selection of the reference level for the optimisation of protection during the long-term phase is a **complex decision** that requires a large amount of information and must be informed by societal and ethical value judgements
- The Commission recommends to select the reference levels in the **lower half of the 1 to 20 mSv per year band** with the objective to progressively reduce exposures to levels towards **the lower end of the band** (i.e. 1 mSv) **and below if possible**
- It also recommends that stakeholders confronted with the situation **should be involved as much as possible**

Preparedness planning

- For the early phase, preparedness relies on the development of **pre-planned protection strategies** for postulated scenarios, based on hazard assessment
- For the long-term phase, preparedness should aim to identify the **vulnerability of potentially affected areas**, and develop guidelines sufficiently flexible to cope with the real situation as appropriate
- A prerequisite to preparedness is to acknowledge the possibility that **a nuclear accident could occur** and the need to develop awareness, if not among the general population, at least among organizations that will be involved in case of an accident
- ICRP recommends that **key representative stakeholders** should participate in emergency and recovery preparedness

Concluding remarks

- A nuclear accident is an unexpected event that profoundly **destabilises** people and society, generates a complex situation, and requires mobilisation of considerable **human and financial resources**

- Operationally, the main recommendation of ICRP is to mitigate the potential effects of radiation on health and the environment using the **principle of optimisation with reference levels** to select and implement protective actions

- To achieve this objective the Commission emphasises the crucial importance of **involving stakeholders**

Annexes: an overview of the Chernobyl and Fukushima nuclear accidents

- The intention of the Annexes is not to give a detailed presentation of the different aspects of these two major accidents, but **to highlight the most significant aspects in terms of radiological protection**

- The presentation of each accident is **in line with the main text** with regard to the successive phases: early, intermediate, and long-term

- The objective is to illustrate the latter by **highlighting the events and decisions** which, over the years, have marked the **management of these two accidents**, and which have served as a reference for the development of Publication 146

NAGASAKI UNIVERSITY
Atomic Bomb Disease Institute
Department of Health Risk Control

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