Radiological Protection
2007

Evolution of the System of Radiological Protection

Third Asian Regional Conference
Tokyo, Japan
5-6 July 2006

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Radiological Protection

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Third Asian Regional Conference
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Co-organised by
The Nuclear Safety Commission (NSC) of Japan
and
The Ministry of Education, Culture, Sports, Science and Technology (MEXT) of Japan

NEA No. 6336

NUCLEAR ENERGY AGENCY
ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT

ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT

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NUCLEAR ENERGY AGENCY

The OECD Nuclear Energy Agency (NEA) was established on 1st February 1958 under the name of the OEEC European Nuclear Energy Agency. It received its present designation on 20th April 1972, when Japan became its first non-European full member. NEA membership today consists of 28 OECD member countries: Australia, Austria, Belgium, Canada, the Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, Luxembourg, Mexico, the Netherlands, Norway, Portugal, Republic of Korea, the Slovak Republic, Spain, Sweden, Switzerland, Turkey, the United Kingdom and the United States. The Commission of the European Communities also takes part in the work of the Agency.

The mission of the NEA is:

- to assist its member countries in maintaining and further developing, through international co-operation, the scientific, technological and legal bases required for a safe, environmentally friendly and economical use of nuclear energy for peaceful purposes, as well as
- to provide authoritative assessments and to forge common understandings on key issues, as input to government decisions on nuclear energy policy and to broader OECD policy analyses in areas such as energy and sustainable development.

Specific areas of competence of the NEA include safety and regulation of nuclear activities, radioactive waste management, radiological protection, nuclear science, economic and technical analyses of the nuclear fuel cycle, nuclear law and liability, and public information. The NEA Data Bank provides nuclear data and computer program services for participating countries.

In these and related tasks, the NEA works in close collaboration with the International Atomic Energy Agency in Vienna, with which it has a Co-operation Agreement, as well as with other international organisations in the nuclear field.

FOREWORD

In 1999, the International Commission on Radiological Protection (ICRP) decided to develop new general recommendations to replace those in its Publication 60, which was issued in 1990. One of the main goals in developing new recommendations was to propose a single, conceptually simple and self-coherent approach to defining appropriate protection under all circumstances, in contrast with ICRP Publication 60 which recommended the use of variable approaches to protection.

The Committee on Radiation Protection and Public Health (CRPPH) of the OECD Nuclear Energy Agency (NEA) organised, in collaboration with the ICRP, several international workshops (in North America, Asia and Europe) to discuss various draft versions of the new ICRP recommendations. Given the advanced stage of the drafting process at the time, the Third Asian Regional Conference focused on the full draft text and its possible implications with the main objectives as follows:

- to evaluate and discuss the possible implications of the draft ICRP recommendations, particularly with respect to Asian expectations and possible future application in Asian contexts;
- to discuss how the new ICRP recommendations could best serve the needs of national and international radiological protection policy makers, regulators, operators, workers and the public with respect to Asian views;
- to continue the open and broad dialogue among stakeholders to reach a common level of understanding of the issues at stake in the Asian context;
- to contribute to the evolution of the new system of radiological protection.

The conference was organised in seven sessions, which considered the new system of radiological protection being proposed from the academic, regulatory and practitioner viewpoints. In addition, lively debates took place during the panel discussions. These proceedings summarise the results and key discussions of the Third Asian Regional Conference on the Evolution of the System of Radiological Protection held on 5-6 July 2006 in Tokyo, Japan.

Acknowledgements

The NEA wishes to express its gratitude to the Ministry of Education, Culture, Sports, Science and Technology (MEXT) of Japan and the Nuclear Safety Commission (NSC) of Japan for co-organising the management of this conference.

The CRPPH and the ICRP would like to thank Professor Henri Mé tivier for the preparation of this report.

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EXECUTIVE SUMMARY

After two previous meetings in Asia, the Third NEA/ICRP Forum on the "Evolution of the system of radiological protection – discussion of ICRP draft recommendations" was held in Tokyo, Japan, 5-6 July 2006, hosted by the Nuclear Safety Commission (NSC) of Japan and the Ministry of Education, Culture, Sports, Science and Technology (MEXT) of Japan. This workshop was the first of a series of three regional meetings (held in Asia, North America and Europe) all scheduled before the end of October 2006.

The objectives of this Asian forum, before adoption of the final draft by the main commission were to:

- To evaluate and discuss the possible implications of the draft ICRP recommendations, particularly with respect to Asian expectations and possible future application in the Asian contexts;
- To discuss how the new ICRP recommendations could best serve the needs of national and international radiological protection policy makers, regulators, operators, workers and the public within the Asian framework;
- To continue the open and broad dialogue between stakeholders to reach a common level of understanding of the issues at stake in the Asian context;
- To contribute to the evolution of the new system of radiation protection.

A broad group of stakeholders participated at the forum including experts from Japan, South Korea, China, Indonesia and Australia. The IAEA also participated in this forum, specifically to present the revision process for the International Basic Safety Standards, BSS, in close connection with the new ICRP recommendations.

Encouraged by the open process of the ICRP for these new recommendations, the forum participants presented during these two days extremely positive comments and criticisms. The constructive attitude by all stakeholders encouraged the ICRP to take comments into account appropriately. This positive attitude is due to the quality of the preparations and presentations by the participants, but also due to the fact that the new draft includes the reactions from the second Asian forum. All stakeholders greatly appreciated the efforts of the ICRP. Without this significantly improved draft proposal such a successful workshop would simply not have been possible. The Asian workshop was extremely useful for receiving feedback on the most recent ICRP draft proposal (June 2006) of its next recommendations.

The chairman of the ICRP, Professor Lars-Erik Holm has clearly presented the new draft focusing on the main changes following the previous discussions, criticisms and discrepancies. All participants have appreciated the new draft, which is clearer. However some criticisms remain, mainly regarding the concept of dose constraints which needs more explanation and clarification. The ICRP has well received the message, and will most probably revise this part of the text.

After significant concerns with earlier drafts, the forum participants have generally given positive comments on many points of the new draft:

- The forum participants appreciated that the new text represents more continuity with ICRP Publication 60 recommendations than change. Maintaining the previous dose limits, while making slight changes to risk evaluation, is well appreciated.

- The new draft clearly describes the goal of radioprotection. The stated attitude of the ICRP is appreciated, it clearly explains that its recommendations are for prospective and protection uses, but not for the prediction of fatalities after an exposure. It was very important to clarify this point, and to express it clearly in the new draft.

- It is well appreciated that the three principles of the ICRP: justification, optimisation and limitation, remain in the new draft. All participants agreed that optimisation is probably the main tool for reducing exposure, particularly at workplace. It is important to reinforce this statement.

- The recommendations of the ICRP continue to be driven by science, but it is clear that social and political forces strongly influence the new ICRP attitude. This is clearly written, and is therefore well appreciated. The presentation of the LNT hypothesis in the text is positively viewed, and it is clearly described as the most appropriate tool for planning and for the implementation of protection. At the same time, LNT is not a universal theory and specific situations could be envisaged.

- The clear description of the decrease in genetic risk is also appreciated.

- Many participants continue to regret that the Sievert is used as the unit for two different concepts of dose; equivalent dose and effective dose. This is not a new viewpoint, and the impetus to change is supported by difficulties encountered with providing explanation to the general public. During this forum it was suggested that equivalent dose should disappear as a regulatory concept and become only a step in the calculation of effective dose. Currently, physicians routinely use Gray to describe the doses they deliver, while regulators use Sievert (but for effective dose). In addition, confusion is caused because equivalent dose should be used to describe deterministic effects, but it is calculated using weighting factors elaborated from stochastic observations.

- Some participants were concerned that the change of weighting factors would result in increased distrust in authorities.

- Participants appreciated that the Commission retained the concept of collective dose, but clearly explained how it should and should not be used. All participants strongly appreciated that the ICRP now clearly recommends that collective dose is not a tool for the evaluation of the predicted number of cancers or cancer deaths, particularly in large populations exposed to very small doses.

- The new recommendations well defined the three types of exposure situations (planned, emergency and existing). It was, however, noted that natural exposure is important in some areas, and it seems important to participants to pursue a uniform implementation of the ICRP recommendations for natural exposure.

- Increased focus on rising medical exposures was seen as urgent for the next years, but the ICRP clearly states that it is essential to keep in mind the balance between benefit and risk for medical use of radiation. It seems for some participants that the translation of the ICRP's medical-exposure publications into their national language is needed.

- Participants agree that the new draft is clearer than the previous one, but they expressed the wish that wording should be carefully examined for non-English mother tongue addressees, that is the majority in the world.

- Dose constraints as described in the draft text remain a point of concern for both regulators and licensees. The nuclear industry does not see a need for dose constraints, but rather feels that the implementation of ALARA has effectively managed worker doses. During discussions, the ICRP recognised that, in effect, dose constraints are already implemented for the day-to-day management of worker exposures, but feels that what is true for the nuclear energy industry is not always true in other field of activities. Thus the question of who will establish numerical values for dose constraints remains a key unanswered question in the draft text. Many participants feel that while the ICRP is the best organisation to describe principles and general recommendations, specific dose constraints should be set by national or local regulatory bodies, or by licensees for worker dose constraints in some cases, through dialogue between regulatory bodies and relevant stakeholders.

The ICRP appreciated these constructive criticisms, and clearly said that the final text will be more clearly explained, and concepts will be more illustrated in order to avoid ambiguity and confusion.

Finally, the conference participants were grateful to the ICRP for the ongoing dialogue over the past several years of recommendation development, and to the NEA for its organisation of these dialogues.

WELCOME ADDRESSES

Shizuyo KUSUMI

Kimihiko ODA

Gail H. MARCUS

WELCOME ADDRESS

Shizuyo KUSUMI
Commissioner, Nuclear Safety Commission of Japan

Dr. Lars-Erik Holm, distinguished guests, ladies and gentlemen:

It is my great honour and pleasure to deliver a welcome address at the opening of the Third Asian Regional Conference on the Evolution of the System of Radiological Protection. On behalf of the Nuclear Safety Commission of Japan, a co-organiser of this conference, I welcome all of you here today.

First of all, I would like to express my sincere appreciation to the International Commission on Radiological Protection (ICRP) for its outstanding achievements in the development of a radiological protection system. In particular, we appreciate the "Open and Democratic" policy initiated by Professor Clarke, former chair of the ICRP, with his open-stance leadership which has fostered constructive discussions about the new ICRP recommendations at the last two Asian Regional Conferences.

I would also like to express my appreciation to Dr. Holm and the ICRP for the "more continuity than change" policy. I also thank Dr. Holm and other members of the ICRP for their active participation in this Third Asian Regional Conference to share the philosophy behind the revised draft of the new ICRP recommendations.

I am grateful to the OECD Nuclear Energy Agency (OECD/NEA), our partner as co-organiser of this conference. The OECD/NEA has conducted a broad-range of activities to enhance nuclear and radiation safety. Together with the Japanese Ministry of Education, Culture, Sports, Science and Technology, the OECD/NEA organised the past two Asian Regional Conferences in 2002 and 2004.

Today I would like to remind you that this year, 2006, is the twentieth anniversary of the Chernobyl accident and the fiftieth anniversary of the founding of the United Nations Scientific Committee on the Effects of Atomic Radiation, UNSCEAR. As you know, public concern about radiation safety has significantly increased since the Chernobyl accident. During this conference held in such a memorial year, I look forward to having fruitful discussions based on new scientific knowledge and to developing a common understanding about the new ICRP recommendations.

Thank you for your kind attention.

WELCOME ADDRESS

Kimihiko ODA
Director-General Science and Technology Policy Bureau, MEXT, Japan

Honourable Dr. Lars-Erik HOLM, ICRP Chairperson, Dr. Shizuyo KUSUMI, Commissioner of Nuclear Safety Commission of Japan, many distinguished guests from the IAEA and Asian-Pacific countries, OECD/NEA staff, secretariat of this conference, ladies and gentlemen.

On behalf of the Ministry of Education, Culture, Sports, Science, and Technology (MEXT) of Japan, I would like to express my deep appreciation to my colleagues for giving me the honour of making the opening statement in this "Third Asian Regional Conference on the Evolution of the System of Radiological Protection". This conference is basically organised by OECD/NEA Committee on Radiation Protection and Public Health (CRPPH), and we MEXT and Nuclear Safety Commission also worked together as co-organisers. We hosted the two conference successfully previously. Today, it is our pleasure that we have a third opportunity to host this honourable conference.

As you know, the International Commission on Radiological Protection (ICRP) has presented their own recommendations and guidelines to the world since 1928. Their recent most important general recommendations were presented in 1990, which is known as ICRP publication 60. This publication contains basic new concepts for the system of radiological protection, therefore, many countries including Japan introduced some of its concepts into their legislation system for radiation protection. Regulatory authorities have accountability to their nations and stakeholders when they introduce a new concept into present regulations. Therefore it is a good opportunity for regulatory authorities to participate in this conference and exchange opinions to understand the new concept.

Nowadays, the ICRP has started to open their draft for new general recommendations which will replace Publication 60 on their internet web site and asking for public comments to the world. I would like to welcome this open minded approach of the ICRP members and hope that the ICRP will listen carefully to the voice of regulatory authorities, operators, workers and other concerned parties. In addition, I would like to dedicate respect to the persons concerned, including Dr. Lars-Erik Holm, the chairperson of ICRP who has played the leading role, and Dr. Yasuhito Sasaki who has served as the member of ICRP main commission.

The CRPPH created this conference in collaboration with the ICRP, in order to reflect the opinions regarding ICRP new draft report from Asian region. It is very significant for Asian countries that this conference is held in Asia, and I would like to appreciate for the activities of the CRPPH.

In today's meeting, first we are expecting a presentation by Dr. Holm and Japanese ICRP committee members regarding ICRP new draft report. Then after, some distinguished guests from IAEA and Asian-Pacific national regulatory authorities such as Korea, China, Australia, Indonesia and Japan, and the academic society and utilities in Japan, will give some comments on the draft report.

I think this conference might be a good opportunity for all the participants to exchange their knowledge and opinions with ICRP Chairperson. I wish you enjoy staying in my country and bring back some fruitful discussions to each country. Finally I hope that this conference will contribute to the further evolution of the radiological protection system in Asia.

Thank you very much.

WELCOME ADDRESS

Gail H. MARCUS
Deputy Director-General, OECD Nuclear Energy Agency

On behalf of the NEA, Dr. Gail H. Marcus, the NEA Deputy Director-General, welcomed all participants to the conference.

In her statement Dr. Marcus noted the broad attendance at the workshop, which gathered 190 participants from Japan, Korea, China, Australia and Indonesia, and included representatives from the regulatory organisations of all these countries. In particular, she noted that Japanese participation included industry, government, radiation protection professionals and the medical profession. Presentations from several international organisations, including the ICRP and the IAEA, also enhanced the value of and interest in the meeting.

Dr. Marcus expressed her thanks to all those who worked so hard to prepare this meeting, and in particular acknowledged the support to and participation in the meeting by NSC and MEXT, which were co-organising this conference with the NEA; NIRS and JAEA, for contributing to the programme committee; Dr. Lars-Eric Holm, chair of the ICRP, and Dr. Jacques Lochard, chair of the CRPPH, who also participated in the programme committee and actively participated in the conference preparation.

In presenting the OECD Nuclear Energy Agency and explaining the focus and activities of the CRPPH, Dr. Marcus noted that this conference is one in a series of meetings aimed at providing the ICRP with regional views on the new draft recommendations, and will be followed by the North American Regional Conference in August 2006 in Washington DC, and the NEA/ICRP forum in Prague at the end of October 2006. She also reminded participants that the NEA will participate actively in the revision process of the International Basic Safety Standards, which will take into account the views that will be expressed at this conference regarding current radiation protection topics.

Finally, Dr. Marcus stressed the importance of the constructive comments and suggestions that will result from this conference. These will be fed to the ICRP to assist in the further development of the new recommendations, thus helping to ensure that they are broadly and clearly understood, and that they will enjoy support and be as universally implemented as previous ICRP recommendations.

SESSION 1

THE NEW ICRP GENERAL RECOMMENDATIONS

Chair: Yasuhito SASAKI
Co-Chair: Jacques LOCHARD

The new draft ICRP recommendations was presented by the ICRP chair, Professor Lars-Eric Holm. His presentation was followed by presentations by Japanese members of the various ICRP committees, discussing their views of the draft recommendations based on their own technical experience. After these presentations, questions from the floor raised many of the key issues of the conference: dose constrains, the LNT hypothesis, dose bands, etc. This showed that the conference participants had carefully and completely read the draft, and were very interested in building a final ICRP recommendation that appropriately addresses all their concerns. These issues were also discussed throughout the entire conference.

THE NEW ICRP SYSTEM OF RADIOLOGICAL PROTECTION

Lars-Erik HOLM
Chair, International Commission on Radiological Protection

ICRP's Recommendations

The first recommendations were issued in 1928 and concerned the protection of medical staff against occupational exposure.

General recommendations have appeared in

- Publication 1 (1959)
- Publication 6 (1964)
- Publication 9 (1966)
- Publication 26 (1977), and
- Publication 60 (1991).

Since 1991, nearly 30 different numerical restrictions on dose have appeared in a number of publications.

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ICRP Main Commission 2005 - 2009

L-E Holm (Chair), Sweden	J.D. Boice Jr, USA
R Cox (Vice-Chair), UK	A Gonzá lez, Argentina
RJ Preston (C 1), USA	J-K Lee, Korea
C Streffer (C 2), Germany	Z Pan, PR China
C Cousins (C 3), UK	Y Sasaki, Japan
A Sugier (C 4), France	N Shandala, Russian Federation
RJ Pentreath (C 5),UK	

<u>Emeritus Members:</u> RH Clarke, UK; CB Meinhold, USA; F Mettler, USA; B Lindell, Sweden; WK Sinclair,USA

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The Work of the ICRP Committees

- Committee 1: Biological & medical effects
- Committee 2: Doses from radiation exposures
- Committee 3: Medical radiation exposures
- Committee 4: Application of ICRP recommendations
- Committee 5: Protection of the environment

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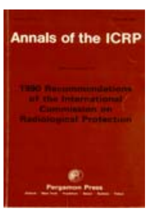
International Basic Safety Standards

- There is a close connection between ICRP's recommendations and the BSS since 1962.
- The BSS have followed the establishment of new ICRP recommendations:



- The 1990 recommendations were the basis for the 1996 BSS.

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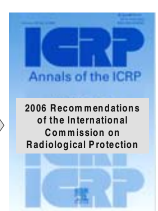
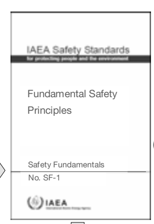
UNSCEAR - ICRP - IAEA

Effects of radiation



Recommendations for protection



Essential principles (*moral obligation*)

Essential requirements (*legal obligation*)

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The Need for Revision

- The radiation risks have not changed substantially.
- Biological and physical assumptions need updating.
- Existing recommendations need to be consolidated and simplified.
- Non-human species should receive more emphasis than in the past
- There is no hurry.

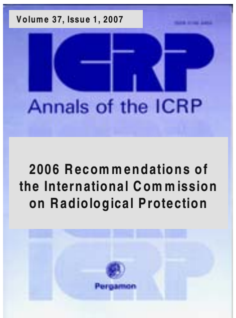
The 2006 Recommendations

The Commission has decided to issue the revised recommendations having three primary aims in mind:

- To take account of new biological and physical information and of trends in the setting of radiation safety standards;
- To improve and streamline the presentation of the recommendations; and
- To maintain as much stability in the recommendations as is consistent with the new scientific information.

ICRP's 2006 Recommendations

- Aims and scope
- Biological aspects
- Dosimetric quantities
- The system of radiological protection
- Medical exposure of patients
- Exposure to natural sources
- Potential exposures
- Emergency and existing situations
- Protection of the environment
- Implementation of the recommendations
- Glossary
- References



What Is New?

There is more continuity than change!

Most recommendations will remain – because they work and are clear.

Some recommendations are to

- Be explained – because more guidance is needed;
- Be added – because there has been a void; or
- Differ – because understanding has evolved.

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The Aim of the Recommendations

- To provide an appropriate standard of protection for people and the environment, without unduly limiting the beneficial actions giving rise to radiation exposure.

* * * *

- The 2006 recommendations consolidate and add to previous recommendations issued in various ICRP publications.
- The existing numerical recommendations in the policy guidance given since 1991 remain valid unless otherwise stated.

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Major Features

- Maintaining the fundamental pinciples of radiological protection, and clarifying how they apply to sources and the individual;
- Updating the weighting factors and the radiation detriment;
- Maintaining the dose limits;
- Extending the concept of constraints in the source-related protection to all situations.

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Practices and Intervention in ICRP 60

Practices

Limit

Constraints

↓

Optimisation

Intervention

↓ Optimisation

Intervention Level

What happens below the intervention level?

No further optimisation?

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Are Practices and Interventions Different?

In both cases

- There is a maximum level of dose above which the regulator will demand action.
- Optimisation of protection is seen to reduce the level of dose at which action is taken.
- No action to further reduce doses is taken below the optimised level of protection.

CONCLUSION: There is no procedural difference

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Types of Exposure Situations

- Replacing the concepts of “practice” and “intervention” with three types of exposure situations that address all conceivable circumstances:
  - Planned situations
  - Emergency situations
  - Existing situations.

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Foundation Documents and Building Blocks

Foundation documents:

- Biological and Epidemiological Information on Health Risks Attributable to Ionising Radiation (C1)
- Basis for Dosimetric Quantities Used in Radiological Protection (C2)

Building blocks:

- Low-Dose Extrapolation of Radiation-Related Cancer Risk (C1)
- Radiological Protection in Medicine (C3)
- Optimisation of Protection (C4)
- Assessing Dose to the Representative Individual (C4)
- The Scope of Radiological Protection Regulations: Exclusion and Exemption (MC)

Scope of the Recommendations

The recommendations

- cover exposures to both natural and artificial sources that are controllable
- apply to control of sources or to pathways leading to doses in individuals.

Protection concerns

- exposure to incremental doses to natural background, and
- risks primarily at levels in the order of a few mSv in a year.

The System of Protection

- Types of exposure situations;
- Types of exposure;
- Identification of the exposed individuals;
- Source-related and individual-related assessments;
- The three fundamental principles of protection;
- A description of levels of individual dose that require protective action;
- A delineation of the conditions for the safety of radiation sources; and
- The implementation of the recommendations.

Quantities for Radiological Protection

Absorbed dose, *D*

⬇

Protection quantities defined in the body and related to risk from stochastic effects

Equivalent dose, H_T, in an organ or tissue T

⬇

Effective dose, E

⬇

Committed dose, $H_T(\tau)$
Collective dose, $S(\tau)$

Linear-non-threshold (LNT) Hypothesis

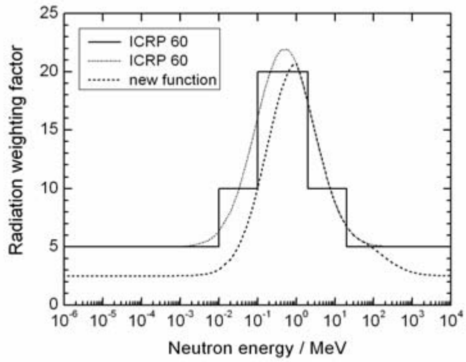
The LNT hypothesis is the basis for:

- Averaging and summing up of doses;
- The concept of effective dose;
- The concept of committed and collective dose;
- Individual dosimetry with integrating detectors; and
- The system of dose record keeping.

Radiation Weighting Factors, w_R

Type and energy range	Publication 60	2006
Photons, all energies	1	1
Electrons and muons, all energies	1	1
Protons	5	**2**
Alpha particles, fission fragments, heavy nuclei	20	20
Neutrons	Stepwise function	**Continuous function**

New w_R for Neutrons



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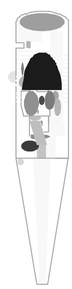
New Reference Phantoms

MIRD Phantom



Voxel Male and Female Phantoms

New dose coefficients in 2008

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Effective Dose (*E*)

- *E* is calculated by using reference values for a reference person or group. Weighting factors are averaged over age and gender.
- *E* should be used only for compliance of constraints and dose limits to control stochastic effects.
- *E* should mainly be used for planning in prospective situations.
- *E* should <u>not</u> be used for more detailed retrospective dose and risk assessments on exposure of individuals.
- *E* should <u>not</u> be used for epidemiological studies.

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Main Conclusions on Biology

Dose-response for stochastic effects: A simple proportionate relationship between dose and risk at low doses.

DDREF: 2.

Genomic instability, bystander effects, adaptive response: Still insufficient knowledge for protection purposes.

Genetic susceptibility: Known disorders too rare to distort risk estimates; impact of weak genetic determinants cannot be judged.

In-utero cancer risk: Life time risk similar to that of young children (a few times higher than that of the whole population).

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Main Conclusions on Biology

Nominal probability coefficients for cancer: Based on incidence and not mortality.

Nominal probability coefficients for heritable diseases: Based on UNSCEAR 2001 and up to 2nd generation.

Tissue reactions in adults: Revised judgements but no major changes.

Risks of non-cancer diseases (A-bomb LSS): Great uncertainty on dose response < 1 Sv; no judgement on low dose risk possible.

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The Tissue Weighting Factors

- Determine lifetime cancer incidence for rad.-assoc. cancers.
- Apply DDREF.
- Transfer risk estimates across populations (ERR:EAR weights).
- Apply weighted risk estimates to and average across seven Western and Asian populations to provide nominal risk coefficients.
- Adjust for lethality, quality of life and for years of life lost to obtain the radiation detriment for each type of cancer.
- Normalize to unity and obtain the relative radiation detriments.
- These are grouped into four categories broadly reflecting the relative detriments, i.e. **the tissue weighting factors**.

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Tissue Weighting Factors, w_T

Tissue	w_T	? w_T
Bone-marrow, breast, colon, lung, stomach, remainder tissues[1]	0.12	0.72
Gonads	0.08	0.08
Bladder, oesophagus, liver, thyroid	0.04	0.16
Bone surface, brain, salivary glands, skin	0.01	0.04

[1] Nominal w_T divided equally between 14 tissues.

Nominal Risk Coefficients for Stochastic Effects (% Sv^{-1})

Exposed population	Cancer		Heritable effects		Total	
	1990	2006	1990	2006	1990	2006
Whole	6.0	5.5	1.3	0.2	7.3	6
Adult	4.8	4.1	0.8	0.1	5.6	4

The Genetic Risk Estimate – 1991 and Now

- In 1991: based on UNSCEAR 1988, DD in mice, extrapolated to theoretical equilibrium (many generations).
- Now: based on UNSCEAR 2001, DD based on humans and mice, 2 generations only since extrapolation to equilibrium makes incorrect assumptions.
- UNSCEAR 2001, BEIR VII also used 2 generations and arrived at similar risks.
- Radiation-induced multigene deletions have very low fitness → selection will remove almost all in 2 generations → 2-generation risk must be close to theoretical equilibrium.

The Genetic Risk Estimate – Now

Keeping gonadal doses ALARA is
still strongly recommended!

ICRP INTERNATIONAL COMMISSION ON RADIOLOGICAL PROTECTION

Summary of Radiation Risks

- The nominal risk estimates are now slightly smaller than in 1990, but the risk is in the same order of magnitude as before.
- The overall risk coefficient of 0.05 Sv^{1} (0.00005 mSv^{-1}) continues to be appropriate for purposes of radiological protection.

ICRP INTERNATIONAL COMMISSION ON RADIOLOGICAL PROTECTION

Principles of Protection

SOURCE RELATED

JUSTIFICATION

Any decision that alters the radiation exposure situation, e.g., by introducing a new radiation source or by reducing exposure, should do more good than harm, i.e., yield an individual or societal benefit that is higher than the detriment it causes.

ICRP INTERNATIONAL COMMISSION ON RADIOLOGICAL PROTECTION

Principles of Protection

SOURCE RELATED

OPTIMISATION

The level of protection should be the best under the prevailing circumstances, i.e., maximising the margin of good over harm. To avoid serious inequities resulting from the optimisation procedure, there should be restrictions on the doses or risks to individuals from a particular source (dose or risk constraints).

Thus, optimisation involves keeping exposures as low as reasonably achievable, taking into account economic and societal factors, as well as any inequity in the distribution of doses and benefits amongst those exposed.

ICRP INTERNATIONAL COMMISSION ON RADIOLOGICAL PROTECTION

Principles of Protection

INDIVIDUAL RELATED

DOSE LIMITS

In planned situations, the total dose to any individual from all regulated sources should not exceed the appropriate limits specified by the Commission.

ICRP INTERNATIONAL COMMISSION ON RADIOLOGICAL PROTECTION

Dose Constraint

- Is the most fundamental level of protection for the most exposed individuals from a single source within a type of exposure.
- Applies to all situations;
- Is used prospectively as the starting point of the optimisation process;
- Is not a form of retrospective dose limitation;

ICRP INTERNATIONAL COMMISSION ON RADIOLOGICAL PROTECTION

Dose Constraint

- In planned exposure situations, it is less than limits;
- In emergency or existing exposure situations, it represents the level of dose/risk where action is ***almost always*** warranted;
- The chosen value will depend upon the circumstances of the exposure;
- It will be established at the national or local level by regulators or operators.

ICRP INTERNATIONAL COMMISSION ON RADIOLOGICAL PROTECTION

Dose Constraint

- The numerical criteria recommended by ICRP in Publication 60 and thereafter can be regarded as constraints.
- The values fall into three defined bands: 0.01-1 mSv, 1-20 mSv and 20-100 mSv.
- These bands will enable selection of an appropriate value for a constraint for a specific situation that has not been addressed explicitly by ICRP.

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Dose Constraint

BANDS OF PROJECTED DOSE	REQUIREMENTS
20 - 100 mSv	Exceptional situations. Benefit on a case-by-case basis. Information, training and individual monitoring of workers, assessment of public doses.
1 - 20 mSv	Individual direct or indirect benefit. Information, training and either individual monitoring or assessment.
Under 1 mSv	Societal benefit (not individual). No information, training or individual monitoring. Assessment of doses for compliance.

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Dose Constraint

BANDS OF PROJECTED DOSE	EXAMPLES
20 - 100 mSv	Action to reduce exposures in a radiological emergency. Exposure situations involving abnormally high levels of natural background radiation.
1 - 20 mSv	Occupational exposure in planned situations. Radon. Countermeasures (e.g., sheltering and iodine prophylaxis) in the event of an accident.
Under 1 mSv	The exposure of members of the public from planned situations.

Additional Radiation Dose and Risk

0.01 – 1 mSv

UNACCEPTABLE RISK

1 mSv – also public dose limit

TOLERABLE RISK

DOSE CONSTRAINT

Optimisation

↓

Protection optimised

ACCEPTABLE RISK

(TRIVIAL RISK)

Additional Radiation Dose and Risk

1 – 20 mSv

UNACCEPTABLE RISK

20 mSv – also occupational dose limit

TOLERABLE RISK

DOSE CONSTRAINT

Optimisation

↓

Protection optimised

ACCEPTABLE RISK

Constraints for Radon

ICRP's policy is based upon setting a level of effective dose from radon where action would be warranted:

10 mSv per year

ICRP's constraints are set where action is almost always warranted:

Home	600 Bq m^{-3}
Work	1500 Bq m^{-3}

National regulators apply the optmisation of protection to arrive at the level at which to act.

ICRP INTERNATIONAL COMMISSION ON RADIOLOGICAL PROTECTION

Additional Radiation Dose and Risk

20 – 100 mSv

UNACCEPTABLE RISK

100 mSv

TOLERABLE RISK

DOSE CONSTRAINT

Optimisation

↓

Protection optimized

ACCEPTABLE RISK

ICRP INTERNATIONAL COMMISSION ON RADIOLOGICAL PROTECTION

The Collective Dose

- Is an instrument for optimisation, for comparing radiological technologies and protection procedures.
- Is not intended as a tool for epidemiologic risk assessment. It is therefore inappropriate to use it in risk projections based on epidemiological studies.
- The computation of cancer deaths based on collective doses involving trivial exposures to large populations is not reasonable and should be avoided. Such a use was never intended and is an incorrect use of the collective dose.

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The Collective Dose

For decision aiding, more information is often necessary, e.g. for the workforce:

- Number exposed, mean dose, dose range, task-related dose, etc.
- When, where, how and by whom are exposures received?

For decision making, it may be reasonable to give more weight to doses that are:

- Moderate or high;
- Received in the near future.

ICRP INTERNATIONAL COMMISSION ON RADIOLOGICAL PROTECTION

Exclusion and Exemption

A legislative system for radiological protection should establish

- What should be within the legal system and what should be excluded from the law and its regulations;
- What could be exempted from some regulatory requirements because regulatory action is unwarranted.

The legislative framework should provide the regulator with the authority to exempt situations from specified regulatory requirements.

ICRP INTERNATIONAL COMMISSION ON RADIOLOGICAL PROTECTION

Exclusion from Legislation

Exposures that may be excluded from radiological protection legislation include

- Uncontrollable exposures, e.g., ^{40}K in the human body, and

- Exposures that are essentially not amenable to control regardless of their magnitude, e.g., exposure to cosmic rays at ground level.

ICRP INTERNATIONAL COMMISSION ON RADIOLOGICAL PROTECTION

Exemption

Principles that should govern the process of exemption:

- The individual risk attributable to the exposure must be insignificant (for man-made sources, this is judged to correspond to an annual dose of around 10μSv);
- Radiological protection, including the efforts for the regulatory control, must be optimised;
- The practice must be justified and its sources should be inherently safe.

ICRP INTERNATIONAL COMMISSION ON RADIOLOGICAL PROTECTION

Recommended Exemption

- Devices emitting adventitious radiation of max. 5 keV and max. 1 μSv h^{-1} at 0.1 m from any surface of the device;
- Radionuclides in activity concentrations smaller than those specified by FAO and WHO for foodstuff and drinking water, and by the IAEA for non-edible commodities, for radiation sources and for materials in transport.

ICRP INTERNATIONAL COMMISSION ON RADIOLOGICAL PROTECTION

Implementation Takes Time…

ICRP 1977 Recommendations (Publication 26)
  International standards 1984
    National standards ~1989

ICRP 1990 Recommendations (Publication 60)
  International standards 1996
    National standards ~2000

ICRP 2006 Recommendations
  International standards 2010?
    National standards 2015?

ICRP INTERNATIONAL COMMISSION ON RADIOLOGICAL PROTECTION

Time Schedule

- June – 15 Sept 2006: New consultation on draft recommendations.
- November 2006: Earliest possible date of adoption of the recommendations in Rabat, Morocco.
- 2007: Publication of the new recommendations.

INTERNATIONAL COMMISSION ON RADIOLOGICAL PROTECTION

VIEWS ON THE NEW ICRP RECOMMENDATIONS FOCUSING ON THE RADIATION EFFECTS

Ohtsura NIWA
Kyoto University, Radiation Biology Center

Will be discussing

The New Recommendations
1. What's new?
2. What's the problem?
3. What to do with the problem?
4. What's Asian views?

1. What's new ?
New and old in the New Recommendations

What's new and what's the same ?

Pagagraph 11 - 12

"Keep the fundamental principles"
"Updating the details"

Updating the biology in the New Recommendation - tissue weighting factors, W_T -

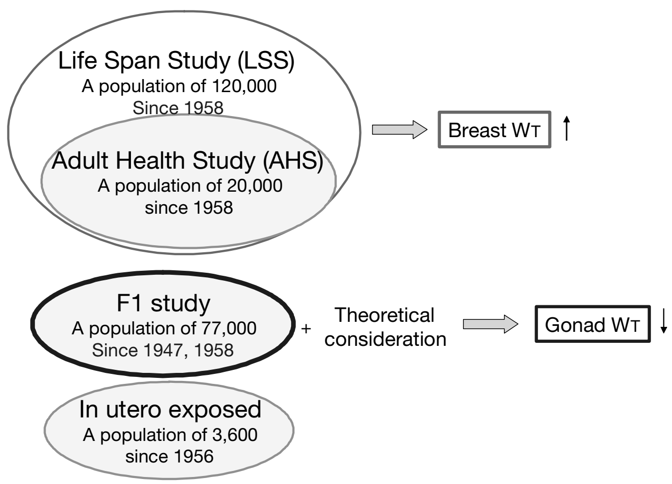
1990

tissue	w_T	Σw_T
gonad	0.20	0.20
Bone marrow, colon, lung, stomach	0.12	0.48
Bladder, breast, esophagus, liver, thyroid	0.05	0.25
Skin, bone surface	0.01	0.02
remainder tissues	0.05	0.05

This time

tissue	w_T	Σw_T
Bone marrow, colon, lung, stomach,breast, remainder tissues	0.12	0.72
gonad	0.08	0.08
Bladder, esophagus, liver thyroid	0.04	0.16
Bone surface, brain, salivary gland, skin	0.01	0.04

New understandings from Hiroshima & Nagasaki



2. What's the problem? The old problem of uncertainty

ICRP risk evaluation system

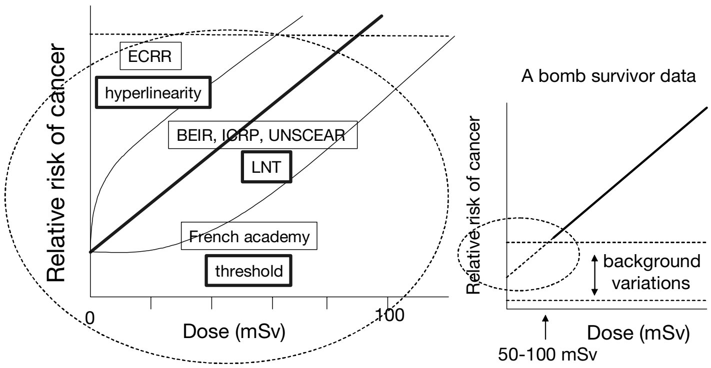
LNT: a theoretical foundation of radiation protection
Risk = cumulative dose x risk estimates x DDREF x W_R x W_T
Data: A bomb survivor data

dose:	measurements + estimation (uncertain)
risk estimate:	Cross population risk transfer (uncertain
DDREF:	varies with biological endpoints (uncertain)
W_R:	varies with biological endpoints (uncertain)
WT:	round up values (uncertain)

Those in blue are all uncertain, more or less

Uncertainty particularly large for low doses and dose rates

3. What to do with the problem?
- the good old principle of LNT hypothesis -



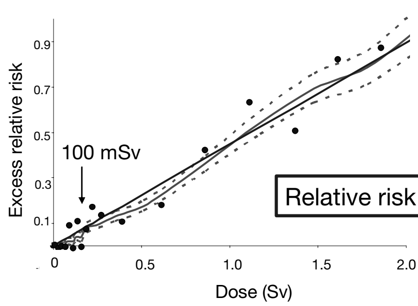
LNT: powerful hypothesis with limitations

Two foundations of LNT
- with their limitations -

Epidemiological studies on A bomb survivors
dose → detriments
“no power for low doses/dose rates”

Radiation biology
dose → damage → detriments
“too naïve a view”

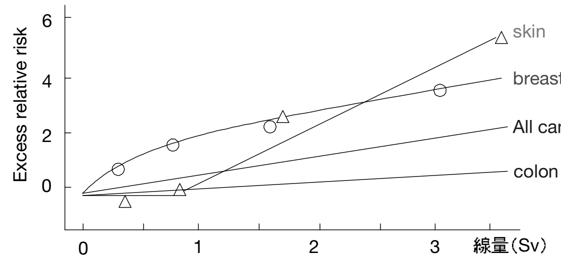
Epidemiological studies
Dose response of A bomb survivors



Relative risk = 1.5/ Sv

Linear increase of the risk above 100 mSv
Uncertain below 100 mSv
Trends do not exclude LNT in low dose range

Shape of the dose response
- tumor type dependent -



All 0.63	oral 0.29	digestiv 0.38	oesoph 0.25	stomach 0.32	intestine 0.72	colon 0.21
liver 0.49	gall 0.12	Pancre 0.18	respirat 0.50	lung 0.95	skin 1.0	breast 1.6
uterus 0.15	ovary 0.98	prostate 0.29	urinary 1.2	bladder 1.0	thyroid 1.2	brain 0.26

Thompson *et al.*
Radat. Res. 1994

Uncertain low risks in epidemiology
- Size of the study population -
- Homogeneity of the study population -

Estimated population size

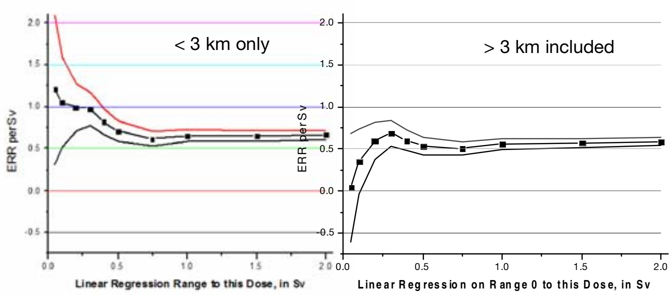
Dose (mSv)	Background risk	Excess risk	Total risk	Size of population
1 000 mSv	10%	10%	20%	67
100 mSv	10%	1%	11%	5 728
10 mSv	**10%**	**0.1%**	**10.1%**	**558 000**
1 mSv	10%	0.01%	10.01%	55 700 000

by Charles Land

⇩

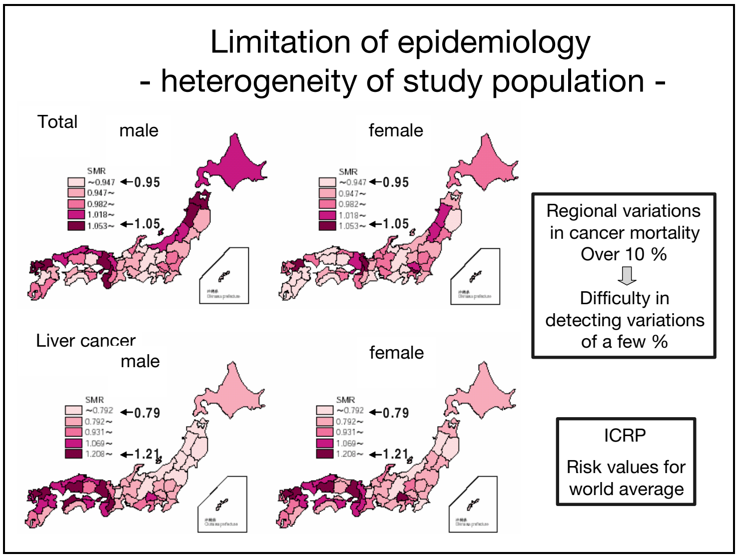
Evaluation of 10 mSv risk not possible even with 100 000

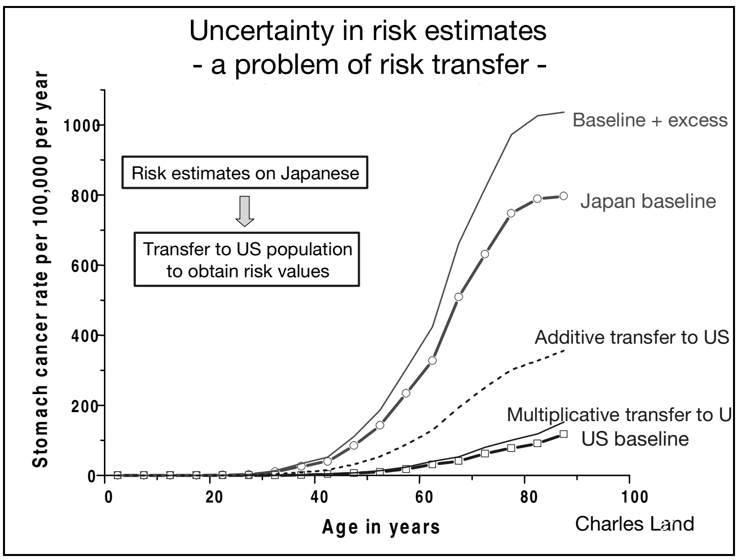
Uncertainty of low dose risk values
ERR/Sv of solid cancer, the survivor data

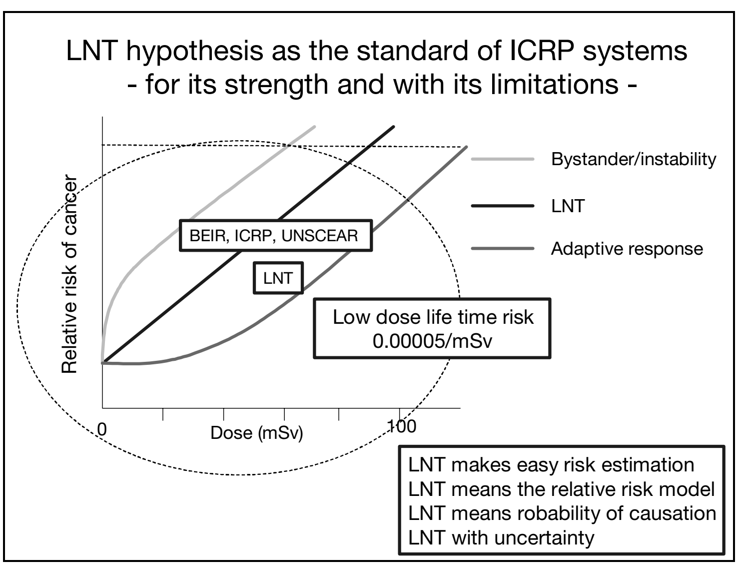


Left-hand panel based on proximal (< 3 000 m) survivors only; in right-hand panel the distal (> 3 000 m) survivors also contribute, resulting in higher zero-dose baseline

Based on data of Pierce & Preston (Radiat Res, 154, 178, 2000), by C Land


Limitation of epidemiology
- heterogeneity of study population -
Total
male
female
SMR
←0.95
←1.05
Regional variations in cancer mortality Over 10 %
Difficulty in detecting variations of a few %
Liver cancer
male
female
←0.79
←1.21
ICRP
Risk values for world average


Uncertainty in risk estimates
- a problem of risk transfer -
Stomach cancer rate per 100,000 per year
1000
800
600
400
200
0
Risk estimates on Japanese
Transfer to US population to obtain risk values
Baseline + excess
Japan baseline
Additive transfer to US
Multiplicative transfer to U
US baseline
0
20
40
60
80
100
Age in years
Charles Land


LNT hypothesis as the standard of ICRP systems
- for its strength and with its limitations -
Relative risk of cancer
BEIR, ICRP, UNSCEAR
LNT
Bystander/instability
LNT
Adaptive response
Low dose life time risk 0.00005/mSv
0
Dose (mSv)
100
LNT makes easy risk estimation
LNT means the relative risk model
LNT means robability of causation
LNT with uncertainty

3-2. What to do with the problem?
ICRP well aware of the uncertainty

ICRP is very careful in using LNT, collective dose, and (cumulative dose)

Pagagraph 29

"LNT is - - - to manage risk from radiation exposure"

Parageraph 146 - 147

"- in the case of low individual doses withwide geographical areas/long time scales, the use of collective dose for risk estimation - - is not reasonable and should be avoided"

Some differences between ICRP and BEIR VII

ICRP: pragmatic, realistic and conservative
- LNT as a tool, not truth
- supplemented with real data

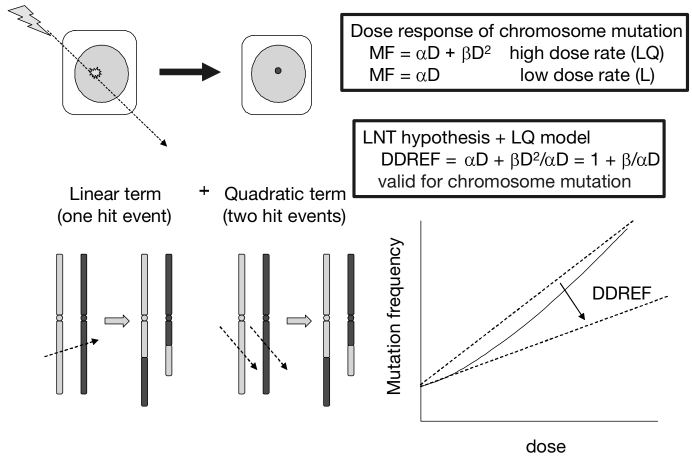
BEIR VII: theoretical, idealistic and radical
- LNT as science
- based mainly on theory

⇧

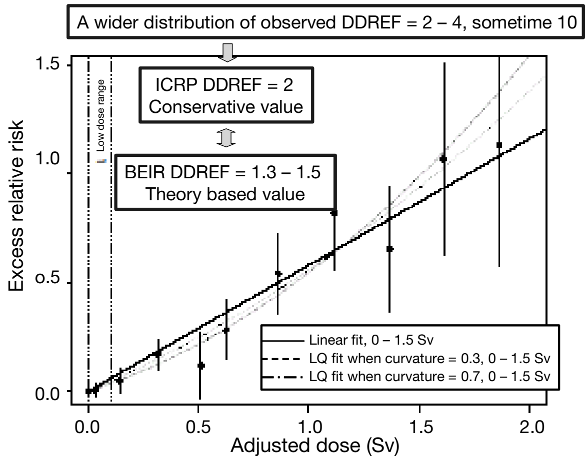
BEIR VII Report on page 30

"The Committee concludes thatthe current scientific evidence is consistent with the hypothesis that there is a linear, no-threshold dose-response relationship ---"

Heavy dependence of BEIR VII on theory
example of DDREF values

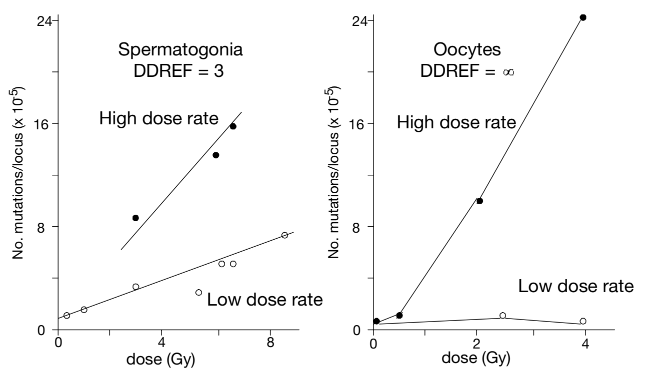


BEIR VII DDREF calculation



Experimental approach to obtain DDREF

Mouse germline mutation



Even the linear portion dose rate sensitive!

Adv. Radiat. Biol.4, 131, 1974

3-3. What to do with the problem?
Further improvement of the recommendations

The New Recommendations by no means perfect

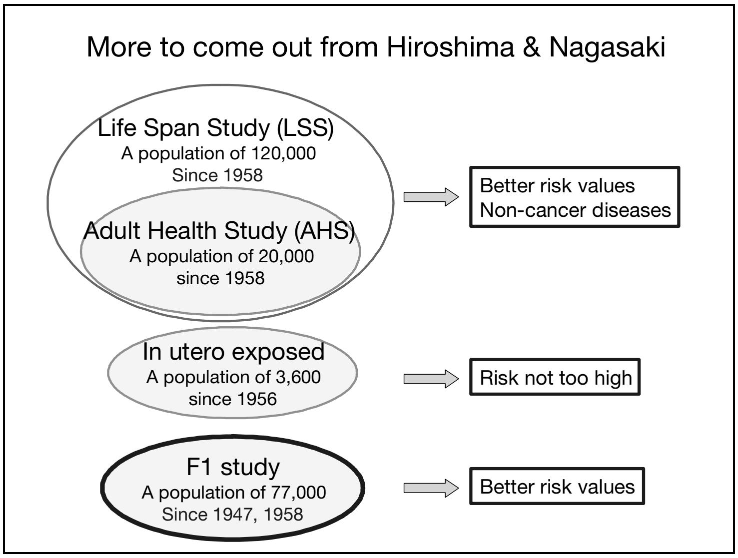
⇩

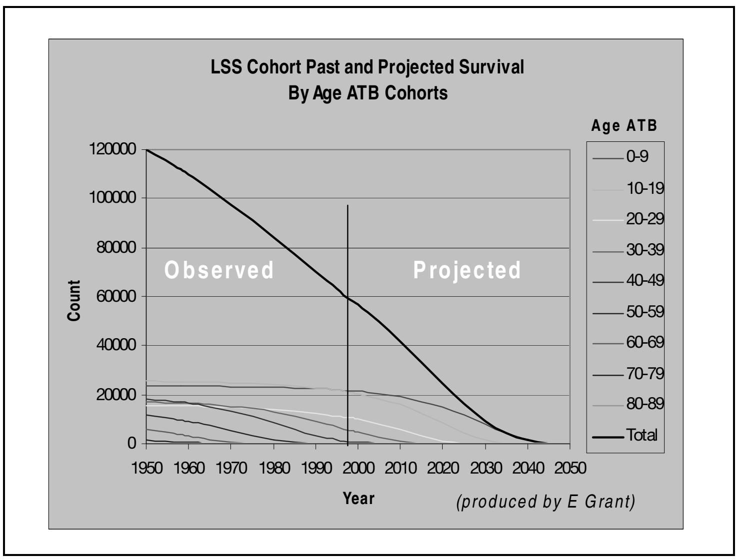
Need to be improved

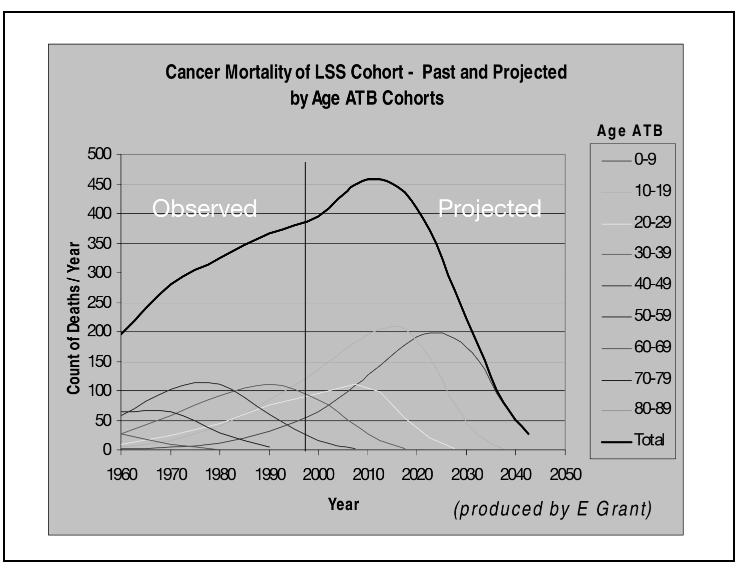
Ex. Protection of individuals
genetic predisposition, gender and age

⇩

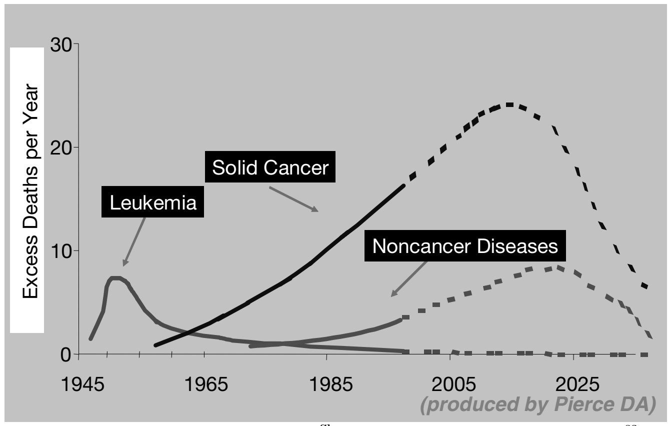
Research needs
Epidemiological studies on low dose risk
Mechanistic understandings of low dose effects


More to come out from Hiroshima & Nagasaki
Life Span Study (LSS)
A population of 120,000
Since 1958
Adult Health Study (AHS)
A population of 20,000
since 1958
Better risk values
Non-cancer diseases
In utero exposed
A population of 3,600
since 1956
Risk not too high
F1 study
A population of 77,000
Since 1947, 1958
Better risk values


LSS Cohort Past and Projected Survival
By Age ATB Cohorts
Age ATB
0-9
10-19
20-29
30-39
40-49
50-59
60-69
70-79
80-89
Total
Observed
Projected
Count
120000
100000
80000
60000
40000
20000
0
1950 1960 1970 1980 1990 2000 2010 2020 2030 2040 2050
Year
(produced by E Grant)


Cancer Mortality of LSS Cohort - Past and Projected
by Age ATB Cohorts
Age ATB
0-9
10-19
20-29
30-39
40-49
50-59
60-69
70-79
80-89
Total
Observed
Projected
Count of Deaths / Year
500
450
400
350
300
250
200
150
100
50
0
1960 1970 1980 1990 2000 2010 2020 2030 2040 2050
Year
(produced by E Grant)

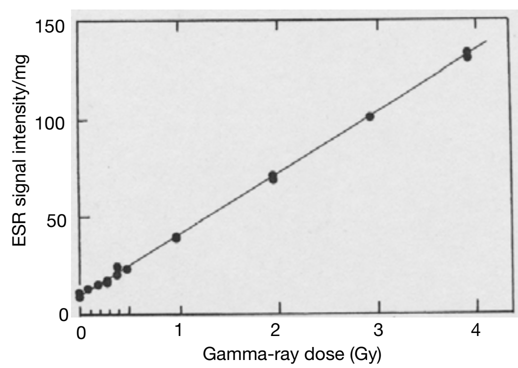
LSS radiation-associated deaths by time period: Observed and anticipated



Shore 23

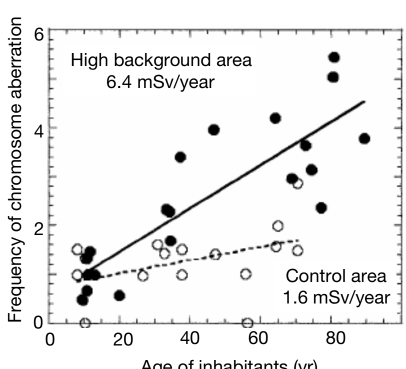
Even the dose estimation is improving

ESR based dose estimation on tooth



Int J Radiat Biol. 73, 619-627, 1998

From China: the high natural radiation area studies - not one of those ecologic studies -



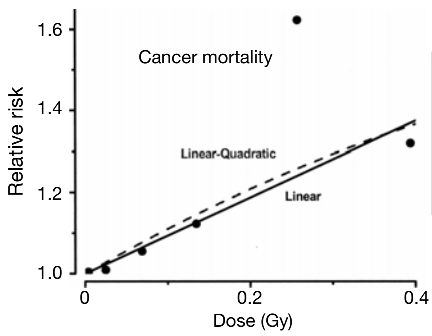
Relative risk of cancer mortality

Dose (mSv)	cases	RR	95% CI
0-99	142	1.00	-
100-199	261	0.83	0.65-1.06
200-299	211	0.98	0.76-1.26
300-399	263	0.90	0.68-1.18

A population of 125,000
Reliable dose estimation
⇩
Chromosome mutation: increase
Cancer mortality: no increase

Jiong *et al.* J. Radiat. Res. 41, 63, 2000
Sun *et al.* J. Radiat. Res. 41, 43, 2000

Techa river cohort with risk higher than the survivors
- higher risk values without DDREF correction -

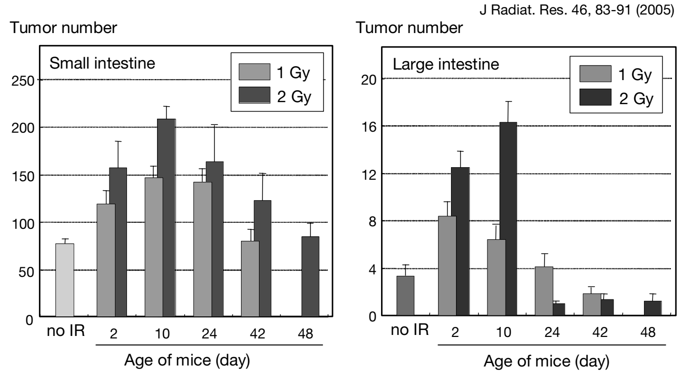


A population of 30,000
Dose estimation not accurate
⇩
Dose dependent increase
No power below 0.3 Sv
ERR = 0.92/Sv
Without DDREF correction !

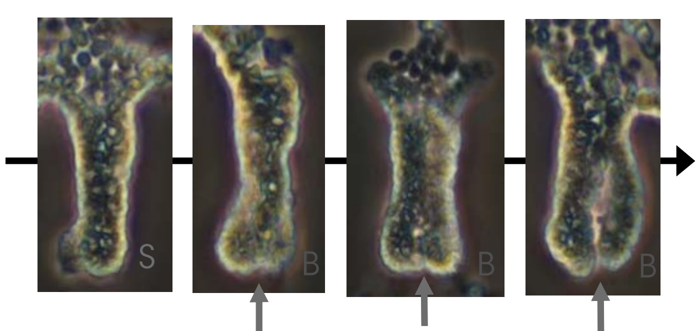
Krestinina *et al.* Radiat Res 164, 602, 2005

3-4. What to do with the problem
The power of basic studies
- an example of the Min mouse system -

M. Okamoto and H.Yonekawa
J Radiat. Res. 46, 83-91 (2005)



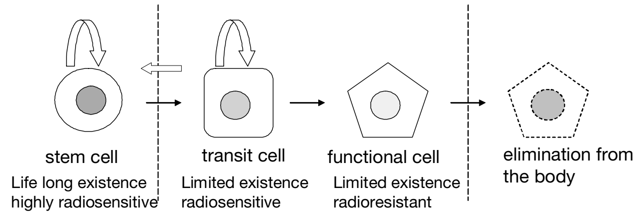
Radiation susceptibility only during
expansion of stem cells in Min mouse



Bi-furcation of crypt of large intestine in12 day old Min mouse

M. Tatematsu and Tsukamoto,
unpublished

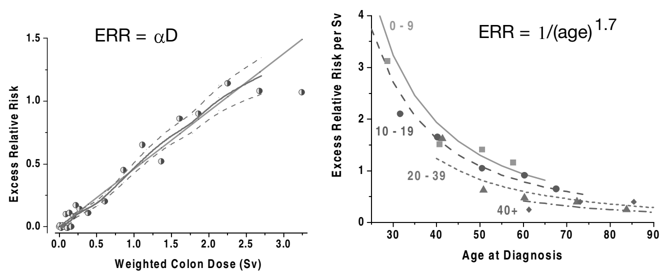
The power of basic studies
Tissue stem cells and tissue turnover



Radiosensitivity and turnover rate of target cells
highly sensitive stem cells or transit cells

Age dependency of radiation carcinogenesis
Cumulative dose: life long or with limitation?
decline of risk: due to tissue turnover?

Observed time trend of cancer risk in the LSS population



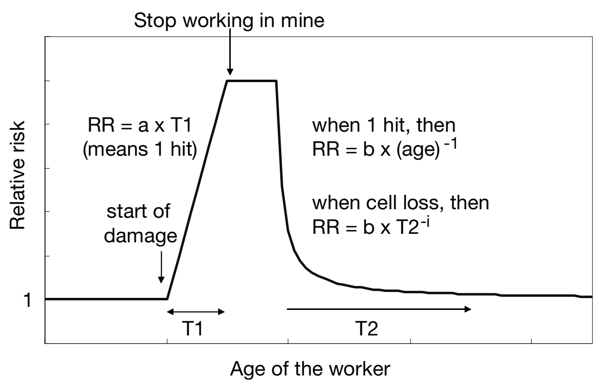
Pierce & Vaeth, Biostatistics 4, 231, 2003

Linear increase means 1 hit
→ ERR declines by 1/age

however

The real rate = $1/(\text{age})^2$
→ Loss of initiated cells?
Due to tissue turnover?

Trend of risk decline in uranium miners



If the rate of decline = $1/(\text{age})^1$
then Loss of initiated cells?

4. What's Asian view?
The way to deal with the uncertainty

ICRP risk evaluation system

LNT: a foundation with a certain limit
Risk = cumulative dose x risk estimates x DDREF x W_R x W_T
Data: A bomb survivor data

⇩

Low dose risk far from certain
Step by step clarification of uncertainty
yet
Regulations/policies needed

Basic principle and tradition of ICRP

ICRP

C1 tires to make uncertainty to certainty
C4 & MC tries to bring better regulations
even in the face of uncertainty

⇩

Fully consistent with Asian view!

Asian views

Tradition of balance, realism and pragmatism

孔子 (Confucius, B.C. - 552)
「知之爲知之不知爲不知是知也」
to know not knowing is knowing

莊子（Zhuangzi, B.C. - 275）
「小知間々大知閑々」
Small knowledge separates things, large
knowledge glues things together

Darai Lama (2005)
"When a Buddhist teaching contradicts
science, revise the teaching"

VIEWS ON THE NEW ICRP RECOMMENDATIONS FOCUSING ON THE DOSES FROM RADIATION EXPOSURE

Nobuhito ISHIGURE
Nagoya University

BASIS FOR DOSIMETRIC QUANTITIES USED INRADIOLOGICAL PROTECTION (Annex B of Main Recommendations)

Contents

Quantities for Radiological Protection

In radiological protection practice, one needs quantities

- a single quantity
- specifying the "amount" of exposure
- related to the probability of stochastic effects
- for all types of radiations
- both for acute and chronic exposures
- both for external and internal exposures

However, this demand is **not** achievable in a strict scientific sense.

Quantities for Radiological Protection

The present approach to establish dose quantities is pragmatic for radiological protection with a justified scientific basis.

- The approach is based upon the assumption of a linear, no threshold, dose-response relationship (LNT).
- Microdosimetric considerations or the three-dimensional track structure are not taken into account.

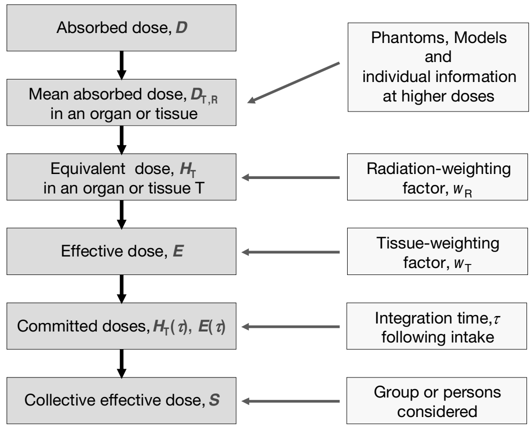
Quantities for Radiological Protection

The initial step : Energy transfer to biological material
⇒ Absorbed energy per unit of mass
(absorbed dose)

However, it is **not** reasonable to use absorbed dose as a protection quantity,
because radiation effects depend on

- the type of radiation;
- the time and space distribution of energy absorption;
- the sensitivity of the exposed tissues or organs.

Dose Quantities for Radiological Protection



Radiation Weighting Factor

Radiation type	Radiation weighting factor, w_R	
	New Recommendations	ICRP 1991
Photons	1	1
Electrons Muons	1	1*)
Protons**)	2	5
Charged pions	2	—
Alpha particles Fission fragments Heavy nuclei	20	20
Neutrons	A continuous curve depending on neutron energy	< 10 keV : 5 10 keV to 100 keV : 10 > 100 keV to 2 MeV : 20 > 2 MeV to 20 MeV : 10 > 20 MeV : 5

*) Excluding Auger electrons emitted from nuclei bound to DNA
**) Other than recoil protons, energy > 2 MeV

Radiation Weighting Factor for Photons

In *in vitro* investigations
Effects: low energy X-rays > ^{60}Co-gamma rays

However, w_R = 1 for all photons because of

- a much lower ratio observed in animal experiment;
- epidemiological data not showing clear difference;
- degradation by Compton scattering in human body;
- strong attenuation of low-energy photons close to the body surface; and
- operational dose quantities providing a conservative estimation in mammography.

Radiation Weighting Factor for Low Energy Electrons

DNA precursors labeled with tritium
Auger emitters incorporated into DNA

Very short range →

Much higher dose in nuclei than mean dose to the tissue

However, w_R = 1 for **all** low LET radiations.

- The ICRP is not proposing a specific scheme for the treatment of doses and risks.
- This simplification is sufficient only for the intended application for limitation and controlling of doses.

Radiation Weighting Factor for Neutrons (1)

Neutron energy ↑

- The production of secondary photons ↓
- The energy of recoil protons ↑
- The release of heavier charged particles ↑

Therefore,

- Radiation field in the body varies between different tissues due to the production of secondary radiations of **different** radiation quality in the body.
- The biological effectiveness of neutrons is strongly **dependent on** the neutron energy.

Radiation Weighting Factor for Neutrons (2)

- A continuous function
  not because of availability of more precise data
  but because of **practical** considerations

- E < 1 MeV

$$RBE_{av} = RBE_{high\text{-}LET}(1-f_{low\text{-}LET}) + RBE_{low\text{-}LET} \cdot f_{low\text{-}LET}$$

$RBE_{high\text{-}LET} = 25$
$RBE_{low\text{-}LET} = 1$
$f_{low\text{-}LET}$: the absorbed dose contribution from secondary photons calculated with anthropomorphic phantoms

Radiation Weighting Factor for Neutrons (3)

◆ 1 MeV < E < 50 MeV

It is appropriate to **stay** with the values in Publ. 60

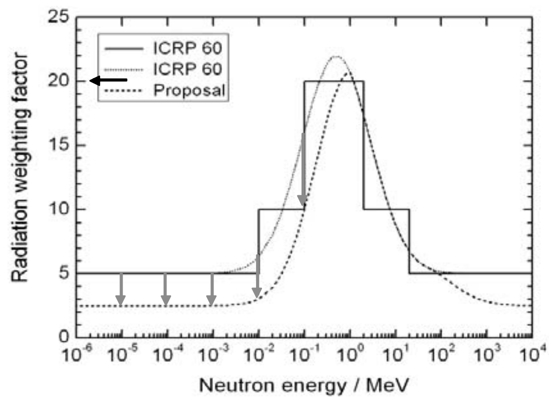
no new experimental data
general uncertainty of RBE in this region

◆ 50 MeV < E

The value is decreasing from 5.5 at 50 MeV to 2.5 at 10 GeV

Calculations of Pellicioni (1998; 2004)
Yoshizawa *et al.* (1998)
Sato *et al.* (2003)

Radiation Weighting Factor for Neutrons (4)



Radiation Weighting Factor for Protons

◆ External exposure of **high** energy protons is relevant to the assessment of effective dose.

4 MeV : 0.25 mm
10 MeV : 1.2 mm
Mostly absorbed in the skin

◆ Animal experiments : 1～2
Q(L) function applied to 100 MeV : less than 1.2
Secondary charged particles at 1 GeV : 1.8

The w_R value adopted is **2** rather than 5 as in Publ. 60.

Radiation Weighting Factor for Alpha Particles

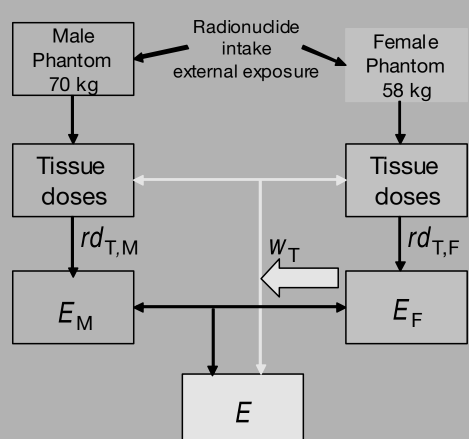
- Limited human data : **10 – 20** for lung and liver
  lower for bone cancer
  and leukaemia
- Animal and *in vitro* studies : **10** or greater
  Complexity in distributions of radionuclides
  Strong model dependence
  Valuable guidance but not the only basis
- Q(L) function applied to 6 MeV : **20**
- Recent data: not support the change of w_R value

The w_R value of **20** is retained.

Tissue Weighting Factor

Organ/Tissue	Tissue weighting factor, w_T		
	New	ICRP 1991	ICRP 1977
Oesophagus	0.04	0.05	—
Stomach	0.12	0.12	—
Colon	0.12	0.12	—
Liver	0.04	0.05	—
Lung	0.12	0.12	0.12
Bone surface	0.01	0.01	0.03
Skin	0.01	0.01	—
Breast	**0.12**	0.05	0.15
Bladder	0.04	0.05	—
Thyroid	0.04	0.05	0.03
Bone marrow	0.12	0.12	0.12
Brain	**0.01**	—	—
Salivary glands	**0.01**	—	—
Remainder	**0.12**	0.05	0.30
Gonads	**0.08**	0.20	0.25

Gender Averaging – Effective Dose



RVM and RVF

Zankl氏より提供のスライドより

Gender-averaged Effective Dose

$$E = \sum w_T \left[\frac{H_T^M + H_T^F}{2} \right]$$

$$H_{rem}^M = \frac{1}{13} \sum_T^{13} H_T^M \quad , \quad H_{rem}^F = \frac{1}{13} \sum_T^{13} H_T^F$$

E : Gender-averaged effective dose

W_T : Gender-averaged tissue weighting factors

H_T^M : Equivalent dose of tissue T for males

H_T^F : Equivalent dose of tissue T for females

Treatment of Remainder Tissues

	New Recommendations	ICRP 1991
Organs/tissue	Adrenals, Extrathoracic tissue, Gall bladder, Heart wall, Kidneys, Lymph nodes, Muscle, Oral mucosa, Pancreas, Small intestine, Spleen, Thymus Prostate (male) Uterus/cervix (female)	Adrenals, Brain, Upper large intestine, Small intestine, Kidneys, Muscle, Pancreas, Spleen, Thymus, Uterus
W_T	0.12	0.05
Averaging of the equivalent dose	Simple arithmetic dose averaging	Mass-weighted dose averaging
"Splitting rule"	No splitting rule	●0.025 to the tisue receiving a dose in excess of the highest dose ●0.025 to the other 'remainder' tissues

Operational Quantities

The protection quantities : **not** measurable in practice

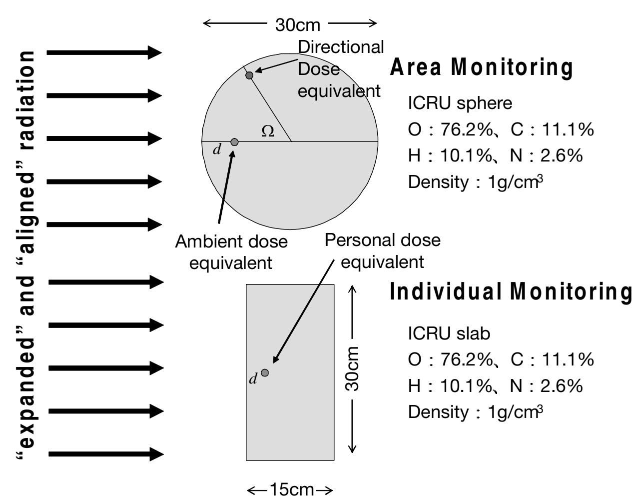
Operational quantities

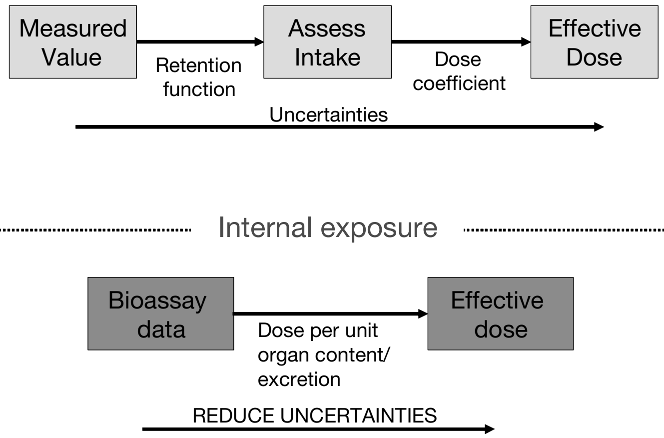
- Upper limit for the value of the protection quantities
- For practical regulations or guidance
- Different types of quantities for internal and external exposures

External Exposure

Operational quantities are defined by ICRU
(ICRU REPORT 39, 43, 51,66)

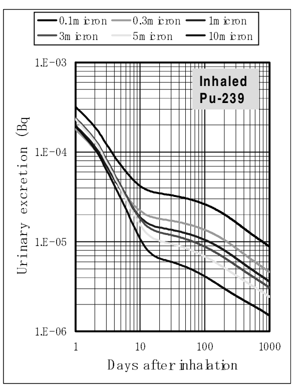
Task	Operational quantities for	
	Area monitoring	Individual monitoring
Control of effective dose	Ambient dose equivalent $H^*(10)$	Personal dose equivalent $H_p(10)$
Control of doses to the skin, the extremities and the lens of the eye	Directional dose equivalent $H'(0.07, \Omega)$	Personal dose equivalent $H_p(0.07)$



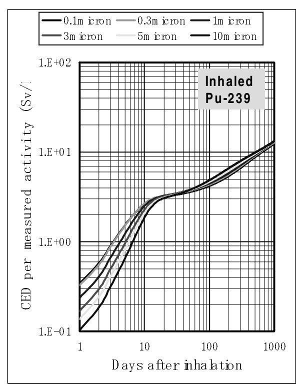


9月15日午後全体セッションでのMenzel氏のスライドより

Retention/excretion

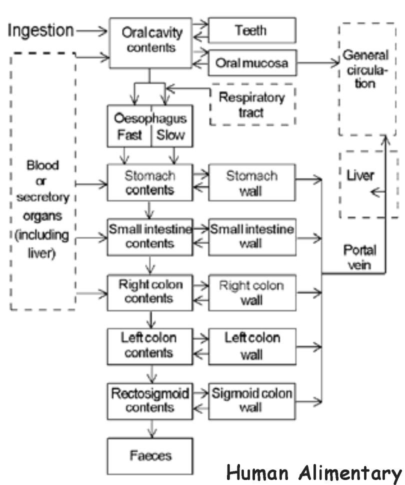


Dose per unit content/excretion

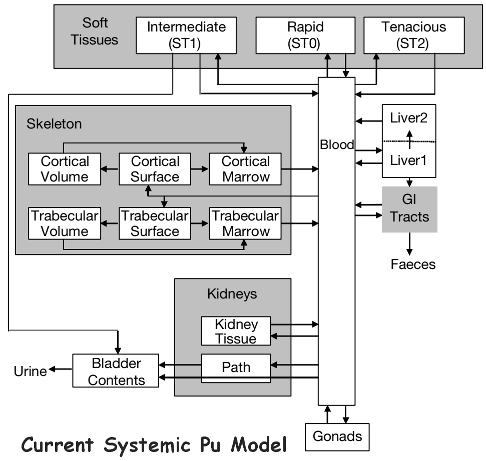


Dose＝Measured value ÷ [Retention/excretion] × [Dose coefficient]

Dose＝Measured value × [Dose per unit content/excretion]



Human Alimentary Tract Model



Current Systemic Pu Model

Uncertainties and Judgements

Effective dose : not measurable

➡ Models and parameter values are necessary

- Best estimate
- Periodical re-evaluation
- Large uncertainties

varies for various parameters and the circumstances

ICRP takes the position that:

- It is impossible to give **general values** of uncertainties.
- The models have been developed primarily for use in **prospective** radiological protection purposes
- The models and the data should be taken as **references fixed by convention** and **not** subject to uncertainty.

System of Quantities for Radiological Protection

Absorbed dose, D

Dose quantities (protection quantities) defined in the body

Equivalent dose, H_T, in an organ or tissue T

↓

Effective dose, E

Committed doses, $H_T(\tau)$, $E(\tau)$
Collective effective dose, S

Operational quantities defined for measurements and assessment of doses in the body

For external exposure

Dose quantities for area monitoring Dose quantities for individual monit. H_T, in an organ or tissue T

For internal exposure

Activity quantities in combination with models and computations

VIEWS ON THE NEW ICRP RECOMMENDATIONS FOCUSING ON THE OPTIMISATION OF PROTECTION AND INDIVIDUAL DOSE LIMITS

Toshiso KOSAKO
The University of Tokyo

Representative Individual

Critical group to representative individuals

1. Deterministic, probabilistic approach.
2. Retrospective & prospective.
3. Normal, existing, emergency.
4. Age dependence (three categorisation).
5. Environment.
6. Habits.
7. Distribution and uncertainty.

Optimisation (1)

Selection of the best option

characteristics of population, exposure social (equity, social benefit, etc.), environmental, non-radiation hazards, technical & economical, political, regulatory conditions

Optimisation (2)

Stakeholder involvement
in the procedure of decision making

1. Lessons learned and examples.
2. Detail structure of stakeholder involvement.
3. Generic and specific.
4. Culture difference.

Optimisation (3)

Exposure distribution and collective dose

1. Exposure distribution in time and space.
2. How to apply a multi-attribute expression to a real world?
3. Applicability of a new idea like a group weighting factor.

Optimisation (4)

Example of Cost-benefit Analysis

1. Question of an applicability or validity of cost-benefit analysis.
2. Monetary value.
3. Relationship to the former publication.

Dose Constraint >> Definition,
Examples

1. Source upper bound
   > allocation of dose limitation.
2. Source related value.
3. Individual dose > target zone.
4. Relationship between dose limitation.

Practice and Intervention

Intervention

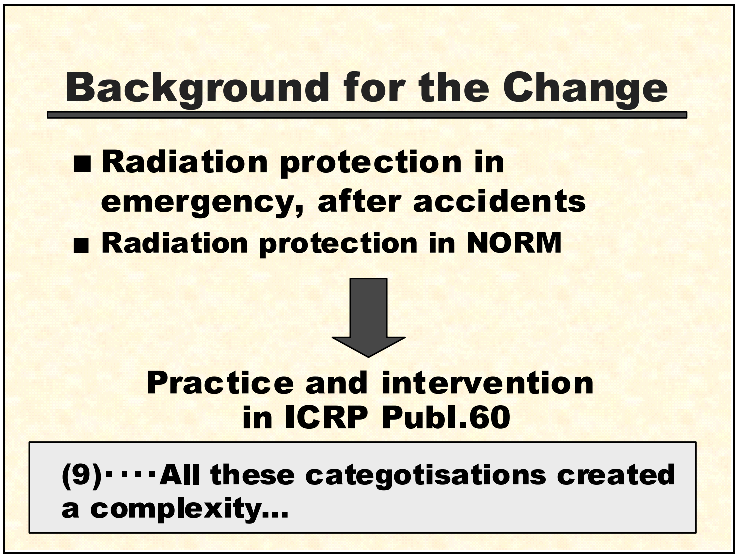
1. Emergency situation.
2. Existing exposure situation.

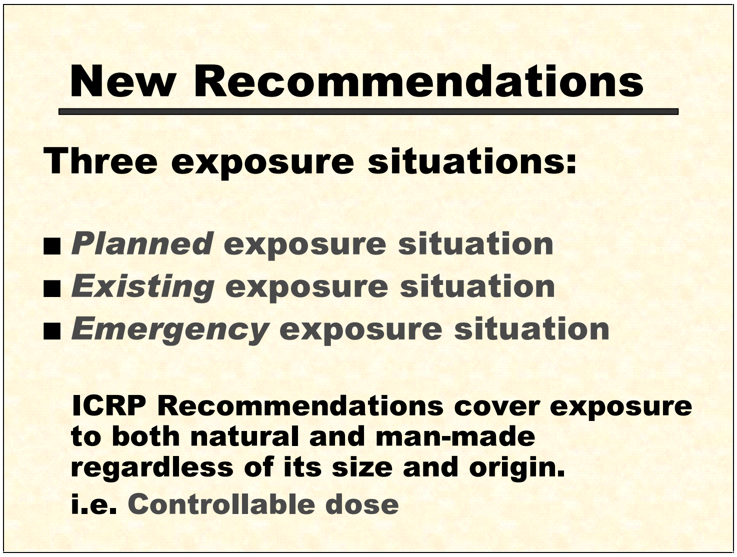
Use of the Intervention concept

1. Other field, ex. economics, etc.

VIEWS ON THE NEW ICRP RECOMMENDATIONS FOCUSING ON DOSE CONSTRAINTS AND DOSE LIMITS

Michiaki KAI
Oita University of Nursing and Health





Dose Limits

- In planned exposure situations, ICRP continues to use the same concepts and values as Publ. 60.
- The dose limits are borderlines between unacceptable and tolerable.

The optimised level under the constraints is acceptable.

Dose Constraints

- The most fundamental level of protection.
- Used for optimisation
- Source-related restriction.
- Applied only for prospective purpose.

Applied in all three types of exposure situations.

Focus on Planned Exposure

Dose constraints	Dose limits
-Single-related	-Individual-related
- Prospective	- Retrospective
- National level	- International
- Protective	- Confirmative

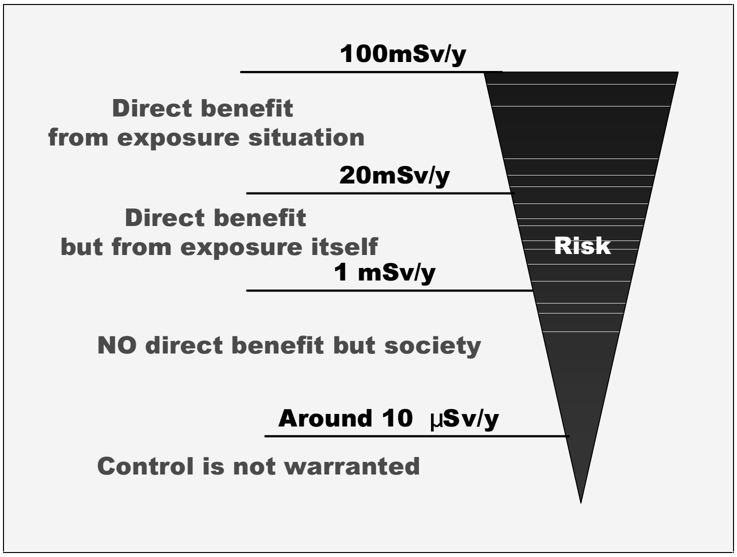
Key Points of the Dose Band

- Rationales of numerical values.
- Promoting understanding of dose constraints in the community.
- Promotion of educating what is radiation risk.

ICRP MUST carry out risk communication !

Rationales for Numerical Values

- 100 mSv
  - Significant risk of cancer
  - lowest for tissue injuries.
- 20 mSv/y
  - Lower bound of unacceptable risk.
- 1 mSv/y
  - Variation of natural background dose in the world.



Nominal Risk Coefficients

- Comparison with ICRP 60
  - No practical significant.
- Useless and misleading
  - Nominal population, gender-average, no age effects
  - NOT applied to the case in radiation protection.
- Useful to get risk coefficients depend on race, sex and age-at-exposure.

SESSION 2

VIEWS FROM REGULATORY AUTHORITIES ON THE DRAFT ICRP RECOMMENDATIONS

Chair: Ches MASON
Co-Chair: Toshiso KOSAKO

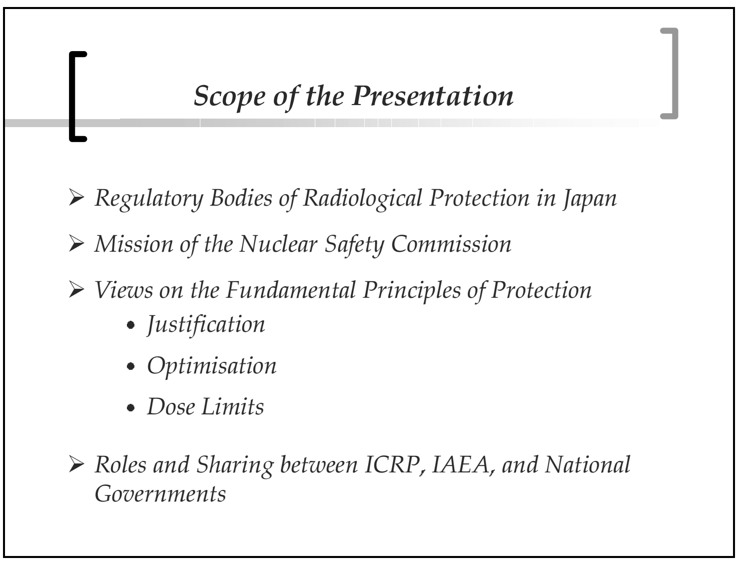
Regulatory views from Japan, South Korea, Australia, China and Indonesia were explained based on their regional context. Some issues, for example "optimisation", "dose constrains", "natural radio-activity", were addressed from the viewpoint of how each country's current regulation system would adopt these new recommendations. It was noted that there would be a need for some flexibility in applying these new recommendations since different countries have different regulatory criteria and benchmarks as well different decision-making processes. It was also noted that definitions and terminologies should be given serious consideration with regard to non-English speaking countries to assure that the new ICRP recommendations are clearly understood, not misinterpreted, easily translated and finally applied in the field of radiation protection. In addition, some recent radiation protection activities, as well as views on utilisation of nuclear power in several countries were presented.

VIEWS FROM THE JAPANESE REGULATORY AUTHORITY

Hiroshi KUNIYOSHI
Director of Radiation Protection and Accident Management Division,
Secretariat of NSC, Japan

On behalf of the Nuclear Safety Commission of Japan, I would like to make a brief presentation of our views on the draft ICRP recommendations. Let me begin by expressing my thanks to Dr. Holm and the organisers of this conference for giving me this opportunity.

Dr. Kiryu and myself will make presentations for a total of 45 minutes on the topic “Views from the Japanese Regulatory Authority”. My presentation will last for about 15 minutes, followed by Dr. Kiryu, representing MEXT, who will present his views for the remaining 30 minutes.

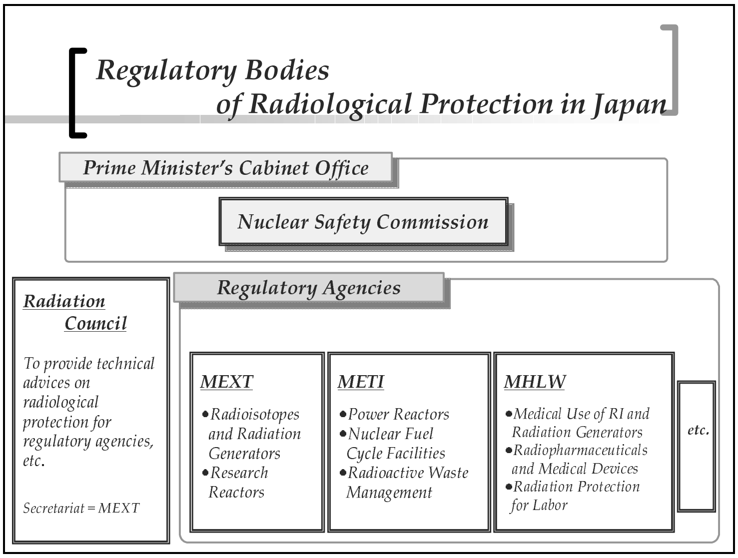


This is the outline of my presentation. First, I will speak about the Regulatory Bodies of Radiological Protection in Japan to give you a rough picture of Japan’s regulatory system. Then, I will give you a brief introduction on the Nuclear Safety Commission.

After these preparatory explanations provided as background information, I will go on to the main points of my discussion, namely the views on the draft ICRP recommendations, focusing on the three fundamental principles of protection, which are justification, optimisation and dose limits.

Lastly, I would like to describe our idea on the roles and desired role sharing of the ICRP, the IAEA and national governments.

These regulatory bodies have close co-operation to ensure the safety of radiation usage in Japan.

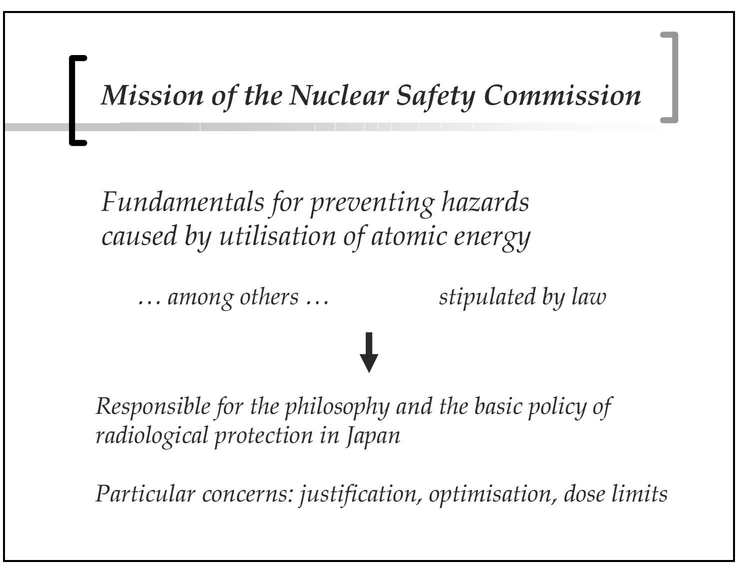


This diagram illustrates the overall organisation of Japan's regulatory authorities for radiological protection.

The Nuclear Safety Commission works under the Prime Minister to formulate the basic policies for the safety of atomic energy usage and to oversee the activities of the regulatory agencies.

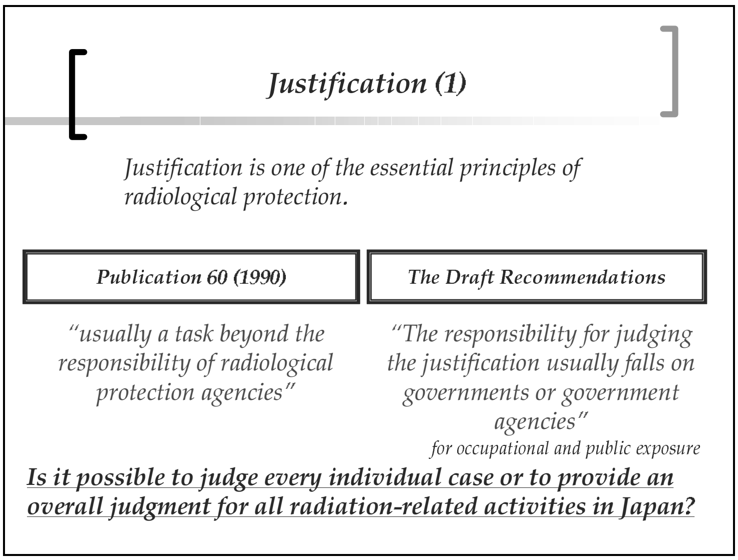
MEXT, the Ministry of Education, Culture, Sports, Science and Technology, is responsible for the safety of radioisotopes, radiation generators and research reactors. METI, the Ministry of Economy, Trade and Industry, covers power reactors, nuclear fuel cycle facilities and radioactive waste management. MHLW, the Ministry of Health, Labour and Welfare, is responsible for the medical use of radioisotopes and radiation generators, radiopharmaceuticals and medical devices and radiation protection for labour. These are the three major regulatory agencies in the field of radiation-related safety.

The Radiation Council provides these regulatory agencies with technical advice on regulations and standards of radiological protection to keep relevant regulations harmonised across the agencies.



The Nuclear Safety Commission, for which I work, conducts various activities to ensure the safety of peaceful use of atomic energy. The principal responsibility of the safety regulation lies with regulatory agencies such as MEXT and METI, while the Nuclear Safety Commission supervises, oversees and gives guidance to their regulatory activities. Among the missions of the Nuclear Safety Commission stipulated by law, there is a mission, which reads "Fundamentals for preventing hazards caused by utilisation of atomic energy". As you can see, we are responsible for the philosophy and the basic policy of radiological protection in Japan.

Therefore, I would like to focus, in this presentation, on the fundamental principles of protection, namely justification, optimisation and dose limits, and to leave out discussing other specific points although they might also be of importance.

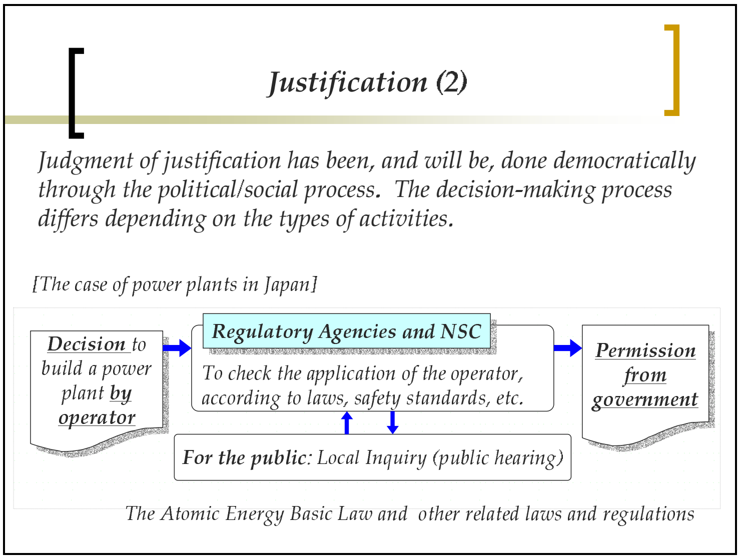


Let me start with the first principle of protection, justification. ICRP recommendations have stressed since long ago the importance of the concept: justification. No decision on radiological activities should be adopted unless it produces more good than harm, or sufficient benefit to offset the detriment it causes. I fully agree to this concept. This should be, without doubt, an essential idea underlying the radiological protection system.

If we compare the descriptions of this important principle between Publication 60 and the new draft recommendations, there are some differences. Concerning the justification, Publication 60 states "To search for the best of all the available options is usually a task beyond the responsibility of radiological protection agencies", whereas the new draft recommendations state "The responsibility for judging the justification usually falls on governments or government agencies to ensure an overall benefit".

I am not quite sure what this judgment in the draft recommendations exactly means. Yet, how can anybody, the government for example, judge the justification of countless activities in one country? Is it possible to judge each and every individual case, or to provide an overall judgment for all radiation-related activities in one country?

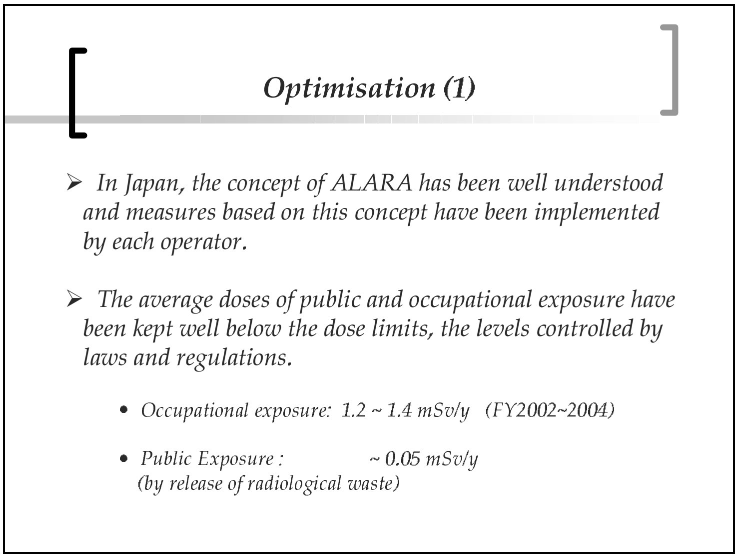
I would think that the process of judging the justification is much more complicated than simply making somebody responsible for it. In other words, can't we understand that all the actors involved in the society should be responsible for judging the justification?



In a democratic country like Japan, anything related to the safety of the people is always judged through the political and social process. For radiological protection as well, the judgment of justification warrants the involvement of the society.

Let me give you an example of constructing power plants in Japan. The basic policy of peaceful use of atomic energy is prescribed in the Atomic Energy Basic Law and other related laws and regulations. However, this does not mean that they provide an overall judgment of justification. When an operator plans to construct a plant, a certain procedure should be taken that involves the public, local governments, the relevant agencies, and so forth.

In other cases such as the utilisation of radioisotopes, the procedures are different. The decision-making process differs depending on the types of activities. It might be misleading to say simply who is responsible for judging the justification.



Let me go on to the second principle of protection, optimisation. In Japan, the concept: “as low as reasonably achievable”, or ALARA, has been well understood and respected by operators. For example, the average dose of occupational exposure in the nuclear power plants has been 1.2 to 1.4 mSv/y – much lower than 20 mSv/y. Also, the exposure at the site-boundaries of nuclear power plants by discharged radioactive gas and liquids is controlled as low as 0.05 mSv/y, which is one twentieth of 1 mSv/y, the dose limit set out for the public.

I believe that in Japan optimisation has been well achieved by the concept of ALARA.

Optimisation (2)

According to the draft recommendations, dose constraints are “the most fundamental level of protection.”

↓

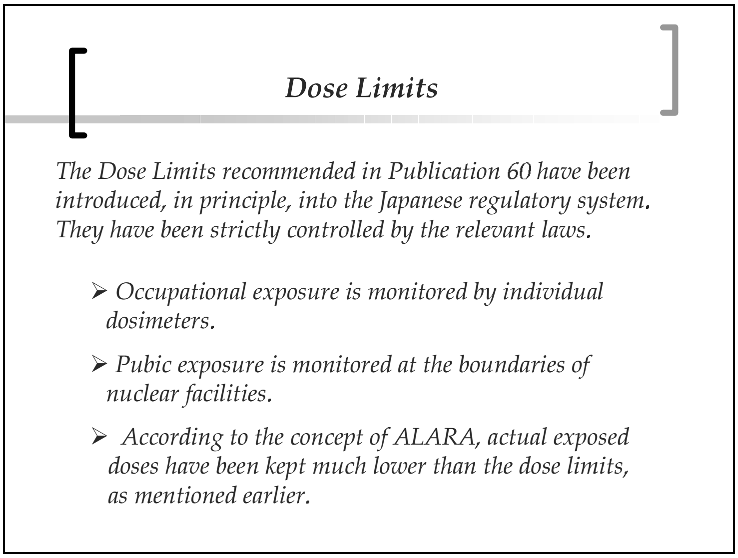
Dose constraints may be a good approach to achieve “optimisation” in some cases. However, there are cases, like in Japan, where optimisation has been successfully achieved based on the concept of ALARA.

- *Is it always necessary to introduce dose constraints into the regulation system regardless of types of exposure?*
- *Doesn’t this make the system more complicated and confusing?*

The draft recommendations have put emphasis on dose constraints, stating that they are “the most fundamental level of protection”, and that they will be fixed at the national or local level.

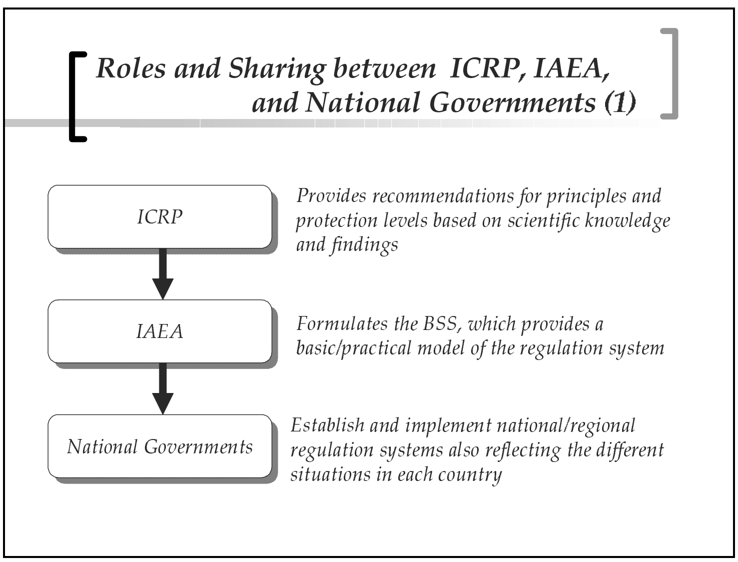
I agree that dose constraints may be a good approach or a tool to achieve “optimisation” in some cases. I would think, however, that the most important thing is not the tool for optimisation but rather the fact of being optimised. These are my simple and basic questions:

- Is it always necessary, or better, to introduce dose constraints into the regulation system regardless of the situation and the types of exposure?
- Doesn’t this make the system more complicated and confusing?



Now I will move on to the third and the last principle of protection, dose limits. Dose limits recommended in the publication 60 have been introduced into the Japanese regulatory system. They have been strictly controlled by law. Also, I would like to remind you that the actual doses exposed have been kept much lower than the dose limits according to ALARA as I mentioned earlier.

As the dose limits proposed in the draft recommendations are basically the same as those in the publication 60, I have no point to discuss further regarding the dose limits.



Finally, I would like to describe our idea, or understanding, on the roles and desired role sharing of the ICRP, the IAEA and National Governments to explain what we hope for on ICRP recommendations.

For decades, the ICRP has provided recommendations for principles of radiological protection and protection levels based on scientific knowledge and findings. I believe that no one but the ICRP can play this important role as an independent group of excellent scientists and experts.

The IAEA has the role of formulating a model of regulation system in the form of BSS based on the ICRP recommendations, taking into account its practicability as a system to be implemented.

National governments establish and implement their own regulation systems based on the ICRP recommendations and the BSS, also reflecting the different situations in each country.

Roles and Sharing between ICRP, IAEA, and National Governments (2)

We appreciate ICRP recommendations

- *that provide the basic principles of radiological protection* **- *philosophy***
- *that also provide protection levels based on the latest scientific knowledge and findings* **- *rationality (scientific)***
- *that can be practically introduced and implemented in many countries* **- *universality***

Based on this understanding, we appreciate ICRP recommendations:

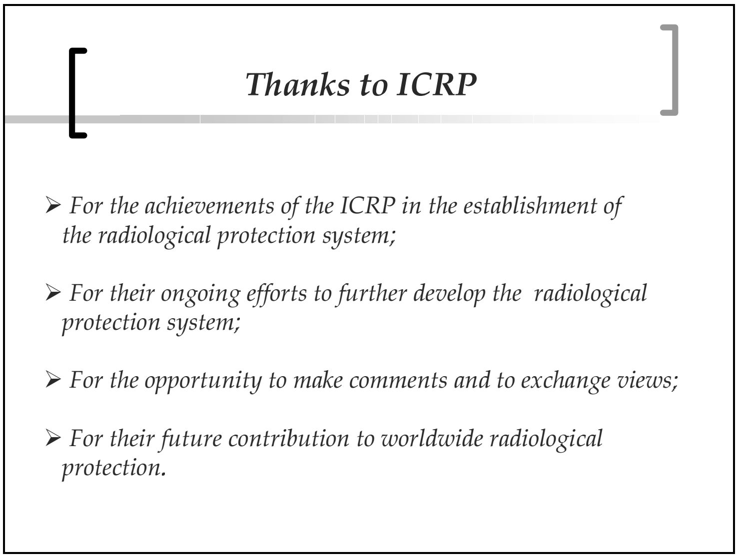
- that provide the basic principles of radiological protection; and
- that also provide protection levels based on the latest scientific knowledge and findings.

These two points are the core of the radiological protection that only the ICRP can recommend. The details, such as who should do what in which kind of procedures, can be left to the IAEA and national governments.

We also appreciate recommendations:

- that can be practically introduced and implemented in many countries.

As the recommendations can be most effective when they are introduced and implemented in national regulations.



To close my presentation, I would like to express our gratitude to the ICRP:

- for the achievements that the ICRP has made in the establishment of the radiological protection system;
- for their ongoing efforts to further develop the radiological protection system;
- for the opportunity they have given us to make comments and to exchange views; and
- for their future contribution to worldwide radiological protection.

Thank you.

VIEWS FROM THE JAPANESE REGULATORY AUTHORITY

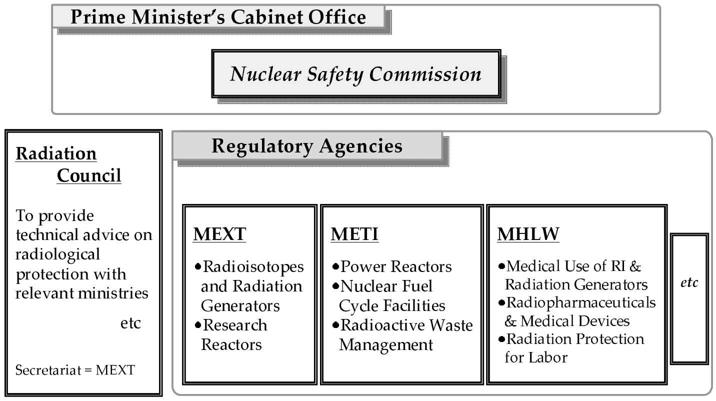
Yasuo KIRYU
Director for Radiation Protection Policy, MEXT, Japan

Agenda

1. Overview of Japanese Regulatory System
2. Undertakings of ICRP recommendations 1990
3. Comments on the new draft recommendations

Overview of Japanese Regulatory System

Regulatory Bodies of Radiological Protection in Japan



MEXT Organisation

- Science and Technology Policy Bureau
  - Nuclear Safety Division
    - Office of International Relations
    - Office of Nuclear Regulation
    - Office of Radiation Regulation
    - Office of Emergency Planning and Environmental Radioactivity
    - Safeguards Office

Nuclear and Radiation Legislation

- Atomic Energy Basic Law
  - Law for the Regulations of Nuclear Source Material, Nuclear Fuel Material and Reactors
  - Law concerning Prevention of Radiation Hazards
- Industrial Safety and Health Law
  - Ordinance on Prevention of Ionizing Radiation Hazards

Undertakings of ICRP Recommendations 1990

- Dose limits
- Restriction
- Exposure in jet aircraft

Dose Limits

- Effective dose limits
  - Occupational
    - 50mSv/y to 100mSv/5y
  - Public (amended in 1988)
    - 5mSv/y to 1mSv/y

Restriction

- Dose rate at the boundary of controlled area
  - ca.15mSv/y to ca. 5mSv/y

Exposure in Jet Aircraft

- Guidelines by the Radiation Council in 2006
- Administrative goal of the crews' exposure
  - 5mSv per year
- No need to measure the individual dose exposed
  - Estimation by calculation is sufficient
- Record of the exposure information
- Explanation and education to the crews

Comments on the New Draft of ICRP Recommendations

General Impressions

- Based on and consistent with the former recommendations.
- New scientific findings have been introduced.
- Main concepts, such as the three principles of protection and dose limit, are not changed.

Dose Limit

- Dose limit has still an important role in radiation protection.
- The values of dose limit are NOT changed, though detriment-adjusted nominal risk coefficients for cancer and hereditary effects are decreased.

New or Altered Concepts

- Dose constraints
- Situations
- Practice and intervention

Dose Constraints

- Various meanings and implications
  - In planned situations and in emergency or existing exposure situations;
  - Unclear distinction from dose limit.
- Difficult to implement
  - Representative individual;
  - In emergency situations.

Several Topics

- Medical exposure of patients
- Exposure to natural sources
- Potential exposure

Risk Communication

Meanings of "Risk"

a. Threat of a harmful event, almost synonymous with hazard
   - Potential risk.
b. Probability of a harmful effect.
c. Magnitude of a harmful effect.
d. Mathematical expectation of a harmful effect (i.e. product of the probability and the magnitude of a harmful effect).

Definition of Risk Communication

An interactive process of exchange of information and opinion among individuals, groups, and institutions; often involves multiple messages about the nature of risk or expressing concerns, opinions, or reactions to risk messages or to legal and institutional arrangements for risk management.

Communicating in a Crisis: Risk Communication Guidelines for Public Officials (US DHHS, 2002)

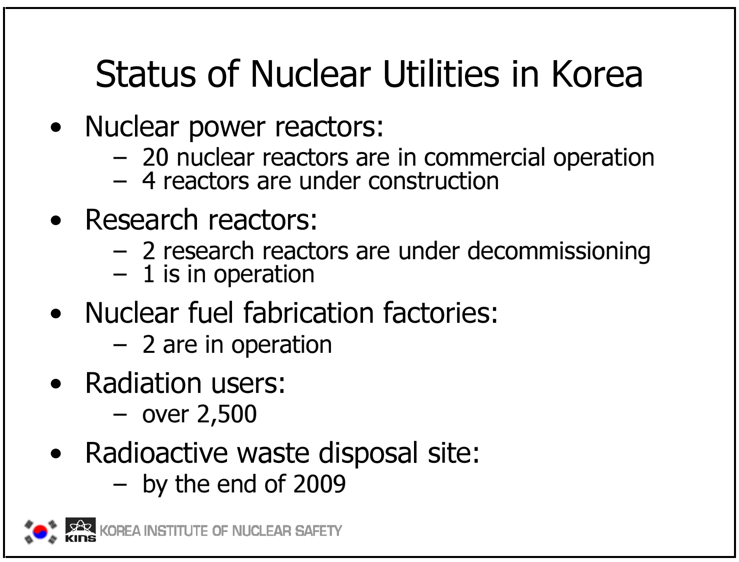
Risk Communication in the Recommendations

- A discipline of *social* science
- Methodology of risk communication
- Important role in decision-making

VIEWS FROM THE KOREAN REGULATORY AUTHORITY

Ho-Sin CHOI
Radiation Safety Regulation Division, Korea Institute of Nuclear Safety, KINS, Korea

Approximately 15 years have passed since the previous main recommendation released in 1990, which brought numerous controversies and concerns in radiation protection. The new draft recommendation has been introduced for external comments and it seems to believe that sufficient time has elapsed for contemplation, review and opinion, which will be reflected into the new version. Having reviews on the draft released in June 2006, we would like to express the current position of the Korean regulatory authority, although several issues are still undergoing internal controversy.



As of December 2005, Korea has 20 operational nuclear reactors while four more are under construction; two research reactors are under decommissioning while another is in operation; there are also two nuclear fuel fabrication factories. Radiation generators and radioactive isotope sources are being used at over 2 500 hospitals, schools, research institutes and businesses. Furthermore, the Korean government is going to construct a low-intermediate radioactive waste disposal site by the end of 2009. Therefore, the impact of the new recommendations on radiation protection will necessarily be greater than ever before.

Nuclear Regulation Responsibility in Korea

- The regulation on nuclear power and radiation is unified under the Ministry of Science and Technology (MOST);
  - Environment, Labour, Construction and Transportation and other related agencies have entrusted their regulation on nuclear power and radiation to the MOST.
  - The regulation on diagnostic using of X-ray tubes in medical institutions are assigned to the Ministry of Health and Welfare.

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The regulation on nuclear power and radiation, except diagnostic purpose, is unified under the Ministry of Science and Technology (MOST) in Korea. The regulation on diagnostic using of X-ray tubes in medical institutions are assigned to the Ministry of Health and Welfare, while other government ministries, such as Environment, Labour, Construction and Transportation and other related agencies, have entrusted their regulation on nuclear power and radiation to the MOST. Therefore, it is not difficult to guess that the application of the new recommendations on radiation protection in Korea will be simpler than in any other countries. Based on the lessons learned, when the radiation protection system requirements were first recommended in 1990, from the following eight years' research conducted on their admissibility in Korea, reflecting them in the laws and subordinate regulations, it is suggested that the new draft ICRP should be published after taking into account preliminary studies or pilot tests especially on the secondary limits and concepts of constraints.

Expected effects of the new ICRP recommendations and suggestions to the ICRP

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Our study of the influence of the latest draft noticed on the ICRP website in June 2006 is summarised as follows:

Biological Aspects of Radiological Protection

- The new approach to estimate hereditary risks accounted two generations of human body resulted in decreased values.
- This reduction is agreed upon in the fact of no direct evidence that exposure of parents leads to excess heritable disease in offspring.
- Regarding the judge of exclusion of the concept of equilibrium generation from the methodology;
  - It should not be allowed to bring it back into consideration again in the future.

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A new approach to estimate hereditary risks taking into account two human generations resulted in the values decreasing heritable effect. This reduction is agreed upon due to there being no direct evidence that exposure of parents to radiation leads to excess heritable disease in offspring. Regarding the judge of exclusion of the concept of equilibrium generation from the aforementioned approach, it should not be brought back into consideration of the methodology again.

Dosimetric Quantities

- The newly recommended radiation weighting factor of protons and neutrons
  - are "welcome" as they affirmatively consider the latest biological influences…
- But, not too frequent change?

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The updated radiation weighting factor of protons and neutrons are welcome as they affirmatively consider the latest biological influences to have been discovered. However, frequent changes of weighting factors, for example, the neutron values updated in ICRP 92, are going to bring negative impact of confidence in radiation protection as well as public trust.

Dosimetric Quantities

- Regarding the newly recommended tissue weighting factors.
- It is advisable to study first:
  - to issue the subsequent data, such as annual limits on intake and derived air concentration; etc. and
  - to prepare the reference reports of bench-markings or pilot tests.

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Furthermore, it is anticipated that the newly recommended tissue weighting factors will have a great impact on the dose assessment of not only internal, but also external exposure. In particular, they shall be followed by calculation of new dose coefficients, annual limits on intakes, derived air concentration, and new derived and auxiliary limits including the criteria for liquid or gaseous effluents. They were specifically revealed in a questionnaire survey conducted by KINS to the non-power reactor utilities in at the beginning of the year of 2006. Those utilities reported their experience of difficulties in applying the derived and auxiliary limits. Therefore, it is necessary to perform simulation of the influences to estimate the ensuing changes in the derived, auxiliary limits, and dose coefficients, before new radiation weighting factors and tissue weighting factors are implemented. Otherwise, it is probable that both utilities and the authority will repeat to experience the problems of misunderstandings and trust, when trials and errors occur as a result of unexpected problems later on.

As a result, the trust of authority will be deteriorated, because of frequent changes in the weighting factors, even though it is expect that they will enhance the radiation protection programmes. As long as allowance is permitted, it is hope that the publication of new ICRP be postponed until the aforementioned foundation documents are prepared completely.

The System of Radiological Protection

➢ New Radiation Protection System based on dose constraints for the single source

- It is desirable to emphasise source related dose constraints, especially for the case of public exposure.
- Dose constraints can overcome the weak-points of dose limit.

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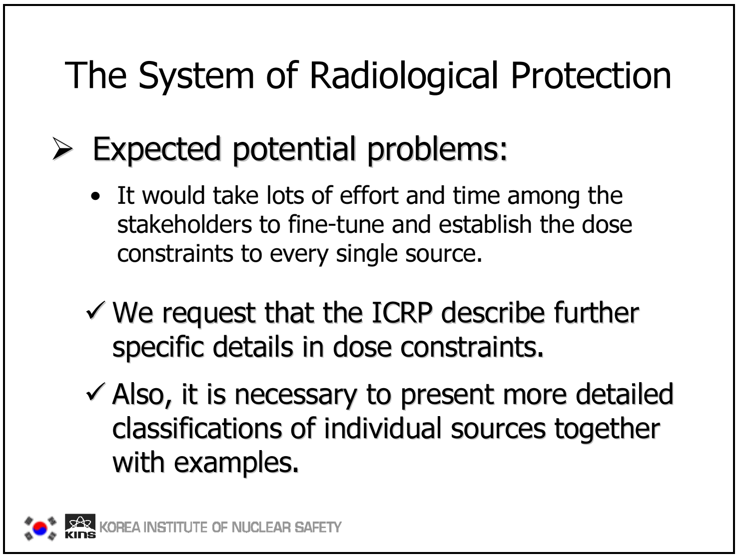
It is believed that the new radiation protection using the concept of dose constraints for the single source has been further systemised to make a practical and reasonable perspective. Regulation based on dose limits ensures easy application and interpretation in cases of simple exposure conditions, i.e. individual exposure to a single source. However, given that diverse types of complex exposures are possible, utilities, business managers and regulators will inevitably face numerous difficulties in complying with the dose limits based on individual relations. Therefore, it has been assessed as desirable to emphasise source related dose constraints, especially for the case of public exposure. It seems that dose constraints can overcome the limitation of dose limit easily in that case.



The Korean regulation system mandates objective or target values similar to the concept of dose constraints that is presented by a single source or practice, and its appropriateness is reviewed case by case in the process of the regulation without specifying dose constraints explicitly. Fundamentally, it is believed that no significant problems will arise in accommodating the new ICRP recommendations. In practical, sufficient reviewing and studies to recognise how the current legal system specifies and applies the concept of dose constraints to general single source, and how and whether they may be used as effective regulatory means, will henceforth be necessary. In particular, it would take lots of effort and time among the stakeholders to fine-tune and establish the dose constraints to every single source. Therefore, we request that the ICRP describe further specific details in addition to the three phase band of dose constraints presented in the current draft ICRP recommendations, if at all possible. The current three phase band of dose constraints seems to be defect-free. However, we believe it is necessary to present more detailed classifications of individual sources together with examples and certain degrees of dose constraints to the single sources in order to make them more useful to the regulators and utilities. The dose constraints might be presented in range values covering a certain band width when it is difficult to present them with specific values.

It would be unacceptable if the range values cover too wide a width, as is currently presented. If the ICRP presents such specific dose constraints to the single source, the regulators and utilities operators will be able to save significant portions of their cost, time and efforts. Scientific approaches to the evaluation methods for establishing constraints are expected to be presented by the ICRP or the relevant international organisations such as IAEA or OECD/NEA.

In a meantime, it is possible that some disputes may arise concerning the managing entity and scope of responsibilities if single sources are defined in too much of an extensive or inclusive way. In particular, medical institutions in Korea would encounter many problems unless the sources are specifically classified or their scope of distinction is clearly defined. In Korea, the MOST undertakes regulations on the therapy exposure situations, on the other hand the Ministry of Health and Welfare has responsible for the regulations on diagnostic exposure situations. In addition, the diversity of radiation sources and numbers will make it more difficult to categorise single source.

The System of Radiological Protection

- Expected potential problems into the Korean atomic energy law system
  - Unavoidable feedback approaches, although it is not originally intended, will bring about conflicts with utilities or stakeholders
  - Research would be necessary as to:
    - how or what feedback will be made when individual exposures exceed the dose constraints; and
    - how the Korean regulatory authority will adjust the regulation intensity or level in the optimisation processes.

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It is also expected that any potential problems arising when the dose constraints are introduced into the Korean atomic energy law system will ensue from retrospective approaches as well as from the prospective approaches originally intended by such dose constraints. It is highly probable that such problems will develop into conflicts with utilities or stakeholders, which is not the matter of simple feedback. It is also necessary to study how or what feedback will be made when excessive dose constraints take place and how the intensity or level of regulation should be applied in the optimisation processes. For the three types of exposure situations recommended by the ICRP draft, it is necessary to present specific examples or specific detailed classification criteria of those exposure circumstances as the division between two different circumstances, planned and emergency situation or accident vs. incident happening condition, are ambiguous.

The System of Radiological Protection

- Dose Limits
  - Korea does not regulate the dose to the lens of the eye of radiation worker because the dose cannot be monitored generally.
  - It is desirable to ICRP offers the specific method for the implementation of the recommendation. ICRP should deal with the problem more carefully.

KOREA INSTITUTE OF NUCLEAR SAFETY

Korea does not regulate the dose to the lens of the eye of radiation workers because the dose cannot be monitored generally. We hope that ICRP might offer the specific method for the implementation of the recommendation. The ICRP should deal with the problem more carefully.

Regarding the articles of patient comforters and carers including families and friends, they need to be discussed in-depth and dealt in separate section other than medical exposure.

Exposure to Natural Sources

- In traditional industries which are not related to the nuclear industries, raw materials including the NORMs can be concentrated in the processing flows.
- Another regulation approach is necessary to regulate the NORMs when their radioactive concentration exceeds their exemption levels.

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Another regulation approach is seemingly necessary to regulate the NORMs when their radioactive concentration exceeds their exemption levels in wastes or by products, as raw materials in traditional industries – which are not related to nuclear industries – are concentrated in their processing flows.

Exposure to Natural Sources

- It would be desirable to present recommendations on possible approaches:
  - for applying the radiation protection system to both existing (existing exposure situation) and new (planned situation) industries;
  - considering the principle of equity.

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It is desirable to present recommendations on possible approaches for applying the radiation protection system to both existing (existing exposure situation) and new industries (planned situation) considering the principle of equity.

Potential Exposures

Accurate expression and application of risk constraints (§317, §318)

- The ICRP presents generic risk constraints
  - 2×10^{-4} for radiation workers
  - 10^{-5} for the members of public
- They should be revised to express "annual risk"
  - to maintain consistency with the previous ICRP.

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The new recommendations are believed to have been compiled very well as they present representative examples – [(1) Events where the potential exposures would primarily affect individuals who are also subjects to planned exposure; (2) Event where the potential exposures could affect larger number of people such as nuclear reactor accident or abuse of a source; and (3) Events in which the potential exposures could occur far in the future, and the doses be delivered over long time periods such as disposal of radioactive wastes] – in connection with the "potential exposures" which have so far been indicated as vulnerable in the previous versions of draft recommendations. In particular, the ICRP provides useful information on the practical applications of the annual risk constraints of individual exposure which have been reserved in its 1990 recommendations. However, we believe further clarification is needed to facilitate practical application of the concepts both in implementation and regulation of the potential exposure under the new recommendations.

The ICRP presents Generic Risk Constraints of 2×10^{-4} for radiation workers and 10^{-5} for the members of public. However, it should be clarified whether or not the constraints are "annual risk", in order to maintain consistency with the previous ICRP documents and to convey more accurate meanings. The risk constraints should be set forth clearly in their annual risk values as it is expected that they will actively apply to diverse fields after the new recommendations have been introduced.

The concept and values of the risk constraints are already reflected in a few Korean regulations such as the MOST Notice No. 2005-17 (Radiological Protection Criteria for Long-term Safety on Low- and intermediate-level Radioactive Waste Disposal). The numerical values of the risk coefficients in these draft recommendations have slightly decreased from those in ICRP 60. However, no significant problems are expected in the application of the new recommendations as they do not differ greatly from the locally applied values (5×10^{-2}/y).

In calculating the risk and comparing the constraints, it is necessary to present a clear position as to whether we need to use a risk coefficient that considers "fatal cancer" only or the "total" value including the heritable effects. We hope that the ICRP would describe its clear position regarding this point for the sake of establishing consistent principles and securing logics for protection, though there should be no significant numerical changes.

Potential Exposures

Actual application system of aggregated or disaggregated approaches to the probability and magnitude of effects (§307, 319)

- New draft do not include any specific guidelines
- ICRP should specify the conditions under which whether aggregated or disaggregated approaches are to be preferred in the actual process of handling potential exposures

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It is noted that the ICRP 60 (§128) presented that, "If the probability of occurrence of the event causing the potential exposures is fairly high, so that several such events might be expected within a year, it should be assumed that the doses resulting from the event will certainly occurs." On the other hand, the position of the ICRP on the potential exposure of high probability is not so clear in the new draft recommendations.

Regarding the paragraph 319, the ICRP emphasised in the probability assessments for unlikely events and proposed to use disaggregated approaches when the annual probabilities of initiating events are much less than 10^{-6}. However, it still seems the new draft recommendations do not give specific guidelines as to the selection of aggregated or disaggregated approaches to the probability and magnitude of effects in the actual applications. Therefore, we hope that the ICRP could specify the conditions under which whether aggregated or disaggregated approaches are to be preferred in the actual process of handling potential exposures.

Potential Exposures

- The radiotherapy accident (§332)
  - Vietnam (1992) and Thailand (2000) accidents did not take place during radioactive therapy processes.
- Such cases should be deleted from the examples of radiotherapy accidents;
- or the title should be changed.

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Among the radiotherapy accident examples outlined under §332, Vietnam (1992) and Thailand (2000) accidents did not take place during radioactive therapy processes. Therefore, such cases should be deleted from the examples of radiotherapy accidents or the title should be changed.

Potential Exposures

- The term of "safety culture" is used in §320~323.
- 'Safety culture" is no longer a strange term at nuclear power plants or other large scale facilities.
- Small-scale user facilities will encounter much difficulties while implement the recommendations.

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The term of "safety culture" is used in §320~323 as an optimisation performance means against potential exposures. In particular, it is also suspected that the §323 provisions expect safety culture-related elements like systematised safety planning in small-scale user facilities other than nuclear reactors. With regard to the small-scale user facilities encounter much difficulties while implement the recommendations, although "safety culture" is no longer a strange term at nuclear power plants or other large scale facilities.

Protection of the Environment

- Protection for the environment would have no significant impact on the regulatory authorities.
- It should be reviewed and evaluated steadily by ICRP.

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Regarding the new draft of ICRP recommendations, it appears that the protection system for the environment or specific actions for the radiation protection of non-human species in particular would have no significant impact on the regulatory authorities. Therefore, it is believed that the regulatory body's position should be reviewed and evaluated steadily once the recommendations have actually been made. Review, consultation with, and discussion among the related government departments about the currently unified Korean radiation protection system will also become necessary if specific and practical radiation protection recommendations are provided for the environment.

Implementation of the Commission's Recommendations

- It is difficult for one agency to regulate radiation protection as the range of protection issues, exposure to natural sources and emergency exposure, varies widely.
- We need to consider an effective compliance of both radioactive and non-radioactive hazards for the safety management of identical workplaces or safety control objects with limited regulation resources.

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It is difficult for one agency to regulate radiation protection as the range of protection issues, exposure to natural sources and emergency exposure, varies widely. In particular, it would be difficult to comply with the recommendations of the Commission on the Radiological Protection because of the possible redundancy or blank area of safety control, or the lack of consistency, while it is necessary to assign the scope of responsibilities based on the objects of radiation protection regulation and control among multiple regulation agencies within a same country. In addition, we need to consider an effective compliance of both radioactive and non-radioactive hazards for the safety management of identical workplaces or safety control objects with limited regulation resources. Therefore, examples or recommendations are required in order for organisational approaches to comply effectively and comprehensively with the recommendations for national radiation protection.

Glossary of Key Terms and Concepts

- Frequent changes in the definition of terms or concepts could lead to future communication problems among the stakeholders
  - “deterministic effect” replaced with “tissue reaction”.
  - Some communication breakdown may arise
    - because of the confusion of terms and concepts despite no significant changes in their actual application and influences.

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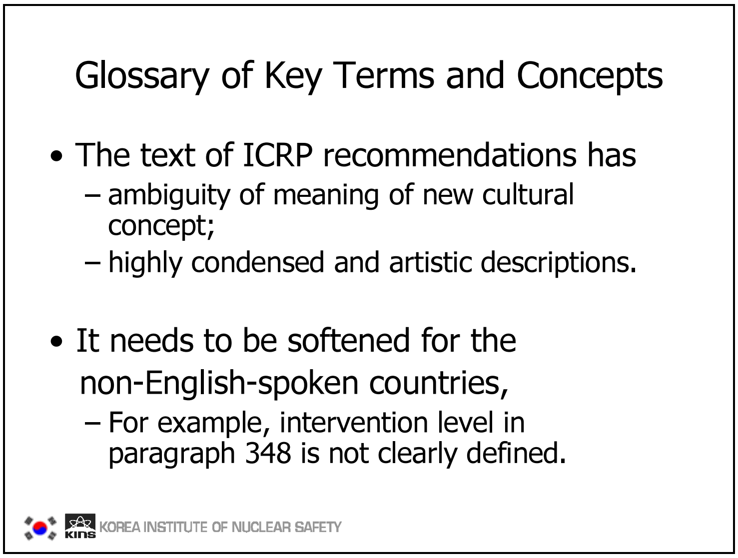
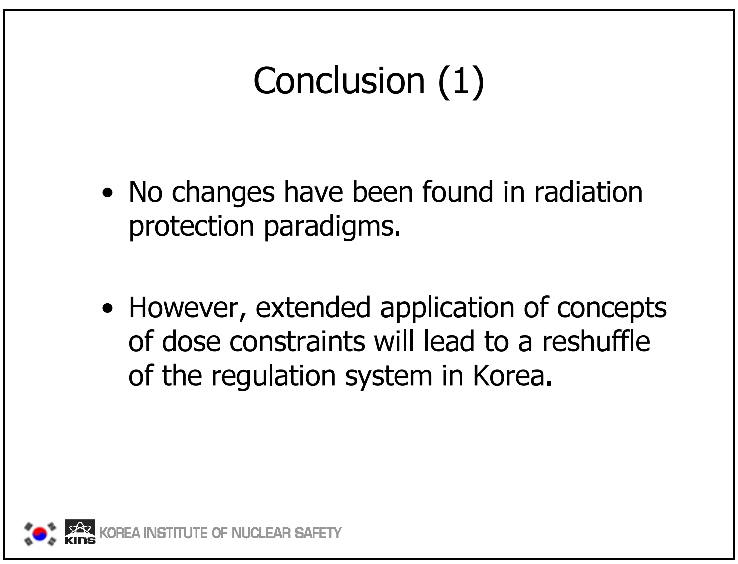
We also hope that the ICRP would exercise a more discreet approach as frequent changes in the definition of terms or concepts could lead to future communication problems among the stakeholders as well. For example, the formerly used term of “deterministic effect” has been replaced with that of “tissue reaction”. Some communication breakdown may arise because of the confusion of terms and concepts despite there being no significant changes in their actual application and influences.

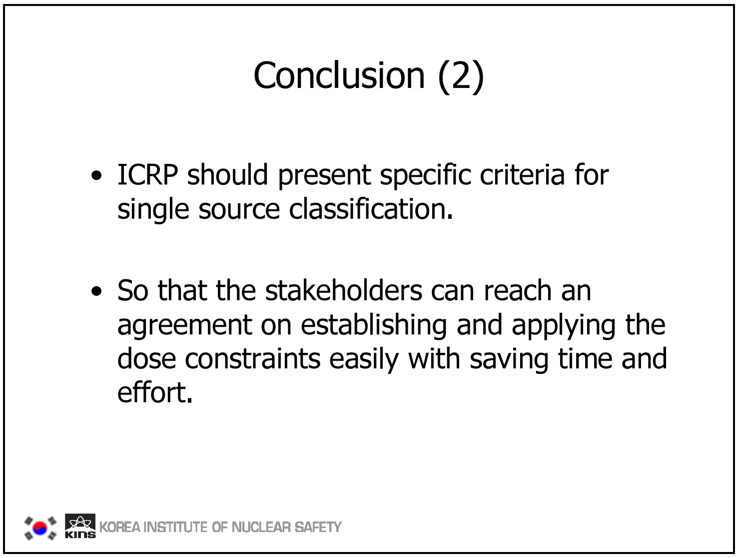


Furthermore, examples and cases need to be provided to avoid misuse of the effective dose whose concept has been applied for protectional quantity. Text needs to add warning of misuses.

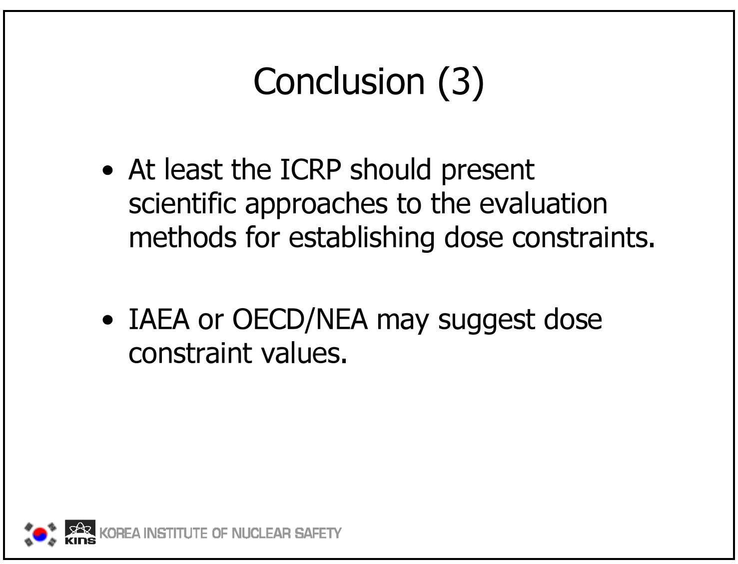
Regarding the text of ICRP, ambiguity of meaning of new cultural concept, highly condensed and artistic descriptions are need to be softened for the non-English spoken countries, for example, intervention level in paragraph 348 is not clearly defined and it is difficult to understand even for the radiation protection experts in Korea.



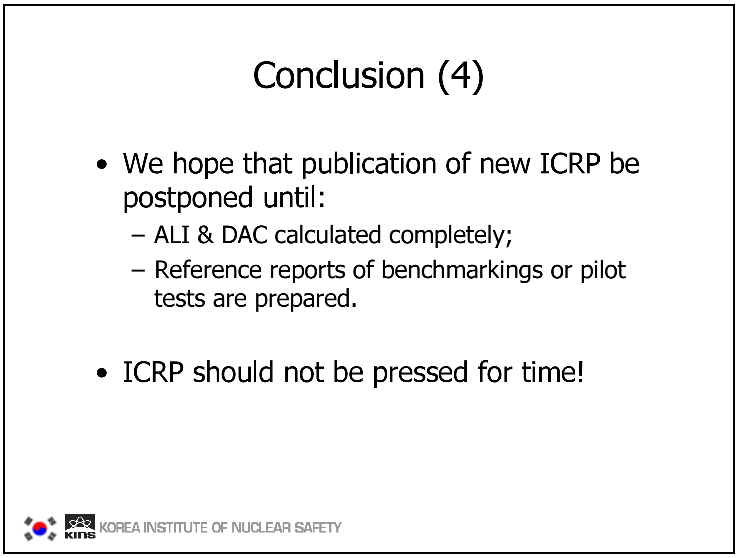
It is expected that the calculation of new dose coefficients will be necessary as changes in radiation and tissue weighting factors will affect the evaluation of internal and external exposure doses. The annual limits on intakes and derived air concentration, auxiliary and derived limits, will be replaced by new data. It is expected that such changes will heap an additional burden and some confusion on utilities. However, essentially no questions can be raised as regards the justification for and necessity of the newly presented ICRP recommendations on radiation protection as they are based on new scientific data and materials.



But, it is necessary to perform simulation of the influences to estimate the ensuing changes in the derived and auxiliary limits and dose coefficients when new radiation and tissue weighting factors are recommended. Otherwise, it is probable that both the utilities and the authority shall be experienced misunderstandings or mistrust by the public when trials and errors occur as a result of unexpected problems later on. As long as allowance is permitted, it is hoped that the publication of new ICRP will be postponed until the foundation documents, regarding auxiliary limits and derived limits such as annual limits on intakes and derived air concentration data, described in the text and the foundation documents of benchmarkings or pilot tests are prepared completely. ICRP should not be pressed for time.



It appears that there will be no great problems as any changes have been found in radiation protection paradigms. However, it is expected that the extended application of concepts of dose constraints and changes in the radiation protection system around dose constraints will lead to a reshuffle of the regulation system in Korea. We would like to suggest that the ICRP present specific criteria for single source classification and specific dose constraints to the every single sources or practices so that the stakeholders can reach an agreement on establishing and applying the dose constraints through amicable consultation, thereby saving time and effort. Otherwise, The ICRP should at least present scientific approaches to the evaluation methods for establishing constraints for every single source so that the relevant international organisations such as IAEA or OECD/NEA may suggest constraint values if the ICRP is unable to do so in view of its organisational nature.



Anyway, the practical evaluation of specific influences will be possible only from the point when the new radiation protection recommendations are formally released. At that time, the ICRP recommendations will have to be selectively accommodated in areas where the unique Korean circumstances are to be considered.

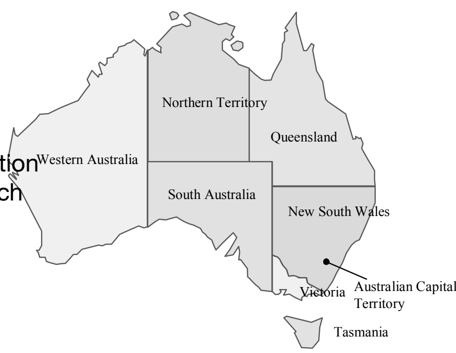
VIEWS FROM THE AUSTRALIAN REGULATORY AUTHORITY

Peter A. BURNS
Director, Environmental and Radiation Health Branch,
Australian Radiation Protection and Nuclear Safety Agency (ARPANSA)

Australian Government
Australian Radiation Protection and Nuclear Safety Agency

Overview – regulatory systems

- Australia is a federation comprising
  - 6 States
  - 2 self-governing Territories.
- Responsibility for radiation regulation rests with each jurisdiction.
- No one set of common laws with common requirements.



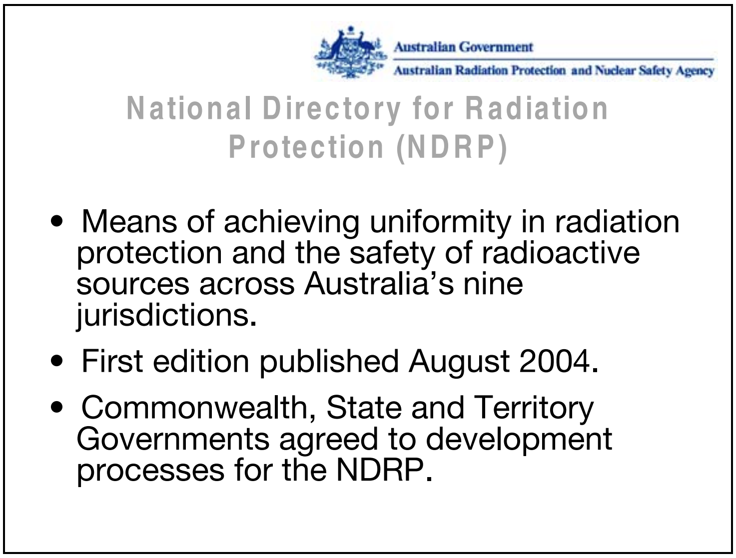
Constitutionally Australia is a Federation of six States where the responsibility for health matters such as radiation protection, rests with the States. There are also two self governing Territories making a total of nine jurisdictions responsible for radiation safety matters.

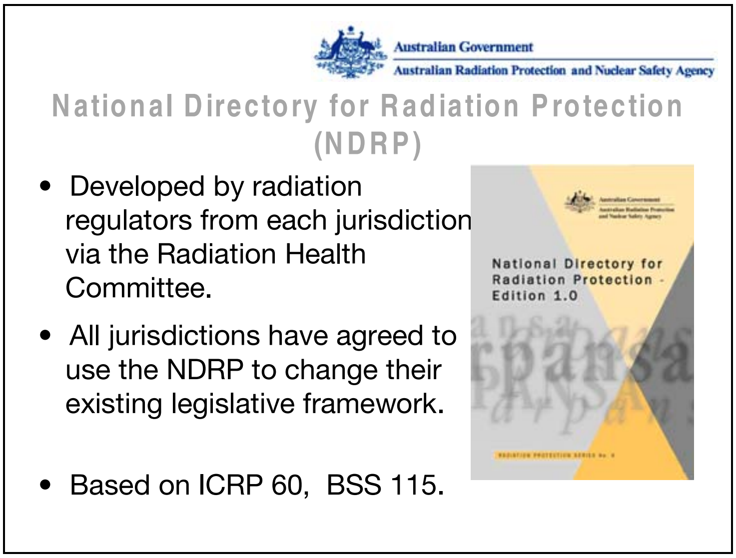
Australian Government
Australian Radiation Protection and Nuclear Safety Agency

Overview – regulatory systems

- Legislative requirements are not identical.
- Uniformity of practice achieved through National Directory for Radiation Protection.

Historically legislation has been developed separately in each jurisdiction and this has led to differences in the regulatory control of radiation practices in Australia. In order to develop a national uniform approach to radiation control relevant ministers agreed to develop a National Directory outlining agreed general principles for regulatory frameworks, uniform regulatory elements such as exclusions, exemptions, authorisations and the national adoption of codes of practice and standards.





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National Directory for Radiation Protection

- National Directory consists of:
  - agreed general principles for regulatory frameworks;
  - uniform regulatory elements such as exclusions, exemptions, authorisations; and
  - national adoption of codes of practice and standards.

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National Directory for Radiation Protection

- Codes and Standards referenced in the Directory must be adopted by Authorities within their regulatory frameworks.

- By direct reference to a Code or Standard in the regulations of an Authority,
- Or by using a Code or Standard as conditions of licence.

Codes and Standards referenced in the Directory must also be adopted by Authorities within their regulatory frameworks.

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NDRP 1- Regulatory frameworks

Radiation protection principles

- **justification** of practices to ensure that benefits outweigh the detriment,
- **limitation** of radiation doses (see Schedule 1) to individuals from all practices, and
- **optimisation** of protection and safety so that individual doses, the number of people exposed and the likelihood of exposure are all kept as low as reasonably achievable, economic and social factors being taken into account.

The framework set out in the Directory is based on the Basic Safety Standards (BSS 115) of the International Atomic Energy Agency and the recommendations of the International Commission on Radiological Protection in ICRP 60.

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NDRP 1- Regulatory frameworks

Management requirements

- establish a safety culture,
- establish quality assurance programmes,
- reduce the probability of human error leading to accidents,
- make appropriate training and information available to staff,
- allocate sufficient resources to enable safety and security of radiation sources over their lifetime (including disposal), and
- provide the qualified expertise necessary to observe the requirements.

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Radiation Protection Series - RPS 1

- Recommendations for limiting exposure to ionising radiation (1995)

(Guidance note [NOHSC:3022(1995)])

- Based on ICRP 60

Standards are set out in “Recommendations for limiting exposure to ionising radiation” (Radiation Protection Series 1, 1995).

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Radiation Protection Series - RPS 1

- The system of radiation protection requires exposure to radiation to be controlled through:
  – **justification**,
  – **optimisation** and
  – dose or risk **limitation.**

The system of radiation protection requires exposure to radiation to be controlled through the principles of justification, optimisation and dose or risk limitation and requires the development of a Radiation Protection Programme to control exposure.

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Radiation Protection Series - RPS 1

- Justification involves a demonstration that there is a net benefit from a practice which leads to exposure to radiation.

- Limitation of dose or risk is used to place bounds on risk to individuals so that risks are considered acceptable for everyday, long-term exposure to radiation.

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Radiation Protection Series – RPS 1

- Optimisation is employed to make the best use of resources in reducing radiation risks.

- Ensure that the magnitude of individual doses, the number of people exposed, and the likelihood that potential exposures will actually occur should all be kept as low as reasonably achievable, economic and social factors being taken into account (**ALARA**).

- Optimisation involves the examination of a suite of possible strategies, ranked in order of reduction in detriment. The optimum will have been reached when any further step to reduce the detriment would involve a deployment of resources that is out of proportion to the consequent reduction.

- Optimisation is principally involved in the design process for the detailed operation of a practice, but the general principles of optimization should always be borne in mind in day-to-day administration of radiation protection procedures.

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Radiation Protection Series – RPS 1

- **Radiation Protection Programme – Control of exposure.**

- **Occupational and medical exposures can usually be controlled at the source.**
- **Operators and employers are responsible for ensuring that a comprehensive plan for the control of exposure to radiation is developed.**
- **The initial plan is based on estimates of radiation exposure.**
- **The plan should be refined based on assessments of actual radiation exposure conditions.**
- **Radiation control measures should be designed and implemented accordingly.**
- **The plan should be reviewed at appropriate intervals or if changes occur which may significantly affect radiation exposure conditions.**

This Plan requires the development of a safety culture and assessments and reviews of radiation exposure as part of the optimisation process.

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Radiation Protection Series – RPS 1

Radiation Protection Programme – Control of exposure

- The experience gained from such practices can be used to establish dos constraints when designing the workplace environment.
- In a well-managed practice, the individual doses are often well below the occupational dose limit.
- In operation, investigation levels, corresponding to those dose constraints may be used.
- When an investigation level is exceeded, the cause or the implications of that level of exposure should be examined.

The proposed ICRP recommendations on optimisation and dose constraints are consistent with the principles already set out in the National Directory but will require modification of the radiation exposure standard so that guidance to operators and authorities can be expanded to assist operators in the development of their Radiation Protection Programmes.

Australian Government
Australian Radiation Protection and Nuclear Safety Agency

DRAFT ICRP Recommendations

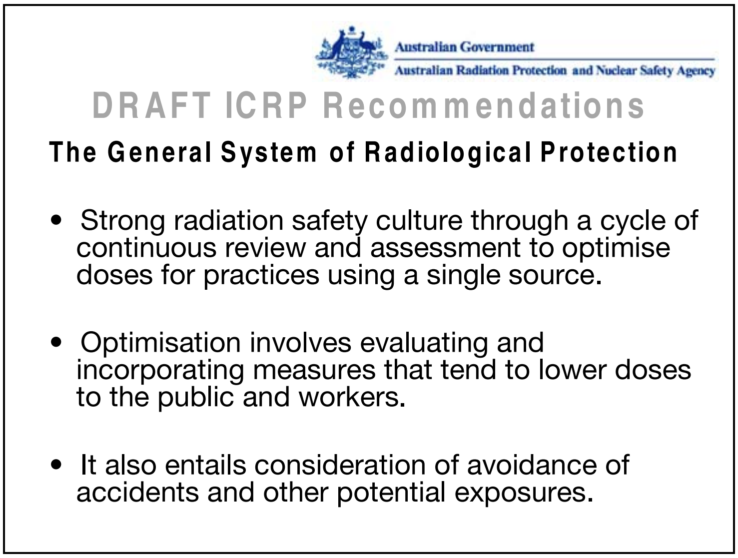
The General System of Radiological Protection

- The probabilistic nature of stochastic effects means a clear distinction between “safe” and “dangerous” is impossible.
- Fundamental principles are justification, limitation and optimisation.
- Dose constraints in the optimisation process are the primary tool in managing radiation safety.

The draft 2006 recommendations cover exposures to both natural and man-made sources. They apply in their entirety only to situations in which either the source of exposure or the exposure pathways leading to doses by individuals can be controlled by some reasonable means. Such sources are called controllable sources. Possible situations where radiation exposure may occur are now characterised as planned, emergency and existing controllable situations.

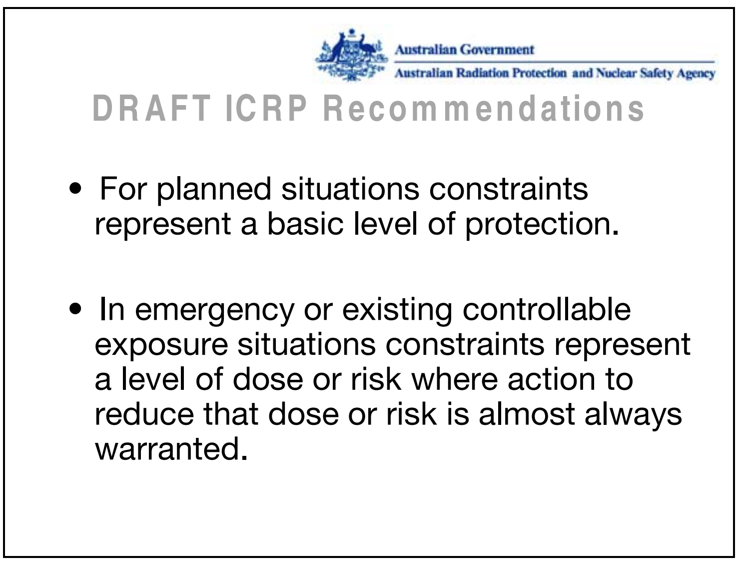
In developing a system of radiation protection it is necessary to determine what is outside the scope of legislation on the basis that certain exposure situations are unamenable to control by regulatory instruments. Such sources are excluded from the legislation. Other sources may be within the scope of the legislation but may be exempt from certain regulatory controls as the risk associated with exposures from these sources is negligible under any conceivable circumstance or the societal efforts needed would be disproportionate to the savings in detriment achieved. Triviality of risk should not be the only consideration for exemption, which should include considerations of unwarranted control. Different circumstances could lead to different dose levels below which regulatory control is considered unwarranted. National regulators should decide exemption on a case-by-case basis.

The probabilistic nature of stochastic effects makes it impossible to make a clear distinction between “safe” and “dangerous”.



This led to the system of protection based on justification, limitation and optimisation. The Commission continues to regard these principles as fundamental for the system of radiation protection but now stresses the use of dose constraints in the optimisation process as the primary tool in managing radiation safety. The aim is to create a strong radiation safety culture through a cycle of continuous review and assessment to optimise doses for practices using a single source.

Optimisation involves evaluating and, where practical to do so, incorporating measures that tend to lower doses to members of the public and workers. It also entails consideration of avoidance of accidents and other potential exposures. Values for constraints are recommended for three exposure situations):



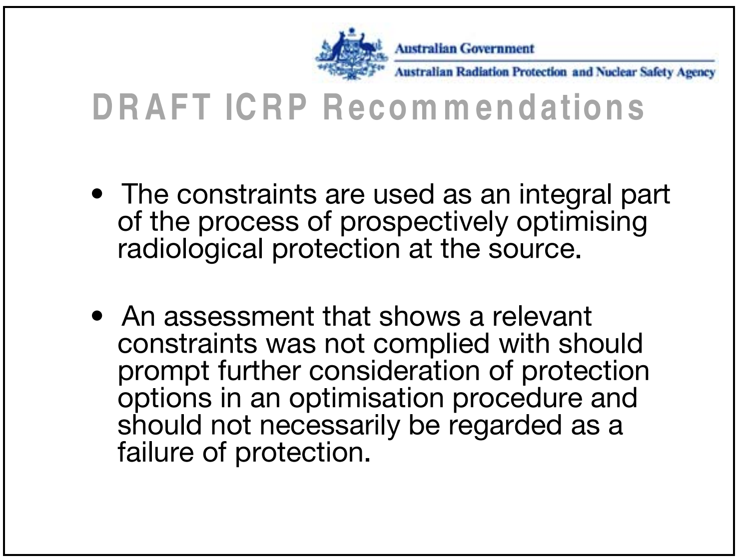
- *planned situations*, which are everyday situations involving the normal planned operation of practices;

- *emergency situations*, meaning unexpected situations resulting from a sudden event or from slow deterioration, leading to the point where urgent action is required;

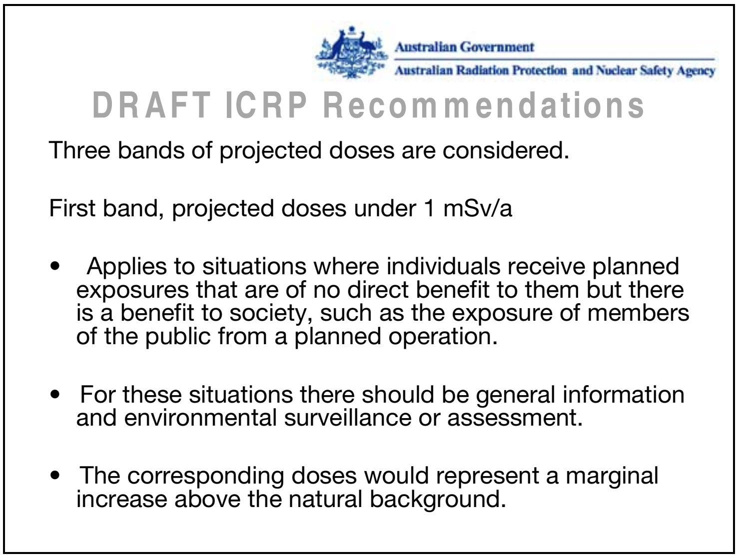
- *existing exposure situations*, which are exposure situations that already exist when a decision on control has to be taken. Such situations and include natural background radiation and residues from past practices.

For each class of exposure the total exposure to any individual may be from several sources. Such an assessment of exposure is called "individual-related". Within a class each source or group of sources can usually be treated on its own and the exposure to all individuals can be considered. This is called "source-related" assessment and is now considered of primary importance in assuring protection. The most fundamental level of protection for the most exposed individuals from a single source within a class of exposure is the source related restriction called the dose constraint. The level of protection set for an individual from all sources within a class of exposure is called a dose limit.

The concept of dose constraints was introduced in ICRP 60 to assure that the optimisation process did not create inequity in that benefits and detriments are unlikely to be distributed through society in the same way. For planned situations constraints represent a basic level of protection and in emergency or existing controllable exposure situations constraints represent a level of dose or risk where action to reduce that dose or risk is almost always warranted in that particular situation.

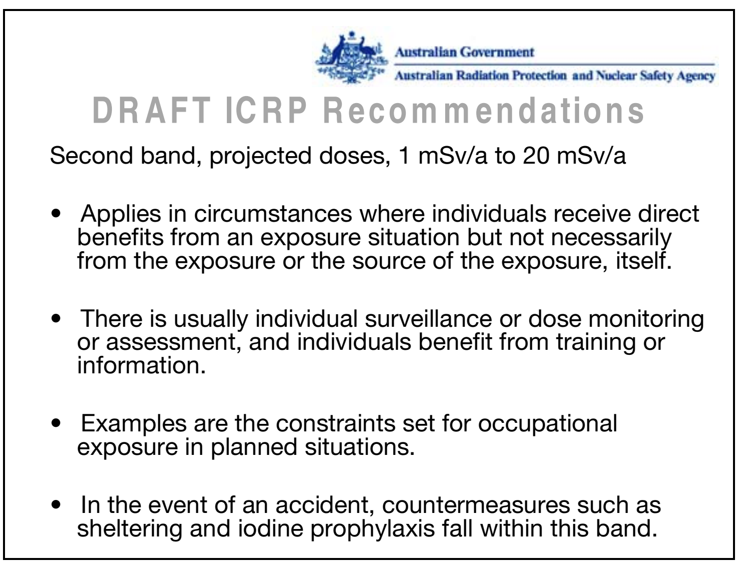


The constraints are used as an integral part of the process of prospectively optimising radiological protection at the source. If a subsequent retrospective assessment shows the relevant constraint was not in fact complied with, this should not necessarily be regarded as a failure of protection but should prompt further consideration of protection options in an optimisation procedure.



The Commission has previously recommended numerical criteria for specific circumstances of exposure in publications since 1990, which can now all be regarded as constraints. These values fall within three defined bands expressed in terms of projected incremental doses (mSv in a year).

The first band, under 1 mSv, applies to situations where individuals receive planned exposures that are of no direct benefit to them but there is a benefit to society, such as the exposure of members of the public from a planned operation. For these situations there should be general information and environmental surveillance or assessment. The corresponding doses would represent a marginal increase above the natural background.



(1) The second band, from 1 mSv to 20 mSv, applies in circumstances where individuals receive direct benefits from an exposure situation but not necessarily from the exposure or the source of the exposure, itself. There is usually individual surveillance or dose monitoring or assessment, and individuals benefit from training or information. Examples are the constraints set for occupational

exposure in planned situations. In the event of an accident, countermeasures such as sheltering and iodine prophylaxis would fall within this band.

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Australian Radiation Protection and Nuclear Safety Agency

DRAFT ICRP Recommendations

Third band, projected doses, 20 mSv/a to 100 mSv/a

- Applies in unusual, and often, extreme situations where actions taken to reduce exposures would be disruptive or where the source is out of control.
- Constraints could also be set in this range in circumstances where benefits from the exposure situation are commensurately high.
- Action taken to reduce exposures in a radiological emergency is the main example of this type of situation, but exposure situation.

(2) The third band, from 20 mSv to 100 mSv, applies in unusual, and often, extreme situations where actions taken to reduce exposures would be disruptive or where the source is out of control. Constraints could also be set in this range in circumstances where benefits from the exposure situation are commensurately high. Action taken to reduce exposures in a radiological emergency is the main example of this type of situation, but exposure situations involving abnormally high levels of natural background radiation may also be in this band.

The table below sets out a framework for dose constraints for workers and members of the public.

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Bands of Projected Effective Dose – Acute or Annual (mSv)	Characteristics of the Situation	Radiological Protection Requirements	Examples
20 to 100	Individuals exposed by sources that are either out of control or where actions to reduce doses would be disproportionately disruptive. Exposures are usually controlled by action on the exposure pathways. Individuals may or may not receive benefit from the exposure situations.	Consideration should be given to reducing doses. Increasing efforts should be made to reduce doses as the doses approach 100 mSv. Individuals should receive information on the radiation risk and on the actions to reduce doses. Assessment of individual doses should be undertaken.	Constraint for evacuation in a radiological emergency.
1 to 20	Individuals will usually receive direct benefit from the exposure situation but not necessarily from the exposure itself. Exposures may be controlled at source or, alternatively, by action in the exposure pathways.	Where possible, general information should be made available to enable individuals to reduce their doses. For planned situations, individual monitoring and training should take place.	Constraints set for occupational exposure in planned situations. Dose constraint for radon in dwellings.
under 1	Individuals are exposed to a source that gives them no direct benefit but benefits general society. Exposures are usually controlled by action taken directly on the source for which radiological protection requirements can be planned in advance.	General information on the level of exposure should be made available. Periodic checks should be made on the exposure pathways to check on the level of exposure.	Constraints set for public exposure in planned situations.

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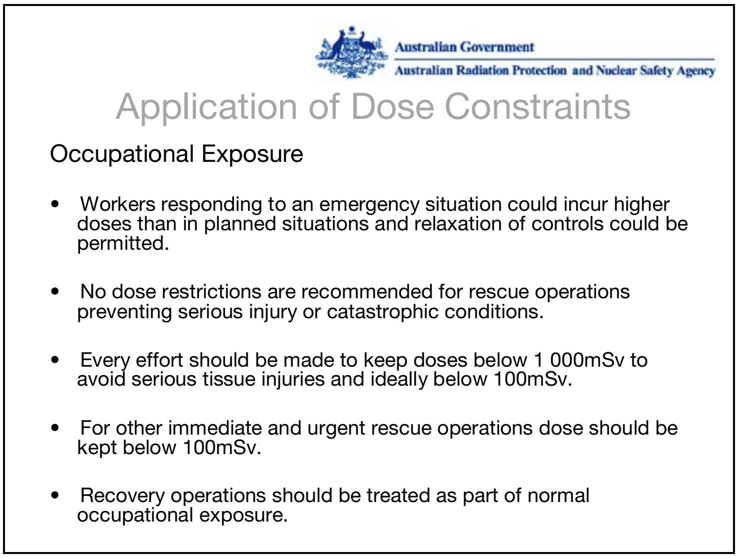
Australian Radiation Protection and Nuclear Safety Agency

Application of Dose Constraints

Occupational exposure

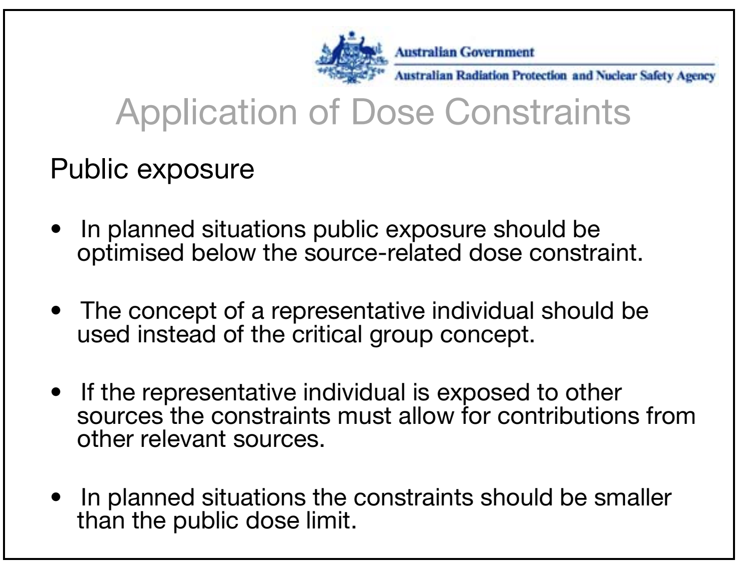
- The level of individual doses in well-managed operations can be used to establish a dose constraint.
- Occupation should be specified in fairly broad terms
  - x-ray diagnostic departments,
  - operation of nuclear power plants, or
  - the inspection and maintenance of nuclear installations.
- Usually dose constraints fixed at the national or local level.
- Sources should specified to avoid confusion with other sources to which the workforce might be exposed.
- Dose constraints set to ensure that the dose limit is not exceeded.

For many types of occupation, it is possible to reach conclusions about the level of individual doses likely to be incurred in well-managed operations.



This information can then be used to establish a dose constraint for that type of occupation. The class of occupation should be specified in fairly broad terms, such as work in X-ray diagnostic departments, the routine operation of nuclear power plants, or the inspection and maintenance of nuclear installations. It will usually be appropriate for dose constraints to be fixed at the national or local level. When using a dose constraint, a designer should specify the sources to which it is linked so as to avoid confusion with other sources to which the workforce might be concurrently exposed. The source-related dose constraints for occupational exposure in planned situations should be set for each source to ensure that the dose limit is not exceeded.

Workers exposed responding to an emergency situation could incur higher doses than in a planned situation.



Because such events are rare relaxation of controls for planed situations could be permitted. No dose restrictions are recommended in principle provided the benefit to others clearly outweighs the risk to the rescuer, for rescue operations involving the prevention of serious injury or the development of catastrophic conditions. Every effort should be made to keep doses below 1 000 mSv to avoid serious tissue injuries and ideally below 100 mSv. For responders undertaking other immediate and urgent rescue operations, all reasonable efforts should be made to keep doses below 100 mSv. Actions taken by workers engaged in recovery operations should be treated as part of normal occupational exposure.

In planned situations public exposure should be controlled by the procedures of optimisation below the source-related dose constraint and by the use of dose limits.

Australian Government
Australian Radiation Protection and Nuclear Safety Agency

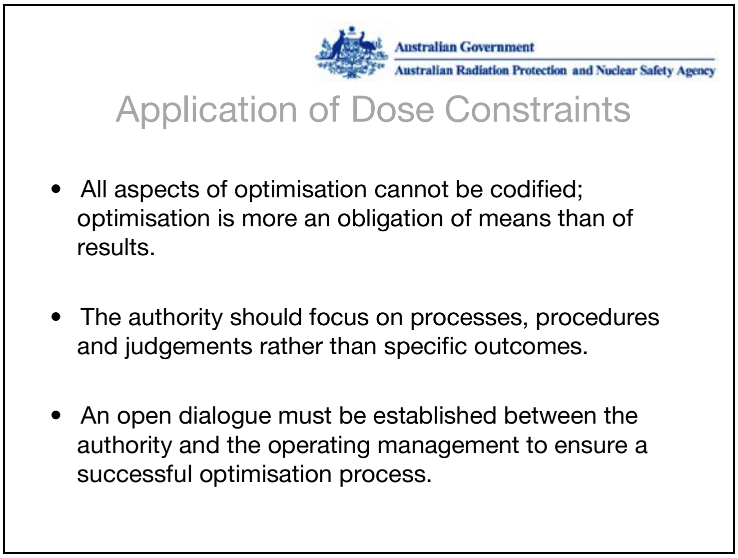
Application of Dose Constraints

The optimisation of protection is a forward looking iterative process aimed at preventing exposures before they occur.

- Operators and the appropriate national authorities have responsibilities for applying the optimisation principle.
- Optimisation of protection is the responsibility of the operating management, subject to the requirements of the authority.
- An active safety culture supports the successful application of optimisation by both the operational management and by the authority.

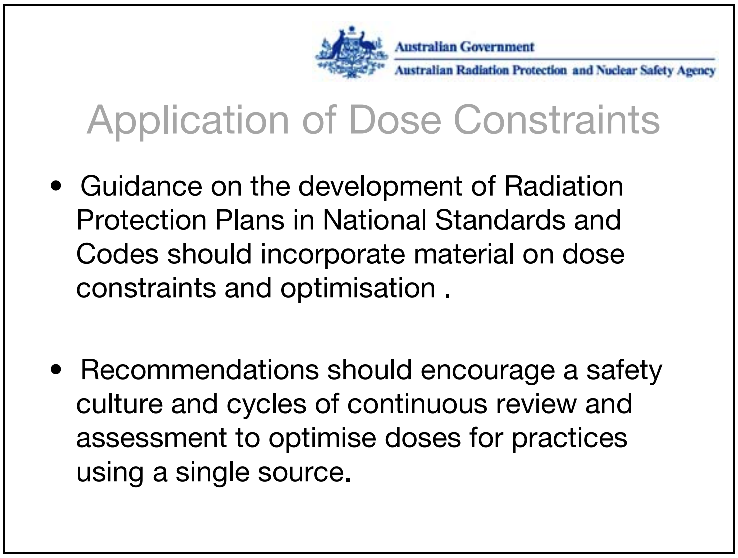
In general, especially for public exposure, each source will cause a distribution of doses over many individuals, so the concept of a representative individual should be used to represent the most exposed individuals. This concept replaces the critical group concept previously used by the Commission. The dose constraint should be applied to the dose to the representative individual from the source for which the protection is being optimised. Occasionally, doses from other sources subject to regulatory control will be received by the representative individual. If the relevant exposures to the representative individual are likely to approach the dose limit for public exposure, the constraints applied to each source must be selected to allow for any significant contribution from other relevant sources to the exposure of the representative individual. The constraints for members of the public in planned situations should be smaller than the public dose limit.

The optimisation of protection is a forward looking iterative process aimed at preventing exposures before they occur.



Within the system of radiological protection both the operators and the appropriate national authorities have responsibilities for applying the optimisation principle. The implementation of the process of optimisation of protection is the responsibility of the operating management, subject to the requirements of the authority. An active safety culture supports the successful application of optimisation by both the operational management and by the authority.

All aspects of optimisation cannot be codified; optimisation is more an obligation of means than of results.



Except in cases of regulatory violation, it is not the role of the authority to focus on specific outcomes for a particular situation, but rather on processes, procedures and judgements. An open dialogue must be established between the authority and the operating management, and the success of the optimisation process will depend strongly on the quality of this dialogue.

VIEWS FROM THE CHINESE REGULATORY AUTHORITY

Zi Qiang PAN
Science and Technology Commission, China Atomic Energy Authority (CAEA)

Yihua XIA
Department of Health Physics, China Institute of Atomic Energy (CIAE)

➢ Progress and improvements

There have been lot of progress and improvements in the drafting of the new recommendations since last 2nd conference, including absorbing the reactions from Asians.

Harmonisation and feasibility have been greatly improved.

1. Collective dose

- Remains the concept;
- Limits the integration of:
  - the period of time;
  - the dose range;
  - the scope of space.

Only for the purpose of
radiation protection.

It is not necessary to say as following (para.230):

Such calculations can be a useful tool for preliminary judgments to examine the feasibility of an epidemiological study in a specific situation, or the plausibility of attributing observed health effects to a source of exposure.

The computation of cancer deaths or hereditary effects based on collective dose involving trivial exposures to large populations is not reasonable and should be avoided.

2. Pay more attention
to natural radiation.

Occupation exposure level in China

	Typical value/mSv a^{-1}	Ranges/mSv a^{-1}	Collective dose/man Sv a^{-1}
Underground mine	4-15	0.46-160	3×10^4
Natural cave	8	0.14-40	?
Tunnel construction	30	(?)	
Underground workplace	4	0.2-31	
Aircrew	4	1-10	
Application of nuclear and radiation tech.	2		2.2×10^2
Nuclear power plant	2		5
Underground uranium mines	10		

Comparison between natural radiation and that of NNP

Individual dose 2-10

Collective dose 10^4

2.1 Aircrew

The exposure of aircrew should be classified into occupational exposure, we have more than 200 international airlines in running now, and most of the aircrew are young girls (20~25 years old).

CBSS:
The exposures of aircrew are clearly classified into the scope of occupational exposure.

2.2 Enhance natural radiation

International BSS have clearly stated that the activities, such as the underground mining of coal and other products also should be concerned.

In China,

- the underground coal miners is about 6×10^{6},
- the total number of underground workers is about 1×10^{7} persons,
- the cave and soil brick is about 1×10^{8} persons.

Radon concentration of underground mine in China:

No-ferrous underground mine:

1 800-9 620 Bq/m³ (F≈0.38)

Underground coal mine:

103-2 074 (aeverage:708)

Bq/m³ (F=0.34)

Rn-222 and Rn-220 equilibrium equivalent concentration Bq m-3

	Rn-222	Rn-220
Country	12	0.8
Cave	22.4	12
Coal slag	122	

Radon concentration (Bq/m^3)

1985-1990	24	
2005	43.8	(26 Cities)

- Air conditioning
- Measuring method
- Utilisation of slag

2006 UNSCEAR

Over 20 analytical studies of residential radon and lung cancer 0.16% per 100 Bq/m^3 excess relative risk.

- Radioactive contents for utilisation of slag
- Not only in building material

3. Dose limit and dose constraint

CBSS

Dose constraints

Simplification
Easy understanding
projected, averted, or residual dose
IBSS

Dose limit	Principle
Dose constraints	Useful

It is necessary to more clearly describe the relationship between constraint and dose limit.

The dose constraints should not be regarded in all case as a rigid boundary, nor that exceeding the constraint would be a regulatory infringement.
How about in new system?

4. The lowest level for optimisation

The new draft para. 226 says:

The best option “is not relevant to determine, a priori, a dose level below which the optimisation process should stop”.

This statement is true in theory,

but in reality a dose of 0.01 mSv/a has been widely considered to be a good basis for exemption on grounds of individual dose.

At or below such low doses, no formal optimisation is warranted.

Is it an actually lower boundary for optimisation?

5. The constraints recommended for Radon-222 look higher

Domestic dwellings	600 Bq/m³
Workplaces	1 500 Bq/m³

They are corresponding to about 10 mSv/a.

In CBSS:

- action level for houses to be built is: 200 Bq/m³
- for existing houses is: 400 Bq/m³

The recommended level by ICRP draft for Domestic dwellings of 600 Bq/m³ looks higher.

The level for workplace
(1 500 Bq/m³)
also looks higher.

The exclusion level for ^{40}K of 10^4 Bq/kg

The content of potassium in human body is fairly constant in human body.

From the point of view of internal exposure, the content of potas-sium in human body is not related to that in materials, thus the exclusion level for ^{40}K looks not necessary.

➢ Brief Summary

- ➢ We are going on the right direction and have obtained important progress on our way to the goal of the new system of radiation protection.
- ➢ Expectations are urging us to do best again.
- ➢ Asian as a big continent and with large population should be actively, with our experiences and expectations, take part into the efforts for establishing comprehensive and coherent radiation protection system.

AOCRP-2

Session 14: Discussion on
new recommendation of ICRP
12 October 2006, Beijing, China
GOLDEN Autum … WELLCOME!!

THANK YOU !

VIEWS FROM INDONESIA

Dr. Taswanda TARYO
Director of Center for Dissemination of Nuclear and Science Technology,
Indonesia National Nuclear Energy Agency (Batan)

CONTENTS

- Background Information.
- History of Regulatory Body and Implementing Body for Nuclear Field in Indonesia.
- Nuclear Facilities in Indonesia.
- BAPETEN and BATAN's Policies to safely secure its nuclear facilities – radioactive source.
- Challenging in assuring nuclear safety and security of radioactive sources in Indonesia.

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MAP OF INDONESIA

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MAP OF JAVA ISLAND, INDONESIA

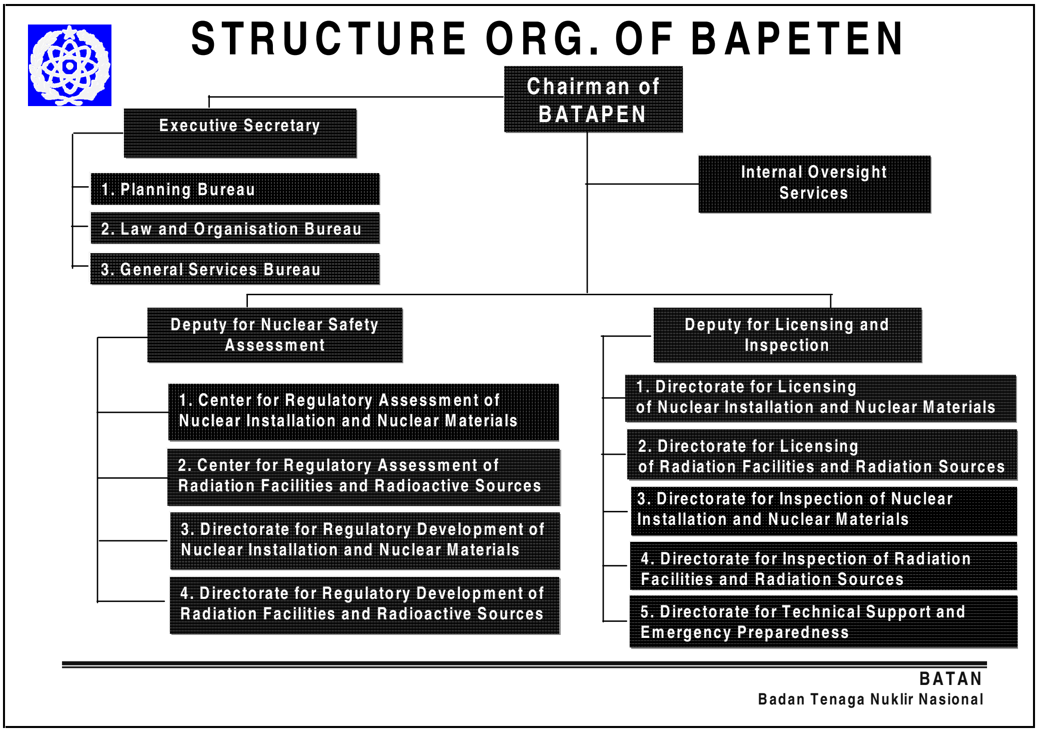
BACKGROUND OF INDONESIA POPULATION

- THOUSANDS OF SMALL AND BIG ISLANDS.
- POPULATION IS 245 MILLIONS AS OF JUNE 2006.
- MOST POPULATED IN INDONESIA.
- ALMOST 70% in JAVA.
- AREA : *total:* 1 919 440 sq km; *land:* 1 826 440 sq km; *water:* 93 000 sq km.
- AGE STRUCTURE:

  0-14 *years:* 28.8% (35 M male and female 34,7 M);
  15-64 years: 65.8% (male 80,7 M /female 80,7 M);
  65 years and over: 5.4% (male 5,7 M/female 7,4 M fem.).

HISTORY OF NUCLEAR REGULATION

- National Committee for Investigation of radioactivity was initiated in 1950s.
- This Committee was established due to the concern of Indonesia on falling out of nuclear test incidents developed by certain countries in Pacific Regions.
- The National Atomic Energy Agency was established in 1958. Regulatory Body and Implementing Body in nuclear fields were still in the same Agency.
- Based on Act No. 10 Year 1997, the Regulatory Body and the Implementing Body for Nuclear Field has been independent.


STRUCTURE ORG. OF BAPETEN
Chairman of BATAPEN
Executive Secretary
1. Planning Bureau
2. Law and Organisation Bureau
3. General Services Bureau
Internal Oversight Services
Deputy for Nuclear Safety Assessment
1. Center for Regulatory Assessment of Nuclear Installation and Nuclear Materials
2. Center for Regulatory Assessment of Radiation Facilities and Radioactive Sources
3. Directorate for Regulatory Development of Nuclear Installation and Nuclear Materials
4. Directorate for Regulatory Development of Radiation Facilities and Radioactive Sources
Deputy for Licensing and Inspection
1. Directorate for Licensing of Nuclear Installation and Nuclear Materials
2. Directorate for Licensing of Radiation Facilities and Radiation Sources
3. Directorate for Inspection of Nuclear Installation and Nuclear Materials
4. Directorate for Inspection of Radiation Facilities and Radiation Sources
5. Directorate for Technical Support and Emergency Preparedness
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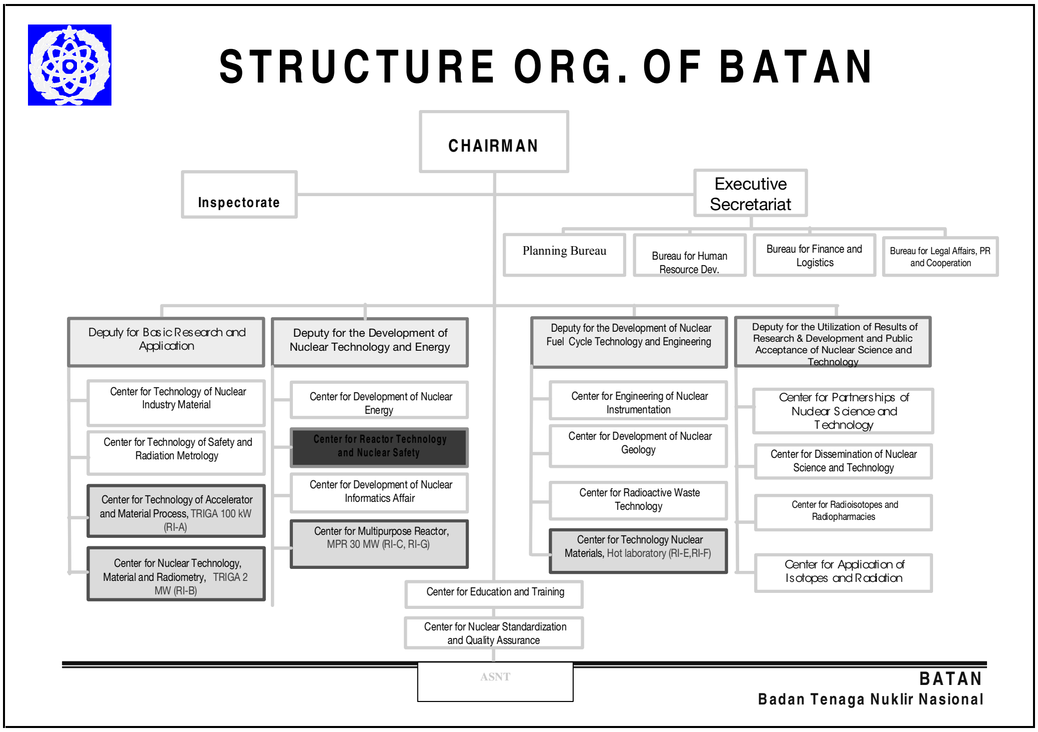
STRUCTURE ORG. OF BATAN
CHAIRMAN
Inspectorate
Executive Secretariat
Planning Bureau
Bureau for Human Resource Dev.
Bureau for Finance and Logistics
Bureau for Legal Affairs, PR and Cooperation
Deputy for Basic Research and Application
Center for Technology of Nuclear Industry Material
Center for Technology of Safety and Radiation Metrology
Center for Technology of Accelerator and Material Process, TRIGA 100 kW (RI-A)
Center for Nuclear Technology, Material and Radiometry, TRIGA 2 MW (RI-B)
Deputy for the Development of Nuclear Technology and Energy
Center for Development of Nuclear Energy
Center for Reactor Technology and Nuclear Safety
Center for Development of Nuclear Informatics Affair
Center for Multipurpose Reactor, MPR 30 MW (RI-C, RI-G)
Deputy for the Development of Nuclear Fuel Cycle Technology and Engineering
Center for Engineering of Nuclear Instrumentation
Center for Development of Nuclear Geology
Center for Radioactive Waste Technology
Center for Technology Nuclear Materials, Hot laboratory (RI-E,RI-F)
Deputy for the Utilization of Results of Research & Development and Public Acceptance of Nuclear Science and Technology
Center for Partnerships of Nuclear Science and Technology
Center for Dissemination of Nuclear Science and Technology
Center for Radioisotopes and Radiopharmacies
Center for Application of Isotopes and Radiation
Center for Education and Training
Center for Nuclear Standardization and Quality Assurance
ASNT
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REGULATION ON RADIOACTIVE SOURCES

- THE REGULATON FOR RADIOACTIVE SOURCES HANDLING AND MANAGEMENT RULED BY PRESIDENT.
- FOR OPERATION, THE SOP WAS ESTABLISHED BY BAPETEN (OWNERSHIP, USER LICENSING, INSPECTION AND DISMANTLING ETC.).
- BATAN THE ONLY ONE AGENCY HAVING DUTIES FOR RADWASTE TREATMENT.

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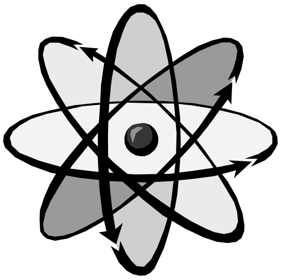
BASIC PRINCIPLES OF BATAN's ACTIVITIES

- NS & T FOR PEACEFUL USES ONLY
- SAFETY IS THE PRIME CONSIDERATION
- DEMAND DRIVEN AND STAKEHOLDER SATISFACTION



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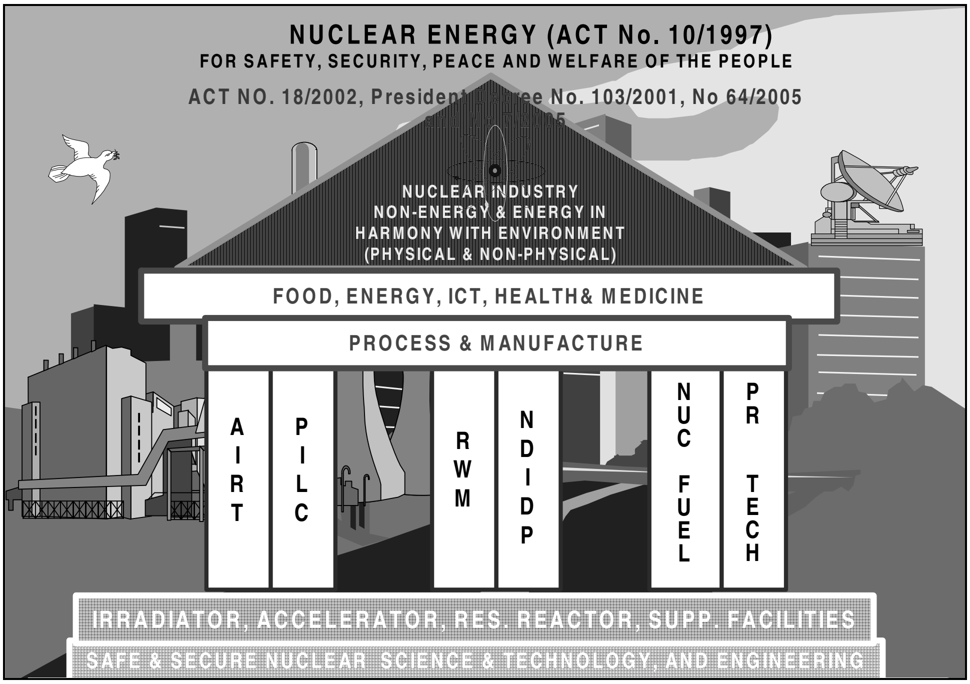

Bases on BATAN's nuclear activities

1. Nuclear Energy (Act No. 10/1997)
   - Safety, Security, Peace and Welfare of People.

2. Act No. 18/2002, Medium Range Development Planning.

3. President Decree No. 7/2005
   - National Technology System on Research, Assessment and Development.

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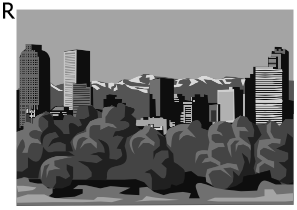
Vision and Mission

- **"NUCLEAR SCIENCE AND TECHNOLOGY WITH RELIABLE SAFETY TO ACTUATE AND ACCELERATE PEOPLE'S WELFARE".**

- R&D OF NUCLEAR SCIENCE AND TECHNOLOGY WITH RELIABLE SAFETY FOR ENERGY AND NON-ENERGY INDUSTRY.
- DISSEMINATION OF PROVEN RESULTS OF R&D IN NUCLEAR SCIENCE AND TECHNOLOGY.
- AND TOTAL QUALITY MANAGEMENT FOR USER/ CUSTOMER SATISFACTION.



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Nuclear facilities containing radioactive sources

- Research Reactors:
  - TRIGA – 2 000 kW Bandung;
  - Kartini Reactor Yogyakarta, 100 kW;
  - RSG-GAS Multipurpose Reactor, Serpong, 30 MW.
- Irradiators:
  - Co-60 Irradiator facility.
- Other supporting facilities:
  - Laboratories: Radio-isotope, Rad-Waste Treatment, Radio-Metallurgy.

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Safety guarantee for whole reactor operation

- Each reactor has a certain time of reactor operation.
- Maintenance activities are always done based on the standards procedures given by the reactor manufacture.
- Regular inspection for each reactor is regularly carried out by Indonesia regulatory body.
- The center having a nuclear research reactor possesses a safety review committee (SRC) based on the decree of BATAN's chairman.

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What's available guidance and help to secure radioactive sources

- Code of Conduct on Safety and Security of Radioactive Sources.
- TECDOCs 1311, 1312, 1313, 1344, 1355, 1388.
- Regulatory software, including for source inventories (RAIS).

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BATAN's Policy on Safety and Security of RSs

- Improving security of radioactive source to response the anticipated threats and to comply with international standards.
- Rules which have been carried, owned and carried out, such as, collaboration with IAEA on physical protection, radioactive source inventory, procedure on safety and security guarding, etc.
- Establishment on standard protection on radioactive source.

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Security and control of BATAN's radioactive sources and nuclear facilities

- BATAN secures licensed radioactive material from unauthorised access or removal.
- BATAN maintains constant surveillance and use devices or procedures to prevent unauthorised use of radioactive materials.
- BATAN secures registered radiation equipments/machines from unauthorised removal.
- BATAN uses devices or procedures to prevent unauthorised use of registered radiation equipments/machines.

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Standards for protection

- Radiation protection programme
- Occupational dose limits
- Dose limits to the public
- Surveys and monitoring
- Restricted areas
- Control of exposure and protection of individuals
- Storage and control
- Signage and posting
- Waste disposal
- Records and reports
- Enforcement

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Security on transportation of radioactive sources

- Transportation of RSs should be carried out fast, safe and secure.
- Therefore, it should be done followings:
  - shorter time of transportation;
  - smaller of quantity and time removal;
  - concern on RS categorisation;
  - selected people and limitation on information.

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Philosophy on security and control

- “We never let anyone get to radioactive sources who doesn’t have any business to use them!”
- “We never let anyone get to nuclear equipment who doesn’t have any business to use it!”

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Challenging on radiological protection system in Indonesia

- Indonesia Plan to construct the first NPP in 2010.
- The use of radioactive sources in many fields will be more in the future.
- Mining of some radioactive sources will be increased in the future.
- Population of Indonesia will be increased significantly in the next decade.
- The trend of public acceptance for nuclear activities could be not as easy as now.

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Strategy to assure public acceptance healthly due to use of radioactive

- Public education and information in all levels of education.
- Providing benefit co-operation with in all top levels of government workers.
- Dissemination of nuclear and science technology for people involved in applying the technology for their fields.
- Public information of NST using TV, radio, newspaper, talk-show, art performance etc.
- Develop agreement with our neighbour countries.
- Providing free-of-charge training/seminar in NST for teachers/lecture.
- Co-ordinated Law Enforcement Plan to make people aware of the use of NST in many fields in daily lives.

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BATAN's and BAPETEN statements on security of non-power radioactive sources

- Safety dan security of RSs are of integrity matters.
- Threats improved come along with the security technology improvement itself.
- Security: Physical and Administrative measures
  - Physical: detect, deter, delay;
  - Administrative: treatments on nuclear materials.
- Nuclear facilities in BATAN are regularly improved to meet with IAEA requirements.
- The success of activities/handling on security of radioactive sources is of responsibilities of all people involved.

BATAN
Badan Tenaga Nuklir Nasional

SESSION 3

VIEWS FROM THE JAPANESE NUCLEAR INDUSTRY AND RADIATION PROTECTION PROFESSIONALS ON THE DRAFT ICRP RECOMMENDATIONS

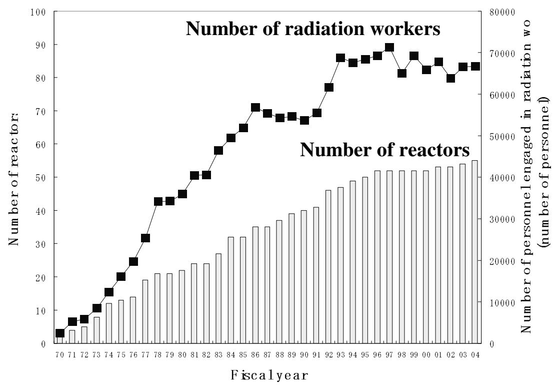
Chair: Yoshiharu YONEKURA
Co-Chair: Ho-Sin CHOI

The views of the Japanese nuclear industry, radiation protection professionals, and medical professionals on the concepts of the draft recommendations were presented. Specific concerns and suggestions were expressed in each of these fields based on practical considerations and experiences in operational radiation protection. It was noted that there is no need to complicate the current system, in particular without effectively expressed and rational reasoning. However, in general, speakers and participants in these discussions showed an understanding of ICRP publications.

VIEWS FROM THE JAPANESE INDUSTRY

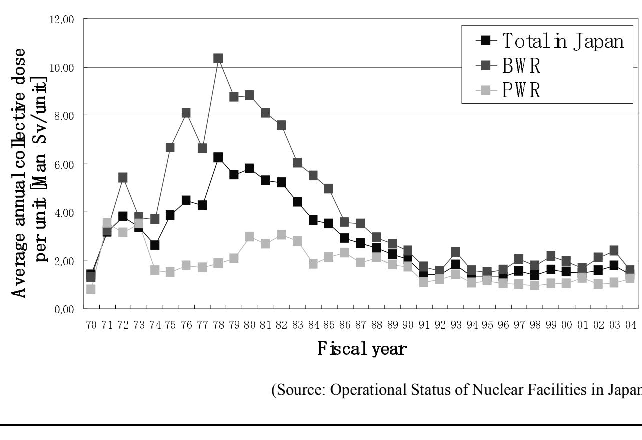
Sakae MUTO
Deputy Director-General of Nuclear Environment Task Force,
Federation of Electric Power Companies, Japan

Number of Reactors and Radiation Workers in Japan



(Source : Operational Status of Nuclear Facilities in Japan)

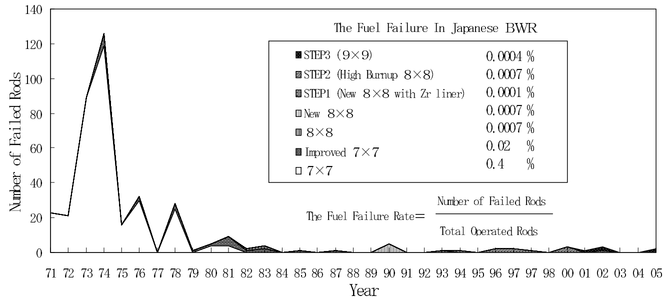
Average Annual Collective Dose per Unit



(Source: Operational Status of Nuclear Facilities in Japan)

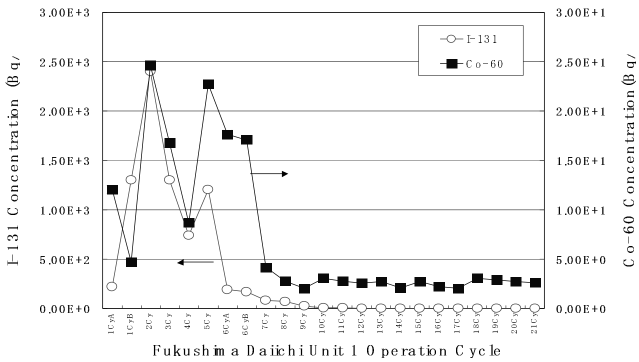
Dose Reduction Measures

- Fuel reliability improvement
  - Improvement of fuel design and operating method



Dose Reduction Measures

- Improvement of reactor water quality
  - Installation of HFF to reduce concentration of Fe in feed water
  - Adoption of low-cobalt material



Dose Reduction Measures

- Dose reducing measures at field
  - Installation of temporary shielding
  - Flushing of piping
  - Chemical decontamination
  - Improvement in Work methods (robotics…)

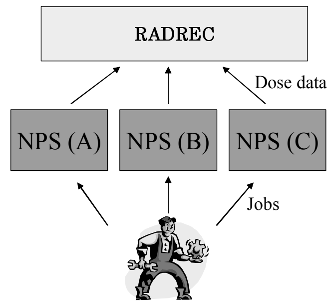
• In Japan, measures through design and work method improvement have been implemented based upon ALARA concept.

• These optimised radiation protection resulted in decreased occupational exposure.

Registration System for Worker Dose

- "The Radiation Dose Registration Center (RADREC)" made in 1977.
- Cumulative dose of any radiation workers received at any nuclear facilities is kept centrally at RADREC.

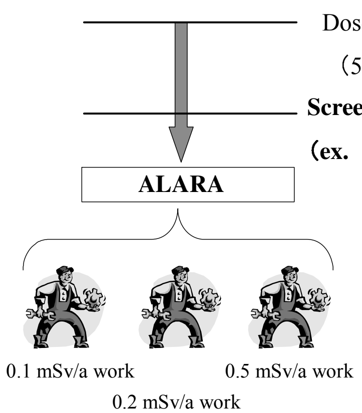
Even if radiation workers moves around multiple nuclear facilities, RADREC keep track of their cumulative dose exactly.



How RADREC Works in Japan

- Individual cumulative dose data is controlled centrally by RADREC.
- By regulation, any nuclear operators are required to inquire the cumulative dose of person, when the facility wants to register the person as a radiation worker.
- As a preemptive measures based upon ALARA concept, screening level for occupational dose is set by each nuclear operator, and if it should be exceeded, dose for the person is controlled not to exceed 100 mSv in five years.

An example of Dose Control for Workers by Nuclear Operators



Dose limits

（50 mSv/year，100 mSv/5 years）

Screening level

（ex.　18 mSv/year，80 mSv/5 years）

○ Nuclear operators set screening level well below dose limits.

○For each work, a planned dose is preset, and managed to keep dose below it.

○ Individual cumulative dose is managed below the screening level.

Views on Dose Constraints

- Change in new recommendation for dose standards（radiation workers）

1990 ICRP Recommendations

・Dose limits（in normal situation）	50 mSv/year, 100 mSv/5 years
・Dose constraints	【only description of concept】

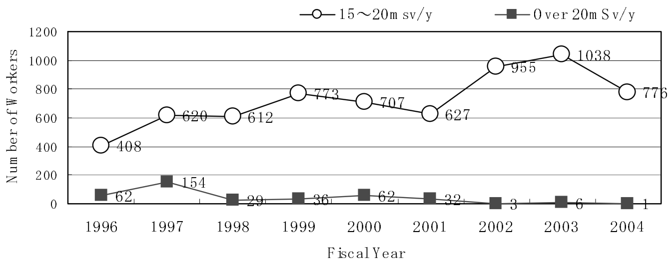
ICRP Draft New Recommendations

・Dose limits（in planned situation）	50 mSv/year, 100 mSv/5 years
・Dose constraints (in planned situation)	1～20 mSv／year

• Risk estimate of radiation effects remains unchanged.

•New recommendations introduces bands for dose constraints to enhance the protection system.

Number of Workers Exceeding 15 mSv/y in Japan



(Source : Radiation Effects Association News)

• In FY2004, 777 workers out of 63 979 exceeded 15 mSv/y.
• Most of those are experienced workers with few substitutes, and if constraint is brought in regulation rigidly, it would hinder operator's optimisation, and even might result in deterioration in the quality of maintenance and/or operation.

Public Dose Constraints

Strict target is already in place

- In 1975, Nuclear Safety Commission issued Guideline for Public Dose around NPS based upon ALAP concept.
- It sets target value of 50 μ Sv/y for a NPS (by release of RW), well below ICRP recommended dose limit in order for attaining public acceptance for nuclear power.
- If sky-shine and direct radiation should be added, or multiple facilities assumed, still ICPR recommendation of 1 mSv/y is well observed.

Dose Limits and Target Dose in Japan

NPS site

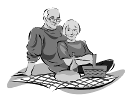
Reactor
(controlled area)

Dose limits for workers

< 50 mSv/year,

< 100 mSv/5 years

Off site of NPS
@site boundary



Dose limits for public

< 1 mSv/year

Target dose for a power station

< 50 μSv/year・station

View of Nuclear Operators
No new risks identified

- The risk and benefit balance is important for imposing proper regulations.
- In new recommendation, no new knowledge which indicate higher risk (health effects) to revise current regulations was identified.
- It mainly discusses how to enhance the implementation in optimised manner. We understand individuals radiation protection is achieved by dose limits, not by dose constraints.
- New recommendation states **"it does not suggest any changes in current regulations**."

View of Nuclear Operators
With no change in risk, the current regulation protects us well.

- In Japan, for both workers and public, appropriate regulations has been implemented to observe dose limit even for multiple sources assumed.
- For all workers, individual dose monitoring is required and "RADREC" keeps track of cumulative doses.
- For public, NSC guideline sets target dose for single station well below the limit.
- With no change in risk, **we understand the current regulation protects both workers and public properly**.

View of Nuclear Operators

Optimisation is only possible by elaboration at field

- For workers, optimisation in actual implementation protection depends on day-by-day status of each field work place which is managed by each operator.
- Dose limit and constraints should bear different meanings.
- New recommendation deals with both similarly, and may make both meanings ambiguous for implementation.
- Moreover we feel it may constitute impractical multilayer standards to cause confusion.
- **Change in radiation protection framework without any change in risk evaluation may lead to confusion and even burden in field**.

View of Nuclear Operators

New recommendations still have some ambiguities

- Definition of dose constraints for radiation workers is ambiguous.
- Therefore meanings of dose limit and dose constraint are ambiguous in order for actual implementation.
- Worker's dose is controlled by the Registry system, and introduction of dose constraint into regulation will not have any benefit at all.

View of Nuclear Operators

Collective dose

- New recommendation states **"the computation of cancer deaths based on collective doses involving trivial exposures to large populations is not reasonable and should be avoided."**
- It also states "LNT hypothesis provides **a prudent basis for radiation protection**", and "because of uncertainty, it is **not appropriate to calculate hypothetical number of cancer or heritable disease**".
- We feel that ICRP should show an application limit of collective dose or coverage of collective dose clearly.
- On the other hand, new recommendation states "it is **scientifically** reasonable" to assume LNT.
- Epidemiologically nor biologically, we understand LNT is still up to further study, and not proven **scientifically**.

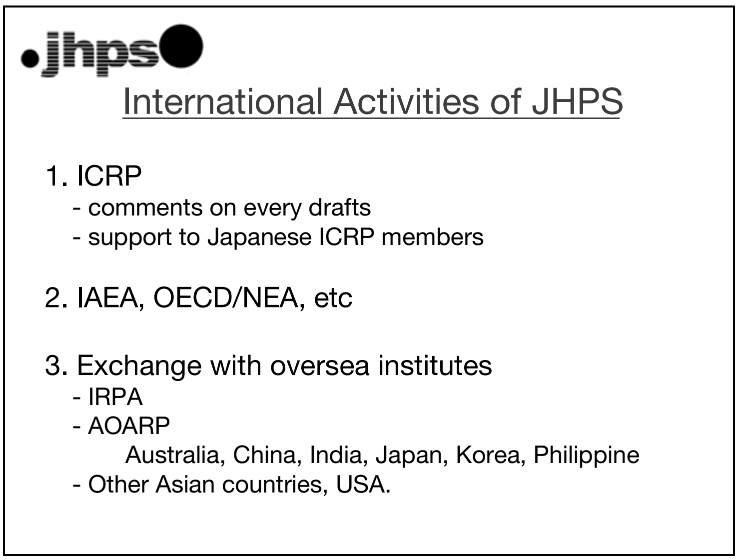
Summary

- Risk evaluation as well as dose limit has not been changed in new recommendation.
- It focuses upon optimisation in radiation protection, or implementation including low exposure range.
- Optimisation can be possible only with consideration of actual field workplace.
- With risk evaluation unchanged, current regulations along with proactive efforts by nuclear operators adequately protect both public and workers.
- We hope new recommendation is dealt with so as not to bring any confusion in field.

VIEWS FROM RADIATION PROTECTION PROFESSIONALS

Keiji ODA
Chair of Committee for International Correspondence,
Japan Health Physics Society (JHPS)

Today I have an opportunity to give some comments on the draft of ICRP recommendation as a chair of the Committee for International Correspondence, Japan Health Physics Society.



Three major missions have been given to this JHPS committee. The relationship with ICRP is most important in our society, so we are always ready for discussion about every draft and exchange of opinions with Japanese members of ICRP subcommittees. Also, we are paying attention to the activities of other international organisations, such as the revision of Basic Safety Standards. We keep contact with academic societies and the institutions of overseas countries, and now we are developing closer relations with other Asian countries.

●jhps●

Policy and Viewpoints

- discuss as scientifically as possible
- frank exchange of views

Recognition of Current Situation

- enthusiastic discussions for several years
- time to be concluded
- not in the stage of request for drastic changes
- constructive opinions, feedbacks and proposals

The Committee for International Correspondence of JHPS consists of 14 members belonging to universities, research institutes and industrial companies. It is very difficult to achieve a full consensus even in this group. There different opinions still exist especially regarding interpretation of the constraints.

As for the draft, I have asked the members to discuss all of the issues as scientifically as possible, because we are not grouping as representatives of a particular interest group but as specialists of a scientific field of radiological protection or health physics.

Secondly, we have to recognise the current of several years' discussions triggered by a kick-off paper by the former president Dr. Clarke. We think it is time to conclude the divergent discussions and to look for the most reasonable solution. Thus, we try to state ever more constructive opinions and proposals.

That is our policy against the draft of ICRP recommendation.

●jhps●

Impression of Draft

- replies/improvements for most of comments
- recession from challenging proposals and revolutionary ideas
- try to classify a number of situations and to deal with generally

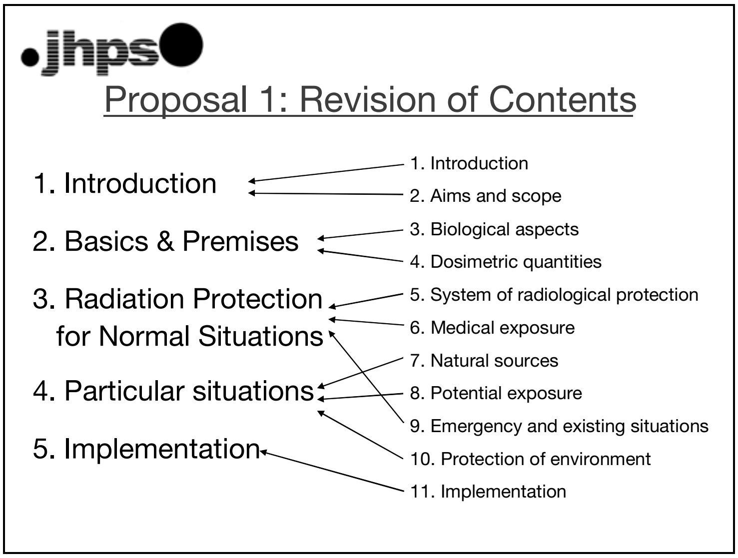
⇩

may be acceptable with minor revisions

Our impression after reviewing all the contents is summarised in this slide. We can find some responses to the comments that we have given in the chance of consultation of five foundation documents last year.

But these adjustments to critical comments would reflect to deletion of challenging proposals and ideas, which seems to be a kind of recession after economic bubble. We can find a new idea of classification of many exposure situations, which has been proposed in the latest draft of the Annals of the ICRP entitles “The Scope of Radiological Protection Regulations”.

As a whole we expect that this draft may be acceptable with minor revisions:



Next, we would like to propose two improvements for simpler and more comprehensive recommendation. The first proposal is the revision of the contents. There are eleven chapters in the original draft, but the weighting factor for each chapter seems to be largely different. In addition, the order is neither proper nor consistent with the classification of exposure situations stated in Chapters 2 and 5. So, we recommend reconstructing the contents, for example as is represented here.

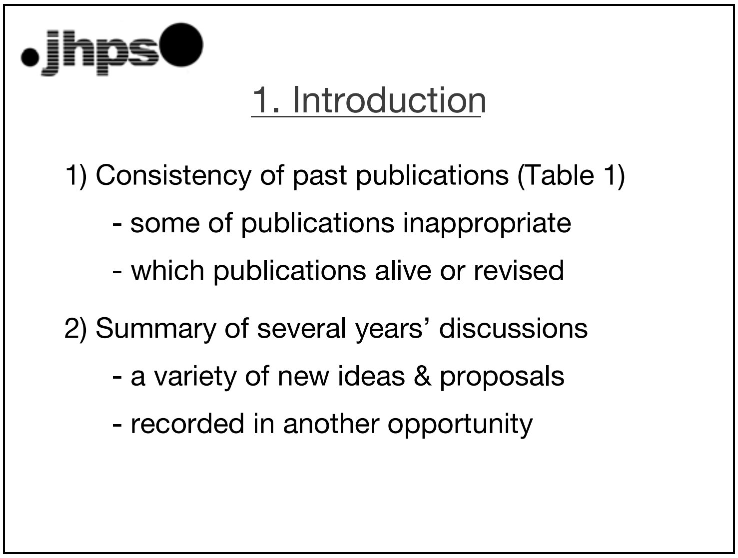
jhps

Proposal 2: Tabulation of Classification

Three types of situations
& three categories of exposures in Chap. 2

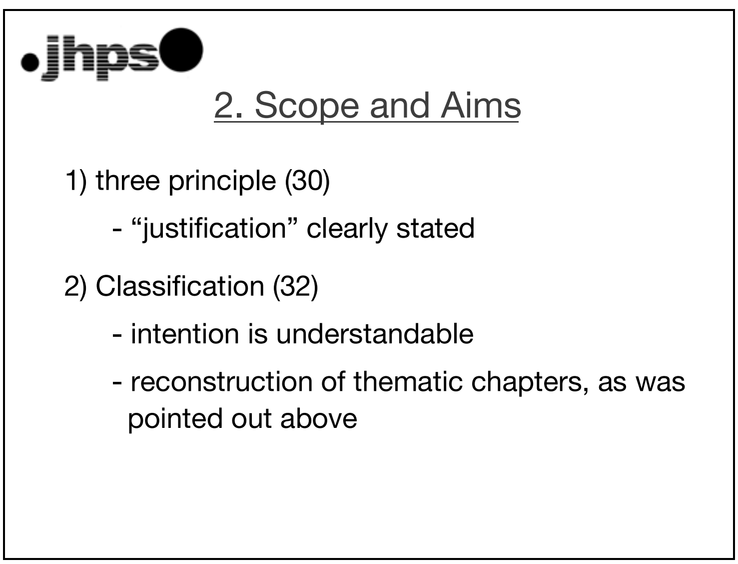
Exposure / Situation	Occupational			Public			Medical		
Planned	5.7	5.8	5.9	5.7	5.8	5.9	5.7 6.1	5.8 6.2 6.4	------
Emergency	5.7	5.8	------	5.7 9.4	5.8 9.5	------	6.1	5.8, 6.4	------
Existing	5.7 7.2	7.4	------	5.7	5.8 7.4 8.4	------	------	------	------

The second proposal is to introduce such a table of classification in Chapter 2 or 5 as is shown here. The draft says possible cases are classified into three types of situations and three categories of exposures. One of nine combinations is impossible. The numbers in each column correspond to the section in which three principles of justification, optimisation and dose limits are described. We are now improving this table to three-dimensional display where the third axis is the magnitude of the dose and the limits or some levels of actions will be indicated.



Let's proceed to the details of our comments in respective chapters. I would like to introduce a part of them quickly because of little time left in my talk.

The past relevant publications are listed in Table 1. The recommendation should state clearly which publications are still alive or already revised.



We accept the explicit statement of the first of three principles. That is one of critical comments that JHPS working group has been insisted all the time on keeping in the new recommendation.

In paragraph 32, possible exposure situations are classified systematically. The contents should be reconstructed, as I proposed earlier.

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3. Biological Aspects

1) Terminology of two types of effects (48)
   - avoid to include new & old expressions
   - unbalance of "cancer" & "heritable disease"

2) Description about LNT assumption (55)
   - "it is scientificallyreasonable to assume"
   - "it is not appropriate to calculate number"

The bases of biological consideration are summarised in Chapter 3. New terminologies for two types of radiation effects are introduced in paragraph 48. Several members in our group oppose the expressions, especially "cancer and heritable diseases", because the latter word has less importance.

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4. Dosimetric Quantities (1/2)

1) No change in dosimetric system
   - sensible decision

2) Role of Equivalent Dose, H_T
   - w_R are derived for stochastic effects at low doses (92)
   - H_T is protection quantity for tissue reaction
   - explanation needed that use of H_T is more practical than introduction of new quantity

Dosimetric quantities used in radiological protection are summarised in Chapter 4. New name of "radiation weighted dose" was proposed in the previous foundation document. We agree with ICRP's decision that no change is introduced in dosimetry system.

There still remains, however, a conceptual problem about "equivalent dose". Namely, the equivalent dose should be used as a protection quantity for tissue reactions, while the radiation weighting factor was determined by referring to RBE data for stochastic effect. The draft should state a reasonableness of use as protection quantity.

4. Dosimetric Quantities (2/2)

3) w_R and average QF

- "a more accurate approach have to be chosen based on the calculation of a mean QF" (111); misleading expression
- overestimation if use w_R of 20 for heavy ions; "One may replace it with a value of average QF, if available."

And some questions are pointed out in the third point about relation between the radiation weighting factor and the average quality factor.

5. System of Radiological Protection (1/2)

1) Single source (160,161)

- allowance in its definition according to situations

2) Order of sections

- revised, for example,

5.1. Introduction
5.2. Classification of situations and exposures
5.3. Level & principle of protection
5.4. Justification
5.5. Optimisation & constraints
5.6. Dose limits

Chapter 5 is an essential part of the recommendation and involved a lot of important arguments.

The first point under discussion is the definition of "single source". Even in our 14 members, the interpretation is splitting. In my opinion, it is better to leave some allowance in the definition of single source so that we can interpret flexibly the source depending on the situation.

For instance, supposing that there are three particle accelerators in a campus, we treat respective of them as single source for radiation workers. For public, on the other hand, these apparatuses may be regarded as one assembly of sources in the campus.

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5. System of Radiological Protection (2/2)

3) Constraints

- one of effective tools
- important description of use for public (174)
- all examples in Table 4 are not explained in the text

4) Justification (185)

- clearly described

The other one of most important and complex arguments is the "constraints", as many comments have been given to this subject in the previous drafts from a lot of countries. The working group of JHPS has continuously pointed out the problem concerning the dose constraint, such as an ambiguity of its definition, some change from the preceding recommendation of Publication 60, applicability to actual regulation frameworks, serious concern of double regulation with both the dose constraints and the dose limit, and so on.

However, we are now not in the stage opposing the use of the constraints as one of tools for controlling the radiation source. I think we should proceed to the next step of discussion, that is: How to practically and reasonably apply this concept to actual regulation frameworks and domestic law, based on admitting its effectiveness.

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6. Medical Exposure

1) Significance

- little description in the past recommendations
- concise summary of Pub.73,84,94

2) Unsealed RI therapy

- a few mSv per episode (274) inconsistent with 5 mSv by IAEA

We appreciate this summary of medical exposure in Chapter 6, because there is little description in the past recommendations.

7. Natural Sources

1) Exposure types (281-287)

- should be classified from a viewpoint of situation, dose level, or controllability

2) Exclusion level

- reference or reason for the values of 1 000, 10 000 Bq/kg and 40 Bq/m^3 (294)

In Chapters 7 and 8 are treated natural sources and potential exposure, both of which cannot be assigned to controllable situations. It seems that the exposure types and possible situations are listed randomly in the draft, so it should be classified from a meaningful viewpoint, for example, magnitude of the dose, probability, and so on.

8. Potential Exposure

1) Significance

- summary of Pub. 64,81
- difference from normal situations
- should be stated in para. 306

2) Possible situations

- any other situations?

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9. Emergency & Existing Situations

1) Improper order
   - should be moved after Chapter 5

2) Two types of situations
   - intention to deal with uniformly
   - difficulty in justification between two situations; longer time allowed in the latter

This chapter should be moved to next to Chapter 5, as was pointed above. The draft intends to deal with two situations in the same way. I think it is possible in part to do that but difficult especially in the process of judging whether the intervention is justified or not.

jhps

10. Protection of Environment

1) Significance
   - agree with its importance
   - only report or introduction of activity, which is not appropriate as “recommendation”

2) Approach
   - should be based on effects on animals and plats

All of us understand the importance of environment protection and a decision of ICRP to discuss and research this subject. But, this chapter, only a report of ICRP activity, seems to be isolated from other chapters which describing recommendations to be carried out by regulating authority.

.jhps

11. Implementation

1) Significance

   - compact summary, referring to Pub. 75,82

2) Supervised area

   - applicable? applied anywhere?

VIEWS FROM THE MEDICAL PROFESSION
(JRS: JAPAN RADIOLOGICAL SOCIETY)

Tsuneo ISHIGUCHI
Aichi Medical University, Japan

Adverse Health Effects of Radiation Exposure

1. **Tissue reactions (Deterministic effects)**
2. **Cancer and Heritable effects (Stochastic effects)**

The adverse health effects of radiation exposure are grouped in two general categories: tissue reactions (also called deterministic effects) and cancer and heritable effects (also called stochastic effects).

As to the biological aspects of radiological protection, the adverse health effects of radiation exposure are grouped in two general categories: tissue reactions (also called deterministic effects) and cancer and heritable effects (also called stochastic effects).

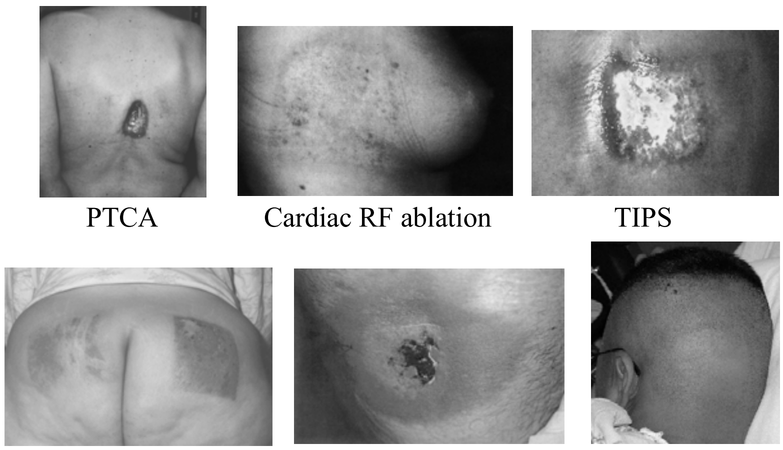
Adverse Health Effects of Radiation Exposure

Comments

- Although the terms deterministic and stochastic effects have a firmly embedded use in the system of radiation protection, **tissue reactions** and **cancer and heritable effects** seem to become much more familiar to the general public.
- The synonymous use of the generic and directly descriptive terms might be confusing.
- It seems to be better that the generic terms will be completely replaced by the **directly descriptive terms**.

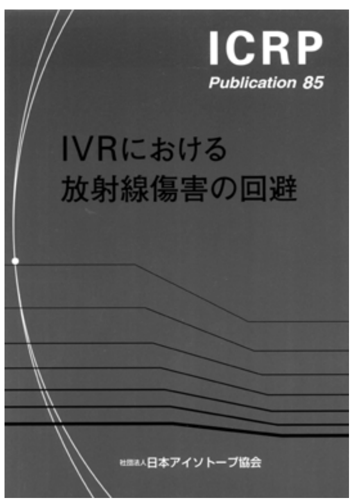
Although the terms deterministic and stochastic effects have a firmly embedded use in the system of radiation protection, tissue reactions and cancer and heritable effects seem to be much more familiar to the general public. We wonder the use of the generic and directly descriptive terms synonymously might be confusing. It seems to be better if the generic terms will be completely replaced by the directly descriptive terms.

Skin Injury in Interventional Radiology



PTCA — Cardiac RF ablation — TIPS

Uterine embolisation — Renal Angioplasty — Aneurysm emb.



ICRP Publication 85
Avoidance of radation-induced skin injury in interventional radiology

Translated by the members of Comittee on Radiation Protection, Japanese Society of Interventional Radiology

医療放射線防護連絡協議会
Japan Association on Radiological Protection in Medicine

Guideline for prevention of Radiation-induced Skin Injury during Interventional Radiology

Tissue Reactions

Early reactions (hours - a few weeks)
Inflammatory type: cell permiability change
histamine release
e.g. Erythema
Subsequent reactions as a consequence of cell loss **"Cell loss-type"**
e.g. Mucositis, desquamation

Late reactions (months – years)
Generic: derect injury in the target tissue **"Direct" or "Primary"**
e.g. Vascular occlusions leading to deep tissue necrosis
Consequential: result of early reactions **"Secondary"**
e.g. Dermal necrosis as a result of epidermal denudation and infection
Intestinal strictures caused by mucosal ulceration

Early tissue reactions (hours to a few weeks) can be inflammatory-type, e.g. erythema, and subsequent reactions as a consequence of cell loss, e.g. mucositis. We suggest that the latter reactions would be called "cell loss-type" reactions.

Late tissue reactions (months to years) are called "generic" if they occur as a result of injury directly in the target tissue e.g. vascular occlusions leading to deep tissue necrosis, or "consequential" if they occur as a result of early reactions, e.g. dermal necrosis as a result of severe epidermal denudation and chronic infection, and intestinal strictures caused by severe mucosal ulceration. These pathological conditions may be related to both and may often not well be assigned to either of the two categories. The term "generic" may not be easily understood as the result of direct injury in the target tissue. Instead, "direct of primary" might be used. "Secondary" might be used instead of consequential.

Radiation-induced Skin Injury

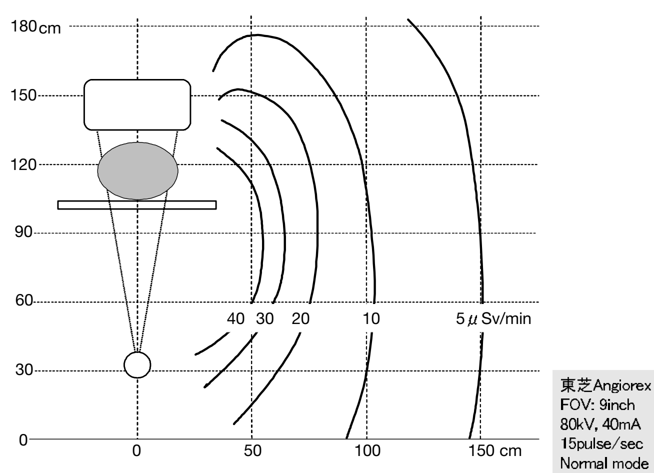
Ischemic necrosis
Threshold 18 Gy
Period to10 w
Secondary ulceration
Threshold 20 Gy

from Wagner, LK

Clinical conditions are often complex and may not be clearly assigned to each of the categories.

Interventional Radiology

Scatter Radiation



Lens Injuries Induced by Occupational Exposure in Non-optimised Interventional Radiology Laboratories

E. Vano, *et al.*: Br J. Radiol 71: 1998, 728-733

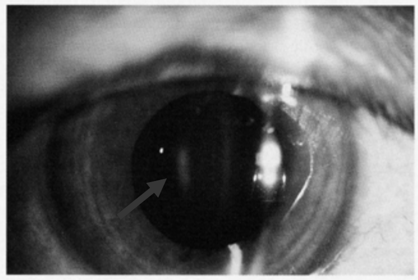


Figure 1. Lens radiation induced opacities of the specialist from centre 2.

Threshold of Effects for Lens

ICRP Pub. 60

	Single exposure	Protracted exposure	Annual dose for many years
Detectable opacities	0.5-2.0 Gy	5 Gy	>0.1 Gy/y
Visual impairment (Cataract)	5 Gy	>8 Gy	>0.15 Gy/y

Occupational dose limit
Equivalent dose: 150 mSv/year

Tissue Reactions

(53) On the basis of current data the Commission judges that the occupational and public dose limits, including the limits on equivalent dose for the skin, hands/feet and eye, given in Publication 60 remain applicable for preventing the occurrence of deterministic effects (tissue reactions).

However new data on the radiosensitivity of the eye are expected and the Commission will consider these data when they become available.

(without a reference)

The Commission judges that the occupational and public dose limits, including the limits on equivalent dose for the skin, hands/feet and eye, given in Publication 60 remain applicable for preventing the occurrence of deterministic effects (tissue reactions). The mSv for equivalent dose is often confused with the effective dose. For evaluation of the focal exposure including the eye, mGy might be used instead of mSv. On the other hand, the following description in the Section 3.1. (Paragraph 53) is shown without a reference, and it needs to be explained; “New data on the radiosensitivity of the eye are expected and the Commission will consider these data when they become available.”

Tissue Weighting Factor

ICRP, 1990		ICRP, 2006	
Gonads	0.20		
		Breast	0.12
Bone marrow	0.12	Bone marrow	
Colon		Colon	
Lung		Lung	
Stomach		Stomach	
		Gonads	0.08
Breast	0.05		
Bladder		Bladder	0.04
Esophagus		Esophagus	
Liver		Liver	
Thyroid		Thyroid	
Bone surface	0.01	Bone surface	0.01
Skin		Skin	
		Brain	
		Salivary glands	
Reminder	0.05	Reminder	0.12
Total	1.00	Total	1.00

The effective dose is calculated using the tissue weighting factor WT. A set of WT values was revised based on the respective values of relative radiation detriment. In the current analyses, breast cancers accounted for about 18% of the radiation-associated solid cancers, and the WT value for breast cancer has been increased from 0.05 to 0.12.

Risk of Cancer

The effective dose is calculated using the tissue weighting factor W_T. A set of W_T values was revised based on the respective values of relative radiation detriment.

In the current analyses, breast cancers accounted for about 18% of the radiation-associated solid cancers, and the W_T value for breast cancer has been increased from 0.05 to 0.12.

Although breast cancer is the prevailing cancer only in women, the commission has made a policy decision that there should only be a single set of W_T values that are averaged over both genders and all ages.

Although breast cancer is the prevailing cancer only in women, the commission has made a policy decision that there should only be a single set of WT values that are averaged over both genders and all ages.

Risk of Cancer

For gonads (i.e., to ovaries or testes), the detriment for heritable effects and cancer following irradiation were combined to give a WT of 0.08.

This combination of the risks is not understandable.

Again, the WT values are assumed to be valid for both genders and all age groups.

It is stated that male and female computational phantoms have been developed and recommended for use in future calculations (117).

We hope this will be pushed forward soon.

For gonads (i.e., to ovaries or testes), the detriment for heritable effects and cancer following irradiation were combined to give a WT of 0.08. The reason for this combination is uncertain and must be explained. Again, the WT values are assumed to be valid for both genders and all age groups. It is stated that male and female computational phantoms have been developed and recommended for use in future calculations (Paragraph 117), and we hope this will be pushed forward soon.

Gender-specific detriments

Table a) in Annex A

What is about the cancer risk for testes in male?

a) Gender-specific detriments for ages 0-85 years at exposure

Tissue	Nominal Risk Coefficient (cases per 10,000 persons per Sv)	Lethality fraction	Lethality-adjusted nominal risk* (relating to column 1)	Relative cancer free life lost	Detriment (relating to column 1)	Relative detriment[+]
Male						
Oesophagus	15	0.93	14	0.87	12.6	0.026
Stomach	68	0.83	66	0.88	57.9	0.120
Colon	91	0.48	69	0.97	66.8	0.138
Liver	41	0.95	41	0.88	36.1	0.075
Lung	76	0.89	75	0.80	59.9	0.124
Bone	7	0.45	5	1.00	5.1	0.011
Skin	1000	0.002	4	1.00	4.0	0.008
Breast	0	0.29	0	1.29	0.0	0.000
Ovary	0	0.57	0	1.12	0.0	0.000
Bladder	46	0.29	25	0.71	17.5	0.036
Thyroid	12	0.07	4	1.29	4.8	0.010
Bone Marrow	48	0.67	43	1.63	69.8	0.144
Other Solid	157	0.49	120	1.03	123.9	0.256
Gonads (Hereditary)	20	0.80	19	1.32	25.4	0.053
Total	***1580***		***485***		***483.9***	***1.00***
Female						
Oesophagus	16	0.93	16	0.87	13.6	0.021
Stomach	91	0.83	88	0.88	77.5	0.117
Colon	40	0.48	30	0.97	29.0	0.044
Liver	19	0.95	19	0.88	17.0	0.026
Lung	153	0.89	151	0.80	120.7	0.182
Bone	7	0.45	5	1.00	5.1	0.008
Skin	1000	0.00	4	1.00	4.0	0.006
Breast	224	0.29	124	1.29	159.7	0.240
Ovary	21	0.57	18	1.12	19.8	0.030
Bladder	41	0.29	22	0.71	15.8	0.024
Thyroid	53	0.07	16	1.29	20.6	0.031
Bone Marrow	36	0.67	33	1.63	53.2	0.080
Other Solid	131	0.49	100	1.03	103.1	0.155
Gonads (Hereditary)	20	0.80	19	1.32	25.4	0.038
Total	***1851***		***645***		***664.6***	***1.00***

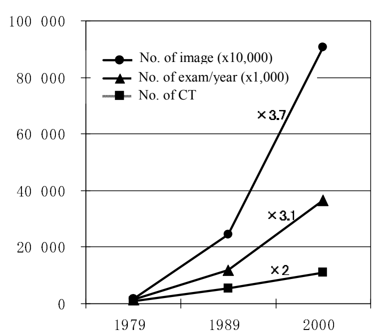
Tables a) and b) in Annex A (pp. 82-83) show estimates of gender-specific detriments for both male and female, however, risk data on testes are not shown. We wonder why the risk data for testes in male are not listed.

Medical Exposure of Patients

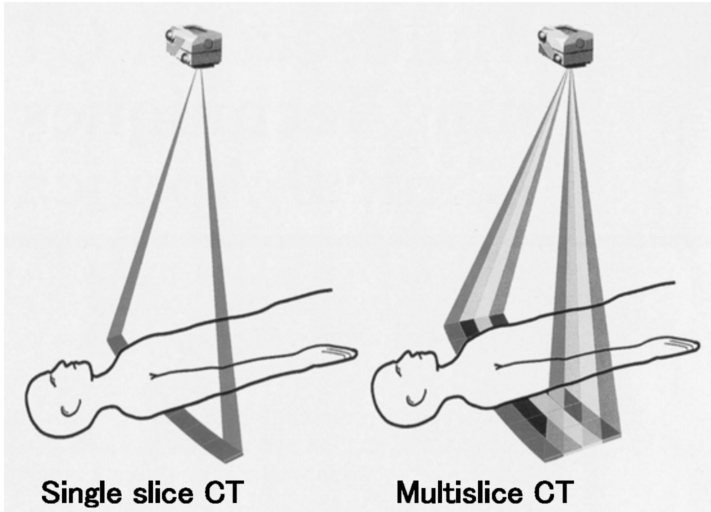
In medical exposure of patients, computed tomography (CT) has become a major source of radiation.
The numbers of CT equipments and examinations are constantly increasing worldwide, and several research papers on cancer risk by CT have been published.

In medical exposure of patients, computed tomography (CT) has become a major source of radiation. The numbers of CT equipments and CT examinations are constantly increasing worldwide, and several research papers on cancer risk by CT have been published recently.

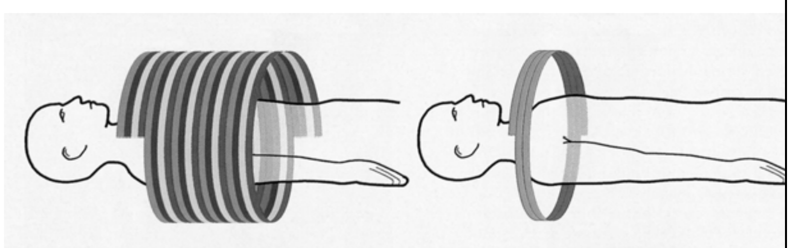
CT Examination is Increasing in Japan



Nishizawa, Acta Radiol Jap 2004; 64:151-158

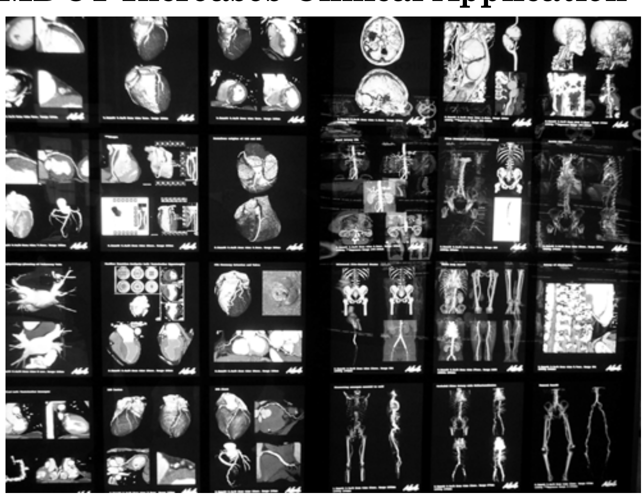


Mutislice CT **Single slice CT**



Detector raws: 4, 8, 16, 64, 264......
Faster exam, higher resolution, wider coverage.

MDCT Increases Clinical Application



Doses from Chest CT

	Helical CT	MDCT (4)	LDCT (single)
kV	120	120	120
mA	100-210	300-350	25
Rotation time (s/r)	1-1.5	0.5	2
Table feed (mm/s)	10	7-11	20/2s/r
FOV (cm)	27	35	30
Organ dose (mGy)			
Bone marrow	5.91	7.19	2.51
Lung	20.94	19.59	3.09
Stomach	8.59	19.83	1.41
Breast	18.24	20.20	2.41
Liver	0.43	19.62	1.64
Esophagus	18.12	18.16	2.90
Thyroid	8.23	23.70	2.41
Effective dose (mSv)	7.62	11.0	1.40

Nishizawa, Acta Radiol Jap 2004; 64: suppl.

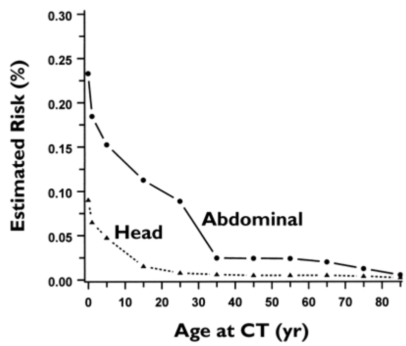
What is the Dose From CT? How High?

- The effective dose in chest CT is in the order of 10 mSv and in some CT examinations like that of pelvic region, it may be around 20 mSv.
- The absorbed dose to tissues from CT can often approach or exceed the levels known to increase the probability of cancer as shown in epidemiological studies.

ICRP Publication 87

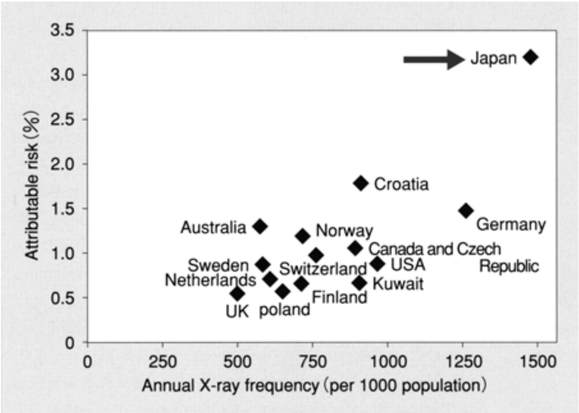
They conclude that the absorbed dose by CT examination varies from 10 to 100 mGy, which may be near or exceed the level to increase radiation-induced cancer risk. We are aware that it is mandatory to reduce the radiation dose while maintaining proper image quality to ensure the patient's real benefit of CT examinations.

Estimated Risks of Radiation-induced Fatal Cancer from Pediatric CT: Brenner DJ, *et al.:* 2001



Graph shows estimated lifetime attributable cancer mortality risk as a function of age at examination for a single typical CT examination of head and of abdomen. Note rapid increase in risk with decreasing age.

Japan: 1477 x-ray Exams/Year: Result in 3.2% (7587 cases) Increase of Cancer



Gonzalez AB, Darby S: Lancet 363: 345-351, 2004

Address from Japan Radiological Society, 2004 Guideline for Pediatric CT, 2005

Although the individual risk seems to be very low, it is important to recognize that radiation from CT might increase cancer risk especially in children and young patients.
Under appropriate justification, every effort to reduce dose while maintaining proper image quality must be made to ensure the patient's real benefit of the diagnostic x-ray examinations.

However, we often wonder whether the estimated increase in number of cancer patient by radiation from CT in a particular country is a real world.

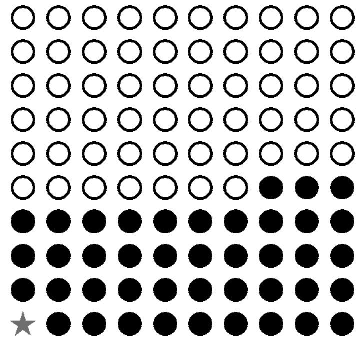
However, we often wonder whether the estimated increase in number of cancer patient by radiation from CT in a particular country is a real world.

The Commission emphasises that while the LNT hypothesis remains a scientifically plausible element in its practical system of radiological protection, biological information that would ambiguously verify the hypothesis is unlikely to be forthcoming.
Because of this uncertainty on effects at low doses the Commission judges that it is not appropriate, for the formal purposes of public health, to calculate the hypothetical number of cases of cancer or heritable disease that might be associated with very small radiation doses received by large numbers of people over very long periods of time (57).

The Commission emphasises that while the LNT hypothesis remains a scientifically plausible element (better revised as "a useful tool") in its practical system of radiological protection, biological information that would ambiguously verify the hypothesis is unlikely to be forthcoming. Because of this uncertainty on effects at low doses the Commission judges that it is not appropriate, for the formal purposes of public health, to calculate the hypothetical number of cases of cancer or heritable disease that might be associated with very small radiation doses received by large numbers of people over very long periods of time (Paragraph 57). We hope this important remark will be constantly announced to avoid anxiety or confusion about medical exposures.

Risk Model for Cancer：BEIR-Ⅶ

Committee to Assess Health Risks from Exposure to Low Levels of Ionizing Radiation,
National Research Council, USA



The calculations in this report suggest approximately one cancer (star) in 100 people could result from a single exposure 100 mSv of low-LET radiation.

In a lifetime, approximately 42 (solid circles) of 100 people will be diagnosed with cancer from causes unrelated to radiation.

In the BEIR VII report by the Committee to Assess Health Risks from Exposure to Low Levels of Ionising Radiation, National Research Council, USA, the calculations suggest approximately one cancer in 100 people could result from a single exposure 100 mSv of low-LET radiation. On the other hand, in a lifetime, approximately 42 of 100 people will be diagnosed with cancer from causes unrelated to radiation. This type of comparison will well understood by the public that the actual risk of radiation by diagnostic x-ray examination is very low compared to the natural incidence of cancer, and compared to the patient's benefit.

The risk of induction of cancer should be discussed not independently but with other major factors unrelated to radiation.

In medical exposures, the risk of induction of cancer should be discussed not independently but with the other major factors unrelated to radiation.

SESSION 4

SPECIAL SESSION ON THE INTERNATIONAL BASIC SAFETY STANDARDS

Chair: Yoshiharu YONEKURA

The view from the IAEA on the draft ICRP recommendations was presented focusing on the potential need for revision of the International Basic Safety Standards. The schedule and process for the BSS revision were presented, and it was underlined that the BSS should incorporate the recommendations of the ICRP, and should represent a collective view of other international organizations, member states and stakeholders. This consistency between the new ICRP recommendations and the revised BSS is necessary for effective regulation.

IMPLICATIONS OF THE NEW ICRP SYSTEM OF RADIOLOGICAL PROTECTION FOR THE INTERNATIONAL BASIC SAFETY STANDARDS

Ches MASON
Radiation Protection Group, IAEA
Former Chairperson of Radiation Safety Standards Committee (RASSC)

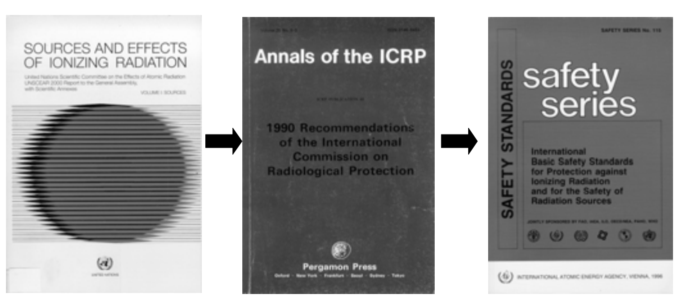
Why Revise the BSS?

? BSS (SS115) is 10 years old and due for ***review***

? Conclusions of review conducted by RASSC:

- No single urgent need for change, but…
- Some improvements could be made
- Need to bring BSS into current *Safety Standards Series*
- Need to take note of new Safety Fundamentals and anticipated new ICRP Recommendations
- which, overall, establish a case for ***revision*** .

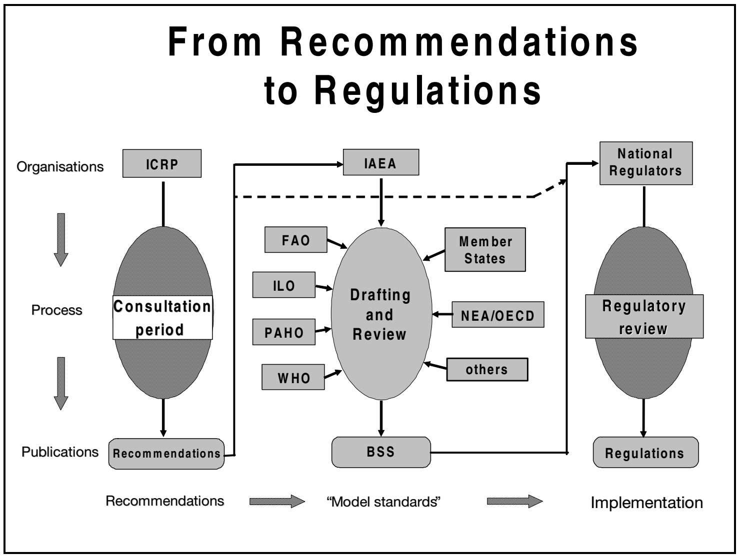
Current Paradigm: UNSCEAR - ICRP - IAEA

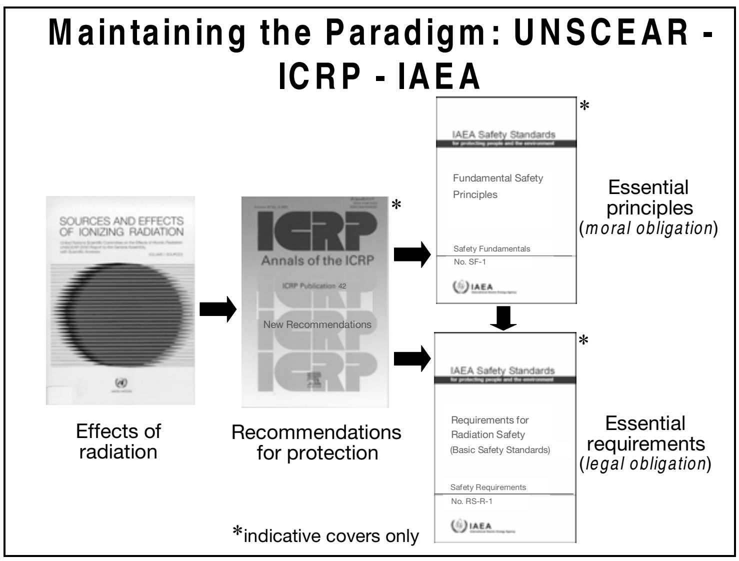


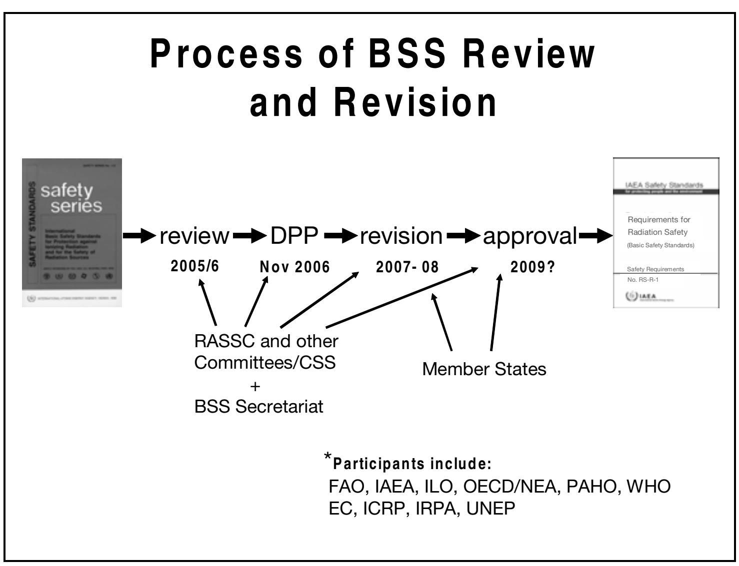
Effects of radiation

Recommendations for protection

Regulatory style standards

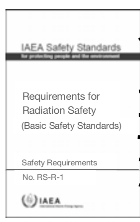

From Recommendations to Regulations
Organisations
ICRP
IAEA
National Regulators
Process
Consultation period
FAO
ILO
PAHO
WHO
Drafting and Review
Member States
NEA/OECD
others
Regulatory review
Publications
Recommendations
BSS
Regulations
Recommendations
"Model standards"
Implementation


Maintaining the Paradigm: UNSCEAR - ICRP - IAEA
SOURCES AND EFFECTS OF IONIZING RADIATION
Effects of radiation
ICRP
Annals of the ICRP
ICRP Publication 42
New Recommendations
Recommendations for protection
IAEA Safety Standards
Fundamental Safety Principles
Safety Fundamentals
No. SF-1
IAEA
Essential principles
(moral obligation)
IAEA Safety Standards
Requirements for Radiation Safety
(Basic Safety Standards)
Safety Requirements
No. RS-R-1
IAEA
Essential requirements
(legal obligation)
*indicative covers only


Process of BSS Review and Revision
safety series
SAFETY STANDARDS
review
DPP
revision
approval
2005/6
Nov 2006
2007- 08
2009?
IAEA Safety Standards
Requirements for Radiation Safety
(Basic Safety Standards)
Safety Requirements
No. RS-R-1
IAEA
RASSC and other Committees/CSS
+
BSS Secretariat
Member States
*Participants include:
FAO, IAEA, ILO, OECD/NEA, PAHO, WHO
EC, ICRP, IRPA, UNEP

IAEA Safety Standards Series

Comprehensive Character of BSS



- Regulatory control of exposure
- Occupational and public exposure from practices
- Safety of sources
- Safety of radioactive waste
- Medical exposure
- Existing exposure
- Emergency preparedness
- Rehabilitation

The essential protection and safety requirements of the BSS underpin all circumstances of exposure to radiation

Guidance From RASSC and BSS Secretariat

- Retain BSS role as the international benchmark for radiation safety standards across all fields.
- Recognise the need for stability in international standards; so be conservative and justify proposed changes.
- Maintain close connection with ICRP.
- Keep co-sponsors (WHO, PAHO, ILO, NEA, etc.) and all Safety Committees fully involved.
- Seek and take note of feedback from Member States on current BSS.
- Assist developing countries to participate.

The New ICRP Recommendations

(first thoughts ***only***)

- ICRP to be congratulated on the process of consultation and on taking note of earlier comments on RP05.
- RP06 is a significant improvement on RP05.
- The draft Recommendations can now be seen as an update of ICRP60, rather than a major change.
- Still room for improvement in:
  - application of dose constraints for existing situations;
  - defining the scope of regulatory control.

Implications for the BSS

(first thoughts ***only***)

- Overall, little change to BSS expected.
- Some change of terminology:
  - practice vs. planned situation;
  - intervention vs. emergency and existing situations.
- More thinking required on the application of dose constraints, especially for existing situations, for BSS purposes (cf: action levels, intervention levels).
- Greater clarity on the scope of regulatory control (exclusion vs. exemption) is needed for the purposes of regulatory-style language in the BSS.

Implications for National Regulators

(*preliminary*) general conclusion:

- If a country has established a system of radiation protection consistent with ICRP60 and the current Basic Safety Standards, that system will also be consistent - in the level of safety provided - with the new ICRP Recommendations and the new BSS
- It is likely that there will be no urgent need to change national regulations simply to bring terminology and detailed practice into line with new ICRP Recommendations and a new BSS

SESSION 5

PANEL DISCUSSION

HOW CAN NEW ICRP RECOMMENDATIONS BEST HELP TO ASSURE PUBLIC AND WORKER HEALTH AND SAFETY?

Moderator: Hans RIOTTE

The panel discussion moderated by the NEA secretariat addressed questions received in advance and during the conference from participants, The panel members were representatives from regulatory bodies of each of the countries participating in the conference, joined by experts from the Japanese nuclear industry, radiation protection and medical professionals. Among the key topics were numerical recommendations for exclusion and exemption.

PANEL DISCUSSION

How can the new ICRP recommendations best help to assure public and workplace health and safety?

For the purpose of this panel discussion participants had been asked to submit questions for this session or views on the new ICRP recommendations prior to the conference and during the first day of the conference. The NEA secretariat received a lot of responses which where categorised into topics for the panel discussion. The panel consisted of participants who had presented their specific views in previous sessions in addition to two new members: Mr. Yasuhito Awatsuji, MEXT, and Dr. Nobuyuki Sugiura, JHPS. (See annex; list of the panellists). Panellists were expected to discuss the questions presented by the moderator in accordance to their scientific, practical, regulation background and or personal ideas.

1. Lower boundary

There were lots of comments about the lower boundary for dose limit. While the panellists had expected the ICRP to give clear guidance for exemption, exclusion and clearance, they also showed many varieties of radiation exposure: occupational, from natural sources, internal exposure to radon. They also pointed out the difficulty to propose the figure set in the recommendations since it complicated the situation. Dr. Holm explained the role of the ICRP was not to recommend precise recommendations but a concept for the decision maker on radiation protection.

2. LNT hypothesis

Almost all participants considered the LNT hypothesis as the best tool at present to ensure radiation protection in low dose for its uncertainty.

3. Collective dose

Due to the uncertainty of dosimetry in low dose level and the LNT hypothesis, the concept of collective dose was recognised as useful. It was agreed however that a more precise explanation for the appropriate application of collective dose was needed in the new ICRP recommendations.

4. Dose constraint

There were a lot of questions and views regarding the concept of dose constraint. Questions were combined into two points: responsibility for setting the dose constraint figure and the effectiveness of prevention of occupational and public exposure, who and how to deal with the dose constraint concept. The responsibility for setting the dose constraint figure should depend on the right position for each state and each country. So, the ICRP should clearly state this in their recommendations. While on the one hand it was suggested that the Government is eligible to set dose constraints, on the other hand, industries stressed the importance for operators to maintain flexibility in order to achieve optimisation of radiation protection. It was shown that it is difficult to apply dose constraints to natural sources and to workers who operate in several nuclear facilities. During the discussion, it was repeated that the ICRP suggests that the dose constraint concept is useful in order to approach the optimisation in the designing stage and the emergent situation.

Furthermore it is expected that consensus on international dose constraint will enhance stakeholder trust and be useful in the technical area. Some participants showed examples where the international peer review to radiation protection in power stations among the industries was effective. And the international effort was expected on the implementation radiation protection under the new ICRP recommendations.

SESSION 6

SYNTHESIS OF THE MEETING

Chair: Yasuhiro YAMAGUCHI

Considering the contents and nature of most discussions, it can be concluded that the process of the new ICRP recommendations is moving forward considering the comments from all over the world. In addition it can be stated that the idea of new recommendations was well accepted by most participants. However, it must be noted that there are still remaining differences in regional legislative as well as cultural frameworks and these must be taken into account. An expectation was expressed that all new comments and questions should be discussed internationally.

SUMMARY OF KEY POINTS

Henri MÉTIVIER
Conference Rapporteur

Agence pour l'énergie nucléaire
Nuclear Energy Agency

The first key point is
the quality of discussion.

You have carefully read
the new draft.

The discussion was free
and very useful for ICRP.

Agence pour l'énergie nucléaire
Nuclear Energy Agency

I fully share the point of view of our Chinese colleague: There has been a lot of progress and improvement in the drafting of the new recommendations since the last conference, including taking into account comments from the RP community.

Agence pour l'énergie nucléaire
Nuclear Energy Agency

Once more, we have to congratulate OECD/NEA for this very efficient brain storming.

AEN NEA Agence pour l'énergie nucléaire Nuclear Energy Agency OECD

Key point 1

More continuity than change is appreciated.

AEN NEA Agence pour l'énergie nucléaire Nuclear Energy Agency OECD

Key point 2

The draft clearly describes the goal of radioprotection:

Prospective Protection

AEN NEA Agence pour l'énergie nucléaire Nuclear Energy Agency OECD

Key point 3

Good discussion on LNT.

A lighter presentation.

A great benefit for RP and the scientific debate.

AEN NEA Agence pour l'énergie nucléaire Nuclear Energy Agency OECD

Key point 4

Problems with the change of Wt, Wr.

ICRP 26, 60 and new draft.

Neutrons, breast.

Trust in authorities.

AEN NEA Agence pour l'énergie nucléaire Nuclear Energy Agency OECD

Key point 5

Clear statement of the decrease of genetic risk is appreciated.

AEN NEA Agence pour l'énergie nucléaire Nuclear Energy Agency OECD

Key point 6

Always the problem of the same name for equivalent dose and effective dose.

Moreover the equivalent dose is used for deterministic effect (lens and skin) with stochastic tools...

Key point 7

I fully agree that the new draft is better than the former, but be careful with the wording for non-English mother tongue audiences.

AEN NEA Agence pour l'énergie nucléaire
Nuclear Energy Agency
OECD

Key point 8

New definition and limits of the use of collective dose are appreciated.

AEN NEA Agence pour l'énergie nucléaire
Nuclear Energy Agency
OECD

Key point 9

Definition of three types of exposure is appreciated.

Agence pour l'énergie nucléaire
Nuclear Energy Agency

OECD

Key point 10

Natural exposure is recognised as a significant issue in China.

Agence pour l'énergie nucléaire
Nuclear Energy Agency

OECD

Key point 11

Urgency for the next years or decades is the medical field, but don't forget how many lives had been saved by these intentional exposures.

It is important to translate in national language some ICRP-C3 publications.

Agence pour l'énergie nucléaire
Nuclear Energy Agency

OECD

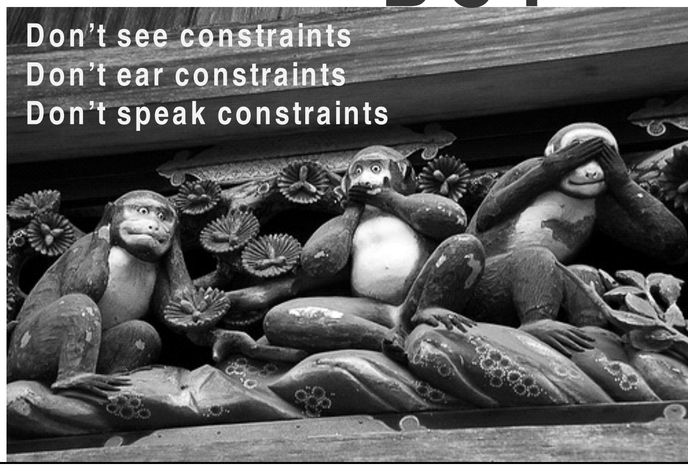
Other points

Our Indonesian colleague raised an important point:

- **Teaching of NST in primary school;**
- **Free NST training/seminars for Teachers.**

AEN NEA Agence pour l'énergie nucléaire
Nuclear Energy Agency
OECD

BUT

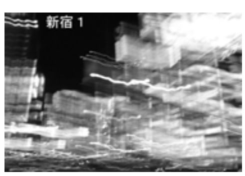


AEN NEA Agence pour l'énergie nucléaire
Nuclear Energy Agency
OECD

Day-to-day efforts by NPP operators is successful, ALARA well implemented in this field of activity is a good illustration that we can already use constraint without the new draft.

But if this concept is well implemented in nuclear industry, don't forget that they are other field of activities where ALARA is not usual.

AEN NEA Agence pour l'énergie nucléaire
Nuclear Energy Agency
OECD



General consensus for rewriting constraint paragraphs:
- More clarity;
- More examples.

"*dose constraint is an ambition level based on experience*".

AEN NEA Agence pour l'énergie nucléaire
Nuclear Energy Agency OECD

CONCLUSION

Lars Erik, your new draft is good, but don't stop the effort, the next one will be perfect, JHPS done half the job.

THE ASIAN PERSPECTIVE

Tsutomu UEKI
Director of Nuclear Safety Division,
Science and Technology Policy Bureau, MEXT, Japan

I would like to say thanks to all participants for fruitful discussions for two days. And I also would like to say thanks again to the ICRP for ongoing efforts to further development of the radiological protection and for the opportunity to make comments and exchange views.

The new ICRP draft recommendation, which was issued last month, is highly appreciated. Because the draft recommendation takes new scientific findings and main concepts, such as the three principles of protection, dose limit and stance to LNT, are not changed.

According to uncertainty of LNT, as Dr. Niwa explained, radiation protection contains uncertainty of dose risks, but we need to have regulation. In ICRP, C1 tries to turn uncertainty into certainly, and C4 tries to come up with best regulations even with uncertainty. Otherwise, the data of Hiroshima-Nagasaki have been useful yet for the new scientific findings. It may solve the problem of uncertainty. Thus, we recognised again the importance of the data of Hiroshima-Nagasaki.

Asian countries including Japan introduce some of the ICRP concepts into their legislation system for radiation protection. The Asian Regulatory authorities are accountable to their nations and stakeholders when they introduce a new concept to present regulations. Therefore there were many explanations and opinions about an application of ICRP recommendations to their regulation in this conference. Through the explanation, we can also discover the regulation systems of other Asian countries.

One of the main opinions was about dose constraint. In the new draft the ICRP recommendation gave a definition of a dose constraint as “a start point of optimisation”. There was an opinion that the definitions permitted many different interpretations in Asian countries and it is unclear the difference of dose constraint and dose limit. Thus, we recognised that we need to have the same understanding as each other for consistency of radiation protection. Also, other many opinions such as environmental protection, radon exposure, the roles and sharing between ICRP, IAEA and national government and the importance of risk communication were issued in this conference. Those were also remarkable opinions.

We expect that ICRP treats properly the opinions which were issued in this conference and reflect our opinions in the recommendation.

Finally, I wish, to thank Dr. Lars-Erik Holm, ICRP Chairperson, Dr. Shizuyo Kusumi, Commissioner of Nuclear Safety Commission of Japan, Dr. Yasuhito Sasaki, Vice President International University of Health and Welfare, Mr. Mason, RASSC Chairperson IAEA, Dr. Choi from Korea, Dr. Pan and Dr. Xia from China, Mr. Burns from Australia, Dr. Taryo from Indonesia, Dr. Marcus, Deputy Director-General of OECD/NEA, many distinguished guests from Asian-Pacific countries, OECD/NEA staff, secretariat of this conference, ladies and gentlemen. Thank you very much.

IMPLICATIONS FOR ICRP DEVELOPMENTS

Lars-Erik HOLM
ICRP Chair

In the summary session, Dr. Holm expressed his thanks to all participants for their commitment and contribution to this conference. Principally he was pleased to see that participants had carefully read the new draft recommendations, and were able to contribute remarkably well in discussions in order to achieve consensus on identifying and solving problems in different countries.

He noted that that discussion of the radiation protection issues has lasted nearly 80 years, and the last eight years have been dedicated to the preparation of the current revision of the recommendations. During this process, the ICRP adopted a new approach and has tried to involve stakeholders in preparation, which has resulted in many specialists and groups around the world participating actively.

Following the Third Asian Regional Conference, the North American Regional Conference is scheduled to be held in Washington, DC, which is expected to be more policy-oriented.

Dr. Holm expressed his intention to summarise and implement comments from these conferences, and finalise the new recommendations as soon as possible.

IMPLICATIONS FOR CRPPH DEVELOPMENTS

Jacques LOCHARD
CRPPH Chair

Dear Colleagues,

First of all, I would like to say that it was a great pleasure for me to participate in this Third Conference on the Evolution of the System of Radiological Protection. I am impressed by the quality of the presentations, the constructive criticism of the present draft document and the numerous positive proposals for improvements that have been made during these last two days.

I am quite confident that the Commission will carefully take into account these criticisms and proposals as has been proven over the last years throughout the preparation of the new recommendations, with other criticisms and proposals.

Having said that, I would like to raise briefly a few points related to the implications of this conference for future CRPPH developments. I see three main directions.

The first one is to develop a reflection on the interactions between radiological protection science and radiation protection principles. These interactions have been mentioned several times by different speakers during the Conference and this is in my view an important issue which deserves to be looked at more thoroughly in the future.

For your information, the CRPPH decided, during its last annual meeting in March 2006, to launch a series of technical workshops aiming at exploring the links between science and policy in radiological protection. This decision resulted from the discussion that followed the presentation of the work of the EGIS expert group chaired by Henri Mé tivier. The CRPPH members clearly expressed their wish to see a continuation of the work achieved so far in order to better understand how scientific findings in the fields of epidemiology and radiobiology are used to develop a system of protection responding to the expectations of a modern society.

Obviously the present conference re-enforce the interest of going into this direction and I hope that Asian experts will actively participate to the work of the Committee to ensure constructive and fruitful debates on this difficult issue, which inevitably will embrace the debate on LNT that has been several time evocated during the last two days.

The second direction, which emerged from our discussion and deserve the attention of the CRRPPH, is certainly the need for developing guidance on the practical application of dose constraints especially as far as their possible role in the regulatory process is concerned. The dose constraint concept is obviously going to play a major role in the future and the discussions during the conference have shown that misunderstanding still remain concerning their use which call for more clarification. This is certainly the role of international organisations like the CRPPH or IAEA to elaborate further the concept on the basis of the ICRP basic recommendations and in this perspective, I think as key tools of the CRPPH, the ISOE System and the INEX Party are perfect forums to open a dialogue between radiation professionals on the use of dose constraints to protect the workforce and to protect the public during and after a nuclear accident or any radiological events.

The third direction is without any doubt the continuation of the cooperation between ICRP and the CRPPH. So far this cooperation has been exemplary. We are finishing a long period during which the Committee has tried to support in the best effective way the preparation process for the recommendations through a systematic review of the successive drafts documents elaborated by the Commission. This was also a period during which the Committee tried to facilitate the dialogue between NEA members and ICRP and beyond with other key stakeholders directly involved in radiological protection. The three Asian Conferences cannot be a better example of the usefulness this dialogue played in the development of the recommendations.

I think a new period for the cooperation between CRPPH and ICRP will start soon which will focussed on the interpretation of the new recommendations and the development of advice and guidance on how to implement them in practice. This will certainly be a period as interesting as the previous one for all professionals and the CRPPH, as an open and forward looking forum, can certainly play a useful role for a rapid dissemination of the recommendations worldwide.

One of the key roles of the CRPPH is to anticipate scientific and social evolutions that may affect radiological protection in the future and, having identified such evolutions, to explore their theoretical, methodological and practical potential impacts on the professionals and organisations involved in day-to-day radiation protection. The recent contribution of CRPPH on the role of stakeholders in radiation protection is a perfect illustration of this anticipating role. The nearly decade of work devoted to this emerging issue was not an effort for nothing when looking at its place in the new recommendations and I hope that the Committee, will continue in the future, to maintain its role, together with the other international organisations, on the forefront of the evolution of radiological protection.

At this stage I would like to take the opportunity, which is offered to me today, to sincerely thank the Japanese authorities for their on-going financial support to the CRPPH over the last few years. This has been an invaluable input for the development of successful actions, among which the three Asian Conferences, and on behalf of all CRPPH members I reiterate once again my most sincere thanks.

In conclusion, I would like also thank Lars-Erik Holm, the Chairman of ICRP for his active participation in the Conference, all lecturers for their high quality presentations, all colleagues in the audience for the detailed discussions they initiated over the two days and also all of those people, including of course the interpreters, who helped in the preparation and the running of the Conference and thus directly contributed to its success.

Thank you for your attention.

CONFERENCE SUMMARY

Based on the discussions that took place during this third forum, this summary report identifies the forum key issues. The CRPPH is grateful to the ICRP for the open discussions held during this forum and for its acceptance of the comments made by various stakeholders, including regulators, industrials and professionals This very positive discussion will be followed by another forum in North America and a final forum in Europe before the main commission acceptance of the new recommendations and their publication in 2007.

1. INTRODUCTION

The objectives of this third conference, following the two previous conferences held in Tokyo in October 2002 and July 2004, were to;

- Evaluate and discuss the possible implications of the ICRP draft recommendations, particularly with respect to Asian expectations and possible future application in the Asian contexts;

- Discuss how new ICRP recommendations could best serve the needs of national and international radiological protection policy makers, regulators, operators, workers and the public within the Asian context;

- Continue the open and broad dialogue between stakeholders to reach a common level of understanding of the issues at stake in the Asian context;

- Contribute to the evolution of the new system of radiation protection.

In recent years, the ICRP has launched an open process to enhance the current set of radiological protection recommendations. The ICRP has presented its new draft proposals and recommendations to the broad radiological protection community seeking a dialogue with all interested parties or stakeholders. The objective of this open process is to arrive at a new generation of ICRP recommendations that are as broadly understood and accepted as possible so they can be efficiently implemented. The ICRP published at the beginning of June 2006 the new draft recommendations on the ICRP web site (http://www.icrp.org/) for comment and is expecting a new set of comments before the publication of these new recommendations in the 2007 time frame.

The preliminary focus of the ICRP development has been on new general recommendations, which will replace Publication 60. As part of this process, the ICRP has also identified a need to clarify and update its views on the radiological protection of the environment. Both of these areas are of great interest to member countries of the Nuclear Energy Agency (NEA).

As an international committee made up of nationally nominated radiation protection authorities and technical experts, the NEA Committee on Radiation Protection and Public Health (CRPPH) has for most of its history actively followed the work of the ICRP. This interest continues as the ICRP develops its new recommendations. Shortly after the ICRP began to develop its new ideas (Roger Clarke, 1999, *J. Radiol. Prot.* 19 No 2, June 1999), the CRPPH began specific work in this area; focusing on how the system of radiological protection could be made more responsive to decision makers, regulators, practitioners and the public. Through a series of expert groups, topical session discussions with the ICRP Chair, and broad stakeholder dialogue fora, the CRPPH has developed a long series of documents discussing relevant issues, and proposing possible directions to move forward effectively. Since the appearance of the new ICRP suggestions in 1999, the CRPPH has developed and published 12 reports specifically concerning development of a new system (see References), all of which are available from the NEA's web site (www.nea.fr).

The occasion of the release of the latest draft ICRP recommendations provides the ideal timing to hold the Third Asian Regional Conference on the Evolution of the System of Radiological Protection. With the recommendations planned to be finalised in 2006 or 2007, this Conference will provide important input to the development process. In addition, CRPPH and ICRP are planning to hold North American Regional Conference (August 2006, Washington D.C.) and Third NEA/ICRP Forum (October 2006, Prague).

During this forum, the first of a series of three ICRP/NEA dialogues to discuss this latest draft, the chairman of the ICRP presented the Commission's new draft recommendations, updated after receiving a considerable number of comments during the last web consultation. This new document, very different from the previous one, largely incorporates many significant comments coming from all over the world. This latest draft is more comprehensive than previous versions, and seems more accepted by stakeholders, although the presentation of dose constraints is an exception to this broader acceptance. This new document retains its reliance on the linear non threshold (LNT) assumption, in spite of new scientific data challenging this hypothesis. A few modifications appear in weighting factors for radiation and tissues. A significant difference from previous recommendations concerns a significant reduction in genetic risk. It should be noted that genetic risks have not been statistically observed in the two generations of Hiroshima-Nagasaki bombing survivors.

There has been a lot of progress and improvement in the drafting of the new recommendations since the last conference, including taking into account many comments from the RP community.

2. THE NEW ICRP GENERAL RECOMMENDATIONS

The first ICRP recommendations issued in 1928 focused on the protection of the medical staff against occupational exposure. General recommendations have appeared later in 1959 (Publication 1) 1964, (Publication 6), 1966 (Publication 9), 1977 (Publication 26) and 1991 (Publication 60). Since 1991, nearly 30 different numerical restrictions on dose have appeared in a number of publications leading many users and stakeholders to confusion. A simplification was needed, and this was one of the main aims of these new recommendations, in addition to the consolidation of the general principles described in 1991.

Since ICRP Publication 60, our knowledge of radiation risk has not changed substantially. However, new results from radiological protection sciences are increasingly challenging the general concepts of the radiological protection system, although currently results are not significant enough to suggest that drastic change of the system is urgent. The system is considered as successful, there is no hurry for changes, and the Commission has wished to maintain as much stability in the new recommendations as is consistent with the new scientific information. This consistency was one of the main requirements expressed during the former consultations both in Asia (Tokyo, 2004) and in Europe (Lanzarote, 2004). There is more continuity than change!

In the new draft recommendations, most previous recommendations will remain because they work and are clear. However some previous recommendations need to be better explained, in some cases more guidance is needed, in others new recommendations need to be added because there has been a void, and in some cases new approaches are needed because understanding has evolved. The new recommendations consolidate and add to previous recommendations issued in various ICRP publications.

The existing numerical recommendations in the policy guidance given in 1991 remain valid unless otherwise stated.

The new recommendations maintain the fundamental principles of radiological protection and clarify how they apply to sources and individuals. The new recommendations update the radiation and tissues weighting factors and the radiation detriment, and maintain dose limits, but expand the concept of dose constraint in source-related protection to all situations.

The main change, or clarification, is the description of practices and intervention. The new recommendations retain the idea of practices and interventions, but not as a way of distinguishing between how the system will be applied. Rather, the new system adopts, for both practices and interventions, the same approach and assumes that there is no procedural difference because:

- There is some level of dose above which the regulator will demand action.

- Optimisation of protection is applied to keep exposure as low as reasonably achievable, taking into account economic and social factors.

- Once protection has been optimised, no further action to reduce doses is seen as necessary unless circumstances change.

- To achieve this, the new draft recommendations will apply to three types of exposure situations; planned, emergency and existing.

These changes result from experience of the implementation of the previous approach, and from dialogue with stakeholders mainly promoting different experience by the NEA/CRPPH.

The recommendations continue to cover controllable natural and artificial source exposure and apply to the control of sources or pathways leading to doses and individuals.

Foundation documents and building blocks will be published by the commission as the result of discussions among the different Committees of the Commission.

The quantities for radiological protection are unchanged but weighting factors for calculations are sometimes changed:

- The W_R for protons decreases from a value of 5 to 2:

- The W_R for neutrons is now a continuous function, and is two times less for neutron energy less than 1 MeV:

- W_T for gonads drops from 0.2 to 0.08. This difference is mainly due to the change of reference for genetic risk estimate, previously extrapolated to theoretical equilibrium (many generations). Today the genetic risk is based on second generations of Hiroshima and Nagasaki survivors:

- W_T for breast increases from 0.05 to 0.12:

- W_T for bladder, oesophagus, liver and thyroid smoothly decrease from 0.5 to 0.4:

- News organs (brains and salivary glands) appear and the splitting rule for remainders (W_T = 0.12 – 0.05 in ICRP publication 60) is deleted:

The Commission has strongly clarified the use of effective dose:

- E is calculated by using reference values for a reference person or group:

- E should be used for planning in prospective situations:

- E should **not** be used for more detailed retrospective dose and risk assessments on exposure of individuals:

- E should **not** be used for epidemiological studies.

The Linear-non-threshold (LNT) hypothesis remains the hypothesis for averaging and summing up of doses, for the concept of effective dose and for the system of dose record keeping. Biological information is challenging the system, but new evolving knowledge is still insufficient to provide a new basis, or a significant change of the current basis, for protection purposes. ICRP considers that LNT is a pragmatic, realistic and conservative tool, not truth supplemented with real data.

Nominal risk coefficients for stochastic effects (% Sv-1) decreased from 6.0 to 5.5 for cancer and 1.3 to 0.2 for heritable effects for the whole exposed population, but the Commission estimates that this decrease is too small to warrant changing the current dose limit values, particularly taking into account uncertainties. Indeed the old problem of uncertainty remains, and is particularly large for low doses and dose rates. However, the Commission continues to assume that the overall risk coefficient of 0.05 Sv^{-1} continues to be appropriate for purposes of radiological protection.

Although LNT remains the basis of radiological protection, the Commission accepts that specific situations with a different dose effect relationship are possible. Thresholds can exist but are not universal; the LNT remains a prospective tool.

The three principles, justification, optimisation and limitation are maintained and consolidated. In planned situations, the total dose to any individual **from all regulated sources** should not exceed the appropriate limits specified by the Commission. However the Commission reinforces the concept of Dose Constraint which is the most fundamental level of protection for the most exposed individuals **from a single source** within a type of exposure. Dose constrains are used prospectively as the starting point of the optimisation process. Numerically, the dose constraint is less than limits, and in planned, emergency or existing situations it represents the level of dose/risk where action is ***almost always*** warranted. Numerical values for dose constraints will be established at the **national level or local level** by regulators **and operators**. It is a level of ambition for operators approved by regulators; it is not a form of retrospective dose limitation.

The numerical criteria recommended by ICRP Publication 60 and thereafter can be regarded as constraints, the values fall into three defined bands: 0.01-1 mSv, 1-20 mSv, and 20-100 mSv. These three bands are explained in the text, and examples are given. For radon, ICRP's constraints are set where action is almost always warranted: 600 $Bq.m^{-3}$ for home and 1500 $Bq.m^{-3}$ at work.

In the new recommendations the Commission has more clearly defined collective dose and the limits of its uses. It is an instrument for optimisation, for comparing radiological technologies and protection procedures; it is not intended as a tool for epidemiologic risk assessment. It is not reasonable and should be avoided for computation of cancer deaths, particularly those based on collective dose involving extremely low individual exposures to large populations.

With regard to exclusion and exemption, the Commission mainly refers to several years of dialogue that various international organisations have undertaken, and suggest that they do not wish to interfere in these discussions.

The Commission is waiting for the results of Committee 5 (Protection of the Environment) before developing recommendations for protection of non-human species. The new recommendations refer today to the ICRP publication 91 (2003), which describes a framework for assessing the impact of ionising radiation on non-human species.

Lastly, after these new set of consultations, the Commission plans the final adoption of these news recommendations for the end of the year 2006 or the beginning of the year 2007 for publication in 2007.

3. COMMENTS ON AND SUGGESTIONS FOR THE NEW RECOMMENDATIONS

For any new radiation protection recommendations to be successful, they must be welcomed and acceptable to policy makers, regulators, industries, stakeholders, scientists and radiation protection professionals. They have to enhance worker safety and health and protection of the environment, and deliver an understandable and cost effective implementable product. It is necessary to maintain stability in the policy and system of radiological protection to avoid unnecessary waste of limited resources. As the ICRP claims that the risk change being proposed is small and that risk is decreasing, it could be understood that the current regulation already protects both workers and public properly.

It is greatly appreciated that the new draft has made significant progress and improvement since the last Asian conference. Many previous criticisms have been addressed, the new draft addresses continuing concerns, and the feasibility of implementing the new draft has been greatly improved.

3.1 The three principles reaffirmed

Regulatory bodies (RB) of Asian and Pacific areas participating at the regional conference have well appreciated that the new recommendations represent more continuity with ICRP 60 than change. The new draft is based on and consistent with the former recommendations. New scientific findings have been introduced and the three principles of protection are not changed. Indeed, regulatory authorities are particularly concerned by justification, optimisation and dose limitation. In many countries national regulations are based on ICRP publication 60.

Justification is one of the essential principles of radiological protection. ICRP reaffirms that the responsibility for judging the justification usually falls on government agencies for occupational and public exposure. Japanese regulatory bodies raised the question of whether authorities would be required to justify every situation individually, or whether broad, overall judgments would suffice for categories of radiation-related activities. Judgment of justification has been, and will be, done democratically through appropriate political/social processes. The decision-making process differs depending on the types of activity being considered.

Optimisation. In Japan as in all Asian countries, the concept of ALARA has been well understood and has been implemented by each operator. The public and occupational exposures have been kept well below the dose limits, the levels controlled by laws and regulations. According to the new draft recommendations, dose constraints are "*the most fundamental level of protection*". Indeed constraints may be a good approach to achieve "optimisation" in some cases. However, is it always necessary to introduce dose constraints into the regulation system regardless of types of exposures? Regulatory bodies are not convinced that the introduction of constraints is in all cases necessary, and think that this introduction could make the system more complicated and confusing. Operators also feel this way. The distinction between dose limits and dose constraints seems to be unclear and difficult to implement. However, the experience gained from nuclear activities can be used to establish dose constraints when designing the workplace environment. An effort of clarification is needed for the final document.

Dose limits recommended by the ICRP in publication 60 have been introduced in Asian countries and have been strictly controlled by the relevant laws. Dose limits still have an important role in radiation protection. Through the implementation of the ALARA concept, doses actually received have been kept much lower than the dose limits. The values of dose limit are NOT changed, though detriment-adjusted nominal risk coefficients for cancer and hereditary effects are decreased. ICRP clearly explains that, taking into account uncertainties in risk evaluation, the decreases presented in the new recommendations are too small to justify any changes in dose limits. This, in essence increases the level of confidence in existing dose limits, and this could be explained to stakeholders.

Japanese authorities think that the role of organisations in the development and implementation of radiological protection principles should be maintained: ICRP formulates recommendations and principles, IAEA develops the BSS, which provides basic/practical model of the regulation system, and national governments establish and implement national/regional regulation systems reflecting the different situations in each country. The universality of the ICRP recommendations is an important contribution to worldwide radiological protection.

Regulatory bodies introduced the notion of risk communication in the recommendations. This communication is a part of social science which is more and more present in the radiological protection system through the involvement of stakeholders. The question of the ICRP's role in defining stakeholder involvement remains a key question.

3.2 Dose from radiation exposure

LNT is the foundation for the ICRP risk evaluation system, but the relation between dose — damage and detriments is probably much too naïve an approach, and has certain limitations. While risk assessment is mainly based on A-bomb survivors, risks from low doses are far from certain. Moreover, it is important to recognise the limits of epidemiological studies, in that, for example, the regional variation in cancer mortality in different Japanese prefectures is over 10%. In spite of this, because a broad, overall approach is needed for regulations and policies, the ICRP approach was endorsed by conference participants.

In radiological protection practice, one needs quantities useful for the management of exposures and regulations. The ICRP has defined a single quantity (Effective dose), specifying an "amount" of exposure and related to the probability of stochastic effects for all type of radiation exposures, both for acute and chronic exposures, and both for external and internal exposures.

One significant confusion in this system is the definition of two concepts ***Equivalent dose*** and ***Effective dose*** both using the same unit; the Sievert. Moreover the equivalent dose is applied to limit deterministic effects, such as to the lens of the eye and to skin, but uses weighting factors that have been established based on stochastic effects. As these limits are only controlled for skin, and estimated for the lens of the eye, another approach could be to simply define equivalent dose as being simply a step in the calculation of effective dose. Effective dose should be described as a double weighed concept, using the unit of Sievert, while the other dose for regulation could be the absorbed dose measured in Gray.

ICRP is not proposing a specific scheme for the treatment of doses and risks, and this simplification is sufficient only for the intended application for the limitation and management of doses.

For dose calculation the ICRP has noticeably changed some weighting factors. For the gonads, this has been a continuous trend since ICRP publication 26 (using a tissue weighting factor of 0.25), to

ICRP publication 60 (using a tissue weighting factor of 0.20), and now to the new draft recommendations (using a tissue weighting factor of 0.08). This corresponds to a continuous trend in scientific observation among the A-bomb survivors and progeny. In another case however, the evolution could be disturbing for stakeholders. For example, the tissue weighting factor for the breast has successively been 0.15 (in ICRP publication 26), 0.05 (in ICRP publication 60) and now 0.12. Neutron weighting factors for neutron energy less than 1 MeV decreased by a factor of 2 from ICRP publication 26 to ICRP publication 60 but now back to the value close to former publication 26. This "yoyo" evaluation could be misinterpreted by some stakeholders or by the "anti-ICRP" world, which have often evoked the costs of such decisions (neutrons for example). Some regulatory bodies are afraid that frequent changes of weighting factors could have a negative impact on radiation protection as well as on public trust. However, it seems reasonable for ICRP to be transparent, and not to hesitate on such decisions that are based on the latest scientific assessment of the situation. This reinforces the credibility of the institution.

Furthermore, it is anticipated that the newly recommended tissue weighting factors will have a great impact on dose assessment of not only internal exposure, but also external exposure. Because of the prospective nature of radiological protection, the Commission does not recommend re-computation of existing values with the new models and parameters (Paragraph 153). The calculation of the Occupational Intake of Radionuclide (OIR) is one of the next objectives of the new mandate, after publication of revised dosimetric models; human respiratory tract model, human alimentary tract models, systemic models and voxel phantoms calculation methodology.

Some regulatory bodies suggest performing simulation of the influences to estimate the ensuing changed in the derived, auxiliary limits and dose coefficients. It is possible that both utilities and authorities could experience problems with trust from stakeholders (workers and the public) when these changes are implemented.

To avoid this, the ICRP must clearly explain that these models are firstly developed for prospective use in protection. In these cases, parameters are default values, invariant results (dose coefficients) without uncertainties. But these modern models could also be used for retrospective purposes and in these cases, it is possible to replace default parameters by realistic parameters and the results (dose coefficients) will be really adapted to the case studied. Today, the lack of explanation sometimes leads to ambiguities.

3.3 Collective dose

It is generally appreciated that the concept of collective dose remains. It is also appreciated that the limits of this concept are more clearly explained, avoiding misuses as in the case of the prediction of number of deaths after the Chernobyl accident.

The new definition is considered as very important: collective dose is not intended as a tool for epidemiological risk assessment and is inappropriate to use in risk projection based on epidemiological studies. The computation of cancer deaths or hereditary effects based on collective dose, particularly those involving very small individual exposures to large populations, is not reasonable and should be avoided.

Collective dose is an instrument for optimisation, for comparing technologies and protection procedures.

The challenge now is to explain to stakeholders that their previous use of collective dose and risk prevision, mainly based on the LNT hypothesis, is not and has not been valid.

3.4 Definition of exposure situations

In the new recommendations three exposure situations are identified:

- Planned situations are everyday situations involving a planned operation,
- Emergency situations are unexpected situations that occur during the operation of a practice and that require urgent action,
- Existing exposure situations are exposure situations that already exist when a decision on control has to be taken, including natural background radiation and residues from previously unregulated practices.

However the new recommendations seem unclear for potential exposures. Safety culture is a concept difficult to understand for users of small sources.

3.5 Natural exposure

ICRP publication 60 had already considered that natural exposure, when controllable, has to be incorporated in the radiation protection system. It was a great progress, and was a key basis of the explanation to the general public that the effects of radiation do not differ between radiation of natural or man-made origin. The new recommendations reaffirm this statement. Equity between different branches of workers, who may have exposure from man-made radiation in nuclear power plants or from natural radiation in coal mine, is reinforced.

Exposure of aircrew should be classified as occupational exposure. This is already the case in many countries; Japan for example has fixed constraints at 5 mSv per year. Nevertheless this is not the main concern for natural exposures for many countries, particularly in China. Underground mining of coal and other products and underground workers in general, count for ten million workers China. This is one of the main sources of exposure for this country.

Many discussions concerned the constraints recommended for Radon-222. For some participants the level of activity 600 $Bq.m^{-3}$ for dwellings and 1500 $Bq.m^{-3}$ are too high. These comments are based on recent epidemiological studies showing statistically significant evidence of lung cancers for levels higher than 100 $Bq.m^{-3}$. Some suggested 200 $Bq.m^{-3}$ for new houses and 400 $Bq.m^{-3}$ for existing houses. ICRP wishes to keep the proposed values because uncertainties remain on epidemiological studies and because old and new approaches are used for determining these constraints values.

3.6 Medical exposure

In medical exposure of patients, computed tomography (CT) has become a major source of radiation. The numbers of CT facilities and examinations are constantly increasing worldwide, and several research papers have been published documenting these increases. The absorbed dose to tissues from CT can often approach or exceed the levels known to increase the probability of cancer as shown in epidemiological studies.

It is important to recognise that radiation from CT might increase cancer risk especially in children and young patients. Every effort to reduce dose while maintaining proper image quality must be made to ensure the patient's real benefit of the diagnostic X-ray examinations.

Some other, less significant needs for clarification, explanation and modification were raised during the conference. The radiosensitivity of the lens of the eye has to be explained and referenced, as well as the Commission's approach to gender differences. In addition, weighting factors and calculation methodologies have to be harmonised.

It was clearly stated that there is a significant need to encourage the translation of important documents of Committee 3 (Protection in Medicine) into many national languages for a more effective dissemination of ICRP recommendations in the medical field.

Because of the uncertainty of effects at low doses the Commission judges that it is not appropriate, for the formal purposes of public health, to calculate the hypothetical number of cases of cancer or heritable diseases that might be associated with very small radiation doses received by large numbers of people over very long periods of time (Paragraph 57). Medical practitioners hope that this important remark will be constantly announced to avoid anxiety of radiophobia about medical exposures.

Lastly risk of induction of cancer should be discussed not independently but with other major factors unrelated to radiation.

3.7 Environment

Regarding the new ICRP draft recommendations, it appears that the protection system for the environment and the protection on non-human species have no significant impact on regulatory authorities. Review and consultation will again be necessary if specific and practical radiation protection recommendations are developed for the environment.

Participants largely estimate that there is no hurry and that the framework for assessing the impact of ionising radiation on non-human species (ICRP Publication 91) is enough. ICRP prefers to wait for the results of the discussion of Committee 5, which was generally well appreciated.

3.8 Constraints

It is important again to discuss the concept of dose constraints even if this has already been discussed in previous chapters, because this is the most controversial concept in the new recommendations.

Is it always necessary to introduce dose constraints into national regulation systems regardless of types of exposures? The majority of participants are not convinced by the introduction of constraints in any case, and think that this introduction could make the system more complicated and confusing. The distinction between dose limits and dose constraints seems to be unclear and difficult to implement.

However, for the workplace, in many cases dose constraints already exist and the experience gained from such practices can be used to establish dose constraints when designing the workplace environment. Radiation protection measures have been implemented since the end of the seventies in accordance with the ALARA concept. These optimised radiation protection approaches resulted in decreases in occupational exposure.

ICRP addresses these concerns by suggesting that in planned situations constraints represent an ambitious level of protection based on experience. For nuclear energy production it is clearly stated by the ICRP that the system will practically not change since optimisation based on the ALARA concept still exists. However the ICRP says that while ALARA is well implemented in the nuclear energy area, this is not true for all other sectors of exposure-causing activities.

In emergency or existing controllable exposure situations constraints represent a level of dose or risk where action to reduce dose or risk is almost always warranted. Dose constraints are set to ensure that it is not planned to exceed constraints. An effort of clarification remains needed for the final document.

The fear of users is if an assessment shows that a relevant constraint was not complied, it could be regarded as a failure of protection. ICRP once more, has to be clear on this important aspect and clearly assume that dose constraints applied only for prospective purpose in all three types of exposures. Dose constraints should not be regarded in all case as a rigid boundary. ICRP should state more clearly that exceeding the constraint would not be a regulatory infringement, and should provide guidance on what judgements can be made retrospectively in emergency and existing situations (to judge the effectiveness of protection efforts since constraints are not applicable). In its draft the ICRP illustrates the constraint concept with a definition of three bands of less than 1 mSv, 1 mSv to 20 mSv, and 20 mSv to 100 mSv. It is recommended that the explanation of these three bands should give more illustrations of the different situations.

ICRP should clearly explain the rationale for its recommended numerical values. Constraints could be a good opportunity for the ICRP or any other appropriate organisation to promote education of radiation risk. For example 1 mSv/y is the variation of natural background dose in the world and this level of dose could be explained as corresponding to a marginal increase above the natural background. Some at the conference recommended public education and information in all levels of education.

Some participants do not understand the recommendation for maximum numerical dose constraints of 0.1 and 0.3 mSv per year for the context of waste management alone, and would prefer to remove it.

Another question raised by a number of participants concerns the dose level below which the optimisation process should stop. The dose of 0.01 mV per year has been widely considered to be a good basis for exemption. Is this actually a lower boundary for optimisation?

All aspects of optimisation cannot be codified; optimisation is more an obligation of means than of results. The authority should focus on processes, procedures and judgments rather than specific outcomes. An open dialogue must be established between the authority and the operating management to ensure a successful optimisation process. Recommendations should encourage cycles of continuous review and assessment to optimise dose for practices using a single source. As such, discussions seemed to indicate that there was not a universal, *a priori*, *de facto* lower bound to optimisation.

Through general discussion, a consensus emerged that, as previously stated, the ICRP should not fix numerical values for dose constraints for specific circumstances. This should be left to appropriate processes at the national or local level. This is an important point in the discussion between Asian stakeholders and the ICRP. For example Japan has already fixed an administrative goal for aircrew exposure at 5 mSv per year.

Some conference participants suggested that dose constraints would be difficult to implement in emergency situations. They claimed that relaxation of controls (applicable for planned situations) could be permitted in an emergency situation, keeping in mind that efforts should be made to keep doses below 1 Sv in some circumstances, but below 100 mSv as the highest recommended constraint.

As such, it was requested that the ICRP should clearly explain what kind of dose constraint(s) should be used for emergency situations?

Another point in need of clarification in the final text concerns the definition of a single source. Exposure to workers is source related, but the source could be a single nuclear power plant or several nuclear power plants on one site. In the case of the public, exposure could come from several sources.

In conclusion it should be explained which concept is the most important for regulatory control under the new system, constraints or dose limits or both. Moreover if constraints are related to a single source, and if constraints become the most fundamental level of protection of exposure in future, how can we ensure that the total dose received from all possible sources will be controlled under some limit? These points are fundamental and often repeated in comments and criticisms.

Finally, it was agreed that the presentation made by the ICRP chair during the conference was very clear, and in fact much clearer than the draft recommendations themselves. As such, much of the confusion from the latest draft seems to be based on terminology and wording, not on the concepts presented.

3.9 General comments

Although the terms deterministic and stochastic effects have a firmly embedded use in the system of radiation protection, tissue reactions, cancer and heritable effects may be much more easily understood by the general public. As such, it seems it would be better if the previous terms were completely replaced by the new, more directly descriptive terms.

Some participants suggested that the ICRP should exercise a more discreet approach to changes, as frequent changes in the definition of terms or concepts could lead to communication problems with many different groups of stakeholders.

Generically, more attention should be paid to the language of the new recommendations, particularly keeping in mind the non-English speaking countries.

The key challenge for the new recommendations will be to demonstrate to regulators that any modification in their regulations necessary to be in full compliance with the new recommendations should be implemented. As expressed by the South Korean experts, some participants agree that once an improved draft proposal is completed, it would be worthwhile to seek the view of radiation protection practitioners (regulators and operators) on the potential, practical implications before issuing the next recommendations.

Lastly, some members of the Japan Health Physics Society (JHPS) have appreciated the enthusiastic discussions that have taken place over the past several years, but think that it is time to conclude. They have made an impressive effort at analysing the new draft and its possible implications, and have suggested some minor editorial revisions. They also suggest a significant re-ordering of the chapters (see their presentations). This suggestion should be studied by the ICRP in light of all three NEA/ICRP regional workshops.

4. IMPLICATIONS FOR THE CRPPH

The quality of the debate and the numerous constructive and positive proposals and criticisms encourage the CRPPH of the NEA to continue this open dialogue between the ICRP and stakeholders.

The Asian forum underlined three actions for the CRPPH:

1. The CRPPH is a useful open forum for discussion with a key role to anticipate potential challenges and dialogue with stakeholders. The Villigen meeting series and working groups such as EGIS (Expert Group on the Implementation of Radiological Protection Science) for science implication in the radiation protection system is another one? It is important to discuss interaction between science, radiological protection and social values. The CRPPH plans a series of technical workshops to discuss the interactions and relationships between science and policy. These workshops will be initiated by the EGIS working group. The CRPPH expects fruitful and positive debates.

2. It is clear that the CRPPH is a good forum for developing guidance for the implementation of the forthcoming ICRP recommendations. It could merge the perspectives of operators, regulators and professionals. The CRPPH experiences, like ISOE (Information System on Occupational Exposure) and INEX (International Nuclear Emergency Exercises), reinforce the role of this forum for this dialogue.

3. Lastly, this Asian meeting reinforces the continuation of collaboration between the ICRP and the NEA. We are at the end of the first period with the publication of the recommendations in 2007. The new period will be focused on interpretation and implementation.

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Evolution of the System of Radiological Protection

The OECD Nuclear Energy Agency (NEA) has actively participated in discussions with the International Commission on Radiological Protection (ICRP) regarding the development of new recommendations that will replace those in ICRP Publication 60, which has long served as the international standard in this field. Part of this development process has involved the organisation of seven international workshops, including the First and Second Asian Regional Conferences on the Evolution of the System of Radiological Protection which took place in Tokyo, Japan in October 2002 and July 2004. The Third Asian Regional Conference was held on 5-6 July 2006, also in Tokyo.

The main objective of these conferences was to ensure that the views and concerns of relevant Asian stakeholders, such as regulatory authorities, industry, professional societies and NGOs, could be expressed and discussed with the ICRP. The three conferences provided the ICRP with specific views on how new recommendations could best be developed to address regulatory and implementation needs in the Asian context. These proceedings summarise the results and key discussions of the Third Asian Regional Conference.

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