

# Evolution of the System of Radiological Protection

Discussion of New ICRP Recommendations  
Fourth Asian Regional Conference  
Tokyo, Japan, 13–14 December 2007



# **Evolution of the System of Radiological Protection**

**Discussion of New ICRP Recommendations  
Fourth Asian Regional Conference  
Tokyo, Japan  
13-14 December 2007**

© OECD 2009  
NEA No. 6363

NUCLEAR ENERGY AGENCY  
ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT

## ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT

The OECD is a unique forum where the governments of 30 democracies work together to address the economic, social and environmental challenges of globalisation. The OECD is also at the forefront of efforts to understand and to help governments respond to new developments and concerns, such as corporate governance, the information economy and the challenges of an ageing population. The Organisation provides a setting where governments can compare policy experiences, seek answers to common problems, identify good practice and work to co-ordinate domestic and international policies.

The OECD member countries are: Australia, Austria, Belgium, Canada, the Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, Korea, Luxembourg, Mexico, the Netherlands, New Zealand, Norway, Poland, Portugal, the Slovak Republic, Spain, Sweden, Switzerland, Turkey, the United Kingdom and the United States. The Commission of the European Communities takes part in the work of the OECD.

OECD Publishing disseminates widely the results of the Organisation's statistics gathering and research on economic, social and environmental issues, as well as the conventions, guidelines and standards agreed by its members.

*This work is published on the responsibility of the Secretary-General of the OECD. The opinions expressed and arguments employed herein do not necessarily reflect the official views of the Organisation or of the governments of its member countries.*

### 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.

Corrigenda to OECD publications may be found on line at: [www.oecd.org/publishing/corrigenda](http://www.oecd.org/publishing/corrigenda).

© OECD 2009

---

You can copy, download or print OECD content for your own use, and you can include excerpts from OECD publications, databases and multimedia products in your own documents, presentations, blogs, websites and teaching materials, provided that suitable acknowledgment of OECD as source and copyright owner is given. All requests for public or commercial use and translation rights should be submitted to [rights@oecd.org](mailto:rights@oecd.org). Requests for permission to photocopy portions of this material for public or commercial use shall be addressed directly to the Copyright Clearance Center (CCC) at [info@copyright.com](mailto:info@copyright.com) or the Centre français d'exploitation du droit de copie (CFC) [contact@cfcopies.com](mailto:contact@cfcopies.com).

---

Cover credit: Ted Lazo, NEA, France.

## **FOREWORD**

The Committee on Radiation Protection and Public Health (CRPPH) of the OECD Nuclear Energy Agency (NEA) has actively supported the open process initiated by the International Commission on Radiological Protection (ICRP) to revise its recommendations. In this process, the NEA member countries in the Asia-Pacific area have played an important role. The specific views of these members were addressed through three Asian Regional Conferences on the Evolution of the System of Radiological Protection, held in Tokyo in October 2002, July 2004 and July 2006. The results of these conferences were provided directly to the ICRP for consideration. These conferences held in Asia also facilitated the communication of the Asia-Pacific stakeholders' opinions to the ICRP.

The ICRP issued its new recommendations in December 2007. The CRPPH organised in parallel the 4<sup>th</sup> Asian Regional Conference on 13-14 December 2007 to consider next steps, notably the implementation of the new ICRP recommendations. This conference was the first opportunity to discuss the implementation of the new ICRP recommendations with a broad range of stakeholders and has provided useful and practical viewpoints for the application of the new ICRP recommendations in the Asia-Pacific region.

This fourth conference was organised by the NEA Committee on Radiation Protection and Public Health in collaboration with the ICRP, the Nuclear Safety Commission of Japan and the Ministry of Education, Culture, Sports, Science and Technology of Japan.

### ***Acknowledgement***

The NEA Committee on Radiation Protection and Public Health would like to thank Professor Henri Métivier for the preparation of this report.

## TABLE OF CONTENTS

Foreword .....	3
Executive summary .....	7
1. Introduction .....	11
2. The new ICRP general recommendations .....	13
3. Revision of the international BSS .....	23
4. Comments on and criticisms of the new recommendations .....	25
4.1 Strengths to the constraints .....	26
4.2 Time for implementation .....	28
4.3 Radon and NORM .....	29
4.4 Environment.....	29
4.5 Weighing factors.....	29
4.6 Medical exposure .....	30
4.7 Reference levels and emergency exposure situations .....	30
5. Implications for the CRPPH.....	33
6. References .....	35
Appendices	
A. Agenda.....	37
B. List of speakers and panellists.....	41
C. List of participants.....	43



## **EXECUTIVE SUMMARY**

After three previous meetings in Asia, the fourth NEA/ICRP Conference on the “Evolution of the System of Radiological Protection” was held in Tokyo, Japan, 13-14 December 2007, hosted by the Nuclear Safety Commission (NSC) of Japan and the Ministry of Education, Culture, Sports, Science and Technology (MEXT) of Japan. This workshop is the first held after the finalisation of the recommendations by the ICRP, in Spring 2007 during its meeting in Essen (Germany).

The objectives of this forum, in Asia, at the moment of the publication of the new recommendations by ICRP, Publication 103, were to:

- Evaluate and discuss the possible implications of these new ICRP recommendations, particularly with the 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 with respects to the Asian view.
- 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.

A broad group of stakeholders participated in the forum, coming from Japan, South Korea, China, Indonesia and Australia for Asian and Pacific areas but for the first time in this context from Russia and United States. The International Atomic Energy Agency (IAEA) also participated in this forum, presenting the status of work on the revision of the International Basic Safety Standards (BSS) in close connection with the new ICRP recommendations.

Overall, the conference endorsed the concepts presented by the ICRP, although the final text of the new ICRP recommendations (Publication 103) had yet to be released at the time of the conference. Clearly, however, the long dialogue that the radiological protection community has had with the ICRP,

much of it arranged by the NEA, has helped the Commission to refine its new concepts and to better structure and frame existing concepts such that stakeholder concerns have been effectively addressed.

Much of this progress was made possible by the action of the former ICRP chair, Roger Clarke. As described in the historical document of the CRPPH (reference), the provocative statement made by Professor Clarke in 1999, suggesting that it was time for a change, was finally very important because that forced all the participants to consider which aspects of the Commission's recommendations were good, and to be kept, and which were too complicated or antiquated and to be changed or simplified. The input of the NEA/CRPPH in this revision has been important.

The positive and constructive attitude of all the stakeholders was also encouraging for the future of the ICRP.

All conference participants have very much appreciated these efforts by the ICRP to listen to stakeholder concerns. Without the significantly improved draft proposal that arose from previous dialogue sessions between the ICRP and the stakeholders, the success of this workshop would simply not have been possible.

Once more, the ICRP chairman, Professor Lars-Erik Holm has clearly presented the new recommendations, focusing on the main changes from the ICRP 1990 recommendations. All participants have appreciated its clear presentation. The quality of the debate and the numerous constructive and positive proposals and criticisms encourage the CRPPH to continue the open dialogue between the ICRP and the stakeholders now for sharing experience of implementation of the new recommendations.

Some criticisms remain, mainly on the concept of dose constraints and reference levels, which need to be translated into regulations and implementation. But in this context, the ICRP has finished its job with the publication of the new recommendations. The new ICRP system must now be implemented, through the international BSS and ultimately national regulations. The CRPPH will continue its stakeholder dialogue work in this area to assist with this translation.

The new recommendations were well accepted and globally endorsed because:

- The participants appreciated that the final text is more a continuity of the ICRP Publication 60 recommendations than a change. Maintaining the previous dose limits, as regard to the light change of risk evaluation is well appreciated.
- The new draft clearly describes the goal of radioprotection.



- It is well appreciated that the three principles of ICRP, justification, optimisation and limitation remain in the new draft. All participants agree to recognise that optimisation was probably the main tool for reducing exposure.
- The new recommendations defined clearly three types of exposures. It is more understandable than the former description and without any ambiguity.
- The ICRP approach is always driven by science, but it is clear that social and political forces strongly influence the ICRP attitude. The new text is clearly written, and therefore well appreciated. The lighter attitude with respect to LNT, now referred to as a “tool” or a “model”, is very positive. It is clearly said that LNT is the best approach from the prospective of protection, but that this is not a “scientifically universal truth”, and that other dose/response relationships should be used in specific situations should good science support such a deviation from the general LNT approach.
- The clear statement of the decrease of genetic risk is also appreciated.
- All participants strongly appreciated that ICRP now clearly recommends not using collective doses for cancer evaluation when a great number of individuals have received very small doses.
- Natural exposure is important in some areas, and participants agreed that it is important to pursue implementation of ICRP recommendation worldwide for natural exposure.
- Constraints (and reference levels) remain somewhat unclear for stakeholders. For the nuclear industry, the ICRP recognises that constraints are already implemented in the day-to-day management of exposures, but claims that what is true for nuclear energy is not always true in other fields of activities. Another question concerns who is responsible to set numerical values for constraints, and how these will be interpreted by regulatory authorities (not as limits). Many participants estimate that while ICRP is the best organisation to lay out broad principles and general recommendations, other agencies or national or local regulatory bodies are better placed to set values for constraints after dialogue with stakeholders.
- The ICRP recommendation for a single reference level for optimisation of emergency situations should be revisited for its application in situations where thyroid exposure could be high, in which case a reference level related to the thyroid organ dose should be used. This subject could be discussed by the CRPPH.

- A first step to implement the new ICRP recommendations will now be their integration in the international BSS. Countries suggested that there is no hurry, particularly where the recommendations from 1991 have already been implemented.
- Some participants are stressed by some change of dose coefficients after changes of weighing factors. But the ICRP will soon publish new dose coefficients for workers.
- NORM industries have been identified as a key focus for the future because they will need the approach taken for some time in the nuclear industry to be implemented in NORM industries, where such an approach will be broadly new.
- Participants appreciate the strong involvement of ICRP in the medical field, but the ICRP clearly says that we will need to keep in mind the balance between benefit and risk for medical use of radiation.

Finally the forum is grateful to the ICRP for the deep and ongoing dialogue that has taken place over the past several years and leading up to the publication of its new recommendations. Participants were also grateful to the NEA for the organisation of this dialogue.

## 1. INTRODUCTION

The objectives of this fourth conference were related to those of the three previous conferences held in Tokyo in October 2002, July 2004 and July 2006, which are to evaluate and discuss with experts from the Asian and Pacific area countries how to implement the new ICRP recommendation published at the end of 2007.

This forum also attempted to identify the future and medium- to long-term issues relating to radiation protection, taking into account the social and cultural backgrounds of the Asian countries, based on the results of recent CRPPH reports by the EGCO and EGIS Expert Groups.

In recent years, the ICRP has launched an open process to enhance the current set of radiological protection recommendations. The ICRP is presenting 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 was to arrive at a new generation of the ICRP recommendations that are as broadly understood and accepted as possible, so as to facilitate their efficient implementation. This 4<sup>th</sup> Asian Regional Conference is a clear demonstration of the full success of this pathway.

Indeed, after a long consultation process the ICRP finalised its new recommendations last spring, taking into account very largely the numerous comments, representing a considerable effort for the writers of the new text. 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 the NEA member countries.

These new ICRP recommendations, very different from the previous ones, broadly incorporates the comments coming from everywhere in the world. It is more comprehensive and seems more accepted by stakeholders, with one key exception being a common understanding of the new concept of dose constraints. In any case, this new document continues to be based on the linear non threshold

(LNT) model of dose and risk, in spite of new scientific data challenging this hypothesis. A few modifications have also been made, based on new science, in weighing factors for radiation and tissues. A key difference with the former recommendations is the consideration of genetic risks only as they appear in two generations following irradiation, rather than the previous approach which integrated genetic risk over all future generations until equilibrium was reached. It should be noted that there continue to be no observed genetic risks observed in the two generations of Hiroshima-Nagasaki bombing survivors.

It should be noted that all the regulatory authorities participating in the conference are pleased with the openness of the ICRP in developing these new recommendations, as well as in the fact that a general continuity has been maintained in the recommendations. This is viewed as an acknowledgement that a revolution was not necessary, and reflects the high level of protection afforded by the previous system.

The other side of this coin concerned the considerable efforts put forth by national experts to assist the ICRP in developing its new recommendations. This demonstrates the importance afforded these recommendations, in this case by regulatory authorities from the Asian region. The respect that the ICRP gave these efforts, as evident by comprehensible text reflecting stakeholder views, was unanimously appreciated by the authorities attending the Conference.

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 (NEA, 2007). Let us recall that 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, all of which are available on the NEA web site ([www.nea.fr](http://www.nea.fr)).

## 2. THE NEW ICRP GENERAL RECOMMENDATIONS

The first ICRP recommendations were issued in 1928 and concerned the protection of medical staff against occupational exposure. General recommendations have subsequently appeared in 1959 (Publication 1), 1964 (Publication 6), 1966 (Publication 9), 1977 (Publication 26) and 1991 (Publication 60). Over the evolution of these recommendations, the dose limits have been reduced from 1 000 mSv in 1928, to 500 mSv in 1934, both for medicine, then 150 mSv in 1950, 50 mSv and 5 mSv in 1964 (worker and public respectively) and lastly 20mSv and 1 mSv in 1991 (for workers and public).

The ICRP Publications 26 and 60 prevented deterministic and minimised stochastic harms. The dose limits in the 1977 and 1991 recommendations were mainly based on cost/benefit analysis, and on judgements of acceptable risk.

Since 1991, nearly 30 different numerical restrictions on dose have appeared in a number of ICRP publications, leading to some confusion amongst many users and stakeholders. The ICPR felt that a simplification was needed, and approached the new draft recommendations with this main aim, as well as a desire for consolidation of the general principles described in 1991.

Since the ICRP Publication 60, radiation risk estimates have not changed substantially. New results from scientific research are challenging the general concepts of the radiological protection system, but are not sufficiently consolidated to indicate a need for drastic change of the system. The system is considered successful, and since there is no hurry for change the Commission has wished to maintain as much stability in the proposed recommendations as is consistent with the new scientific information. This was one of the main requirements expressed during the former consultations; thus, there is more continuity than change.

The ICRP chairman wished to recall that these new recommendations would never have reached this level of quality without the important collaboration of all the experts of the world.

Lastly, during these last decades ICRP has always kept close contact with UNSCEAR which is the main upstream scientific source, as well as the BSS of the international organisations, which is the main downstream level before national regulations.

The new recommendations consolidate and add to previous recommendations issued in various ICRP publications. The primary aim of the recommendations was always to contribute to an appropriate level of protection for people and the environment without unduly limiting the desirable human actions that may be associated with radiation exposure. The bases of the system of protection are the reference anatomical and physiological models of man to assess doses, the molecular and cellular studies to assess hazards and the animal experiments and epidemiology to assess probability of detriment.

It is noted that most ICRP recommendations will remain because they work and are clearly understood. Some others will change because they require additional explanation or more guidance, are needed to fill a void, or the basic understanding has evolved. The existing numerical recommendations in the policy guidance given in 1991 remain valid unless otherwise stated. Finally, the ICRP reiterates that its recommendations relate to only the exposures in addition to natural background.

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

In support of the draft recommendations, the commission has published foundation documents and building blocks resulting from the discussions of the different Committees of the Commission. These source documents include:

- Biological and epidemiological information on health risks attributable to ionising radiation (C1).
- Basis for dosimetric quantities used in radiation protection (C2).
- Low-dose extrapolation of radiation-related cancer risk (C1).
- Radiation protection in medicine (C3).
- Optimisation of protection (C4).
- Assessing dose to the representative individual (C4).
- The scope of radiation protection regulations: exclusion and exemption (MC).

Specific impacts of these documents on the draft recommendations are discussed below.

The deterministic effects are now also referred to as tissue reactions, and are due to cell killing above a threshold of 100 mGy or more. New data on the deterministic risk of cataracts in the eye will be considered when available.

Cancer and heritable diseases continue to be referred to as stochastic effects. To predict their risk, the ICRP continues to use the LNT model, scientifically plausible but not unambiguous. The DDREF is maintained at a value of 2, a value judged by the ICRP to be more representative than 1 yet not sufficiently well known to be specified to two significant figures (i.e. a value of 1.5). With regard to stochastic risks, there was a clear recommendation by the Conference participants to wait until the latest results of the Life-Span Study, of the survivors of Hiroshima and Nagasaki bombing, were published by Preston *et al.* (2007). However, these data had already been factored into the ICRPs new risk assessments, and in fact by the time Publication 103 was printed the Preston data had in fact been published. Genomic instability, bystander effects, adaptive response were seen as processes that could cause non-LNT response, but today the ICRP judged that there is insufficient knowledge of these processes to modify the current system for protection purposes.

The ICRP considers that *in utero* risk remains similar to that of young children, that is, a few times higher than the risk for the general population.

Today the nominal probability coefficients for heritable diseases are based on the conclusions of the UNSCEAR 2000 report, which estimates the risk of such effects for 2 generations only. For non-cancer disease, no judgment on low-dose risk is possible as there is great uncertainty on the dose-response pattern below 1 Sv.

In conclusion, the nominal probability coefficients ( $\%Sv^{-1}$ ) are now 5.7 for the whole population instead of 7.3 in the ICRP 60 and 4.2 for the adult instead of 5.6 in the ICRP 60.

However, the Commission estimates that these changes are too small and uncertain to affect the choice of dose-limits. Indeed the problem of uncertainty remains, and is particularly large for low doses and dose rates. The Commission continues to assume that the overall risk coefficient of  $0.05 Sv^{-1}$  is appropriate for the purposes of radiological protection. Finally, overall risk is now based on cancer incidence rather than mortality.

In spite of the decrease of heritable risk, the ICRP continues to strongly recommend keeping gonads doses as low as reasonably achievable.

The quantities for radiological protection are unchanged but the radiation and tissue-weighting factors used in the calculations of these quantities have undergone some revision:

- 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 a factor of two 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 the theoretical equilibrium (many generations), but now limited to the first 2 generations (based on the Hiroshima and Nagasaki survivors).
- $W_T$  for breast increase from 0.05 to 0.12.
- $W_T$  for bladder, oesophagus, liver and thyroid have been decreased from 0.5 to 0.4.
- New organs (brains and salivary gland) have been added, and the splitting rule for remainders ( $W_T = 0.12 - 0.05$  in the ICRP publication 60) is deleted.

New reference voxel male and female phantoms are now available and will be used when new dose coefficients are published for workers, probably in 2009 superseding publications 30, 54 and 78. After radionuclide intake, equivalent dose calculations are made separately for male and female then averaged before effective dose calculation using a sex averaged  $W_T$ .

Today, the ICRP assumes that the system of protection is sufficiently robust to achieve adequate protection for both sexes and for all ages. Thus there is no need for sex- or age-specific radiological protection criteria. This precludes discrimination. However, for individual retrospective assessments, individual-specific information is needed.

One of the main changes, or clarifications, in the draft recommendations is the description of the types of exposure situations, described to replace the terms “practices” and “interventions”.

- The planned exposure situations involve the deliberate introduction and operation of sources; it is the situation, not the exposure that is planned. These situations include what was formerly known as practices, but they also include medical exposures.
- Existing exposure situations are situations that already exist when a decision on radiological protection needs to be taken. These include natural sources on which one can act, as well as the inheritance from past practices or prolonged situations resulting from previous accidents.
- Lastly, emergency exposure situations are an unexpected development of a planned situation or a malicious act, which require urgent action to avoid or reduce undesirable consequences.



These changes result from the experiences identified through dialogue with stakeholders, including those promoted and conducted by the OECD/NEA CRPPH. For all these types of exposure situation the radiological protection system based on justification, optimisation and dose limits in the case of planned exposure situations, is applied.

For members of the public the system of protection uses individual dose criteria, but doses to individual members of the public cannot be measured directly. Doses will depend on individual characteristics, such as age, location eating habits, etc. Thus it is necessary to generically characterise an exposed individual, and for this, the ICRP now uses the representative person. This new concept described in the ICRP Publication 101, replaces that of critical group whose connotation of crisis could lead to confusion. There are, however, no significant differences between the Critical Group and the Representative Person, the latter now being better characterised statistically should actual data on demographics and habits not be available.

After describing the type of exposure situation, the ICRP describes the categories of exposure. However, before going in to details it recalls once again that the exposure to a source must be justified, i.e. that the introduction of a new source or the reduction of an old source must bring more benefit than of detriment, that it is necessary to optimise protection, using constraints or levels reference to increase equity and account for the existence of multiple sources, and lastly to apply dose limits except in the case of medical exposure of patients.

The three categories of exposure are:

- Occupational exposure: all radiation exposure of workers incurred as a result of their work that can reasonably be regarded as the responsibility of the operating management.
- Public exposure: all exposure of the public from radiation sources, excluding any occupational or medical exposure and the normal local natural background radiation.
- Medical exposure of patients: comforters and carers, and volunteers in research.

With regard to the exposed individuals, one finds also defined in the new text:

- Workers, who are any employed persons with rights and duties in occupational radiological protection. Workers are not classified, only work areas are classified, either as controlled areas where special procedures are needed, or as supervised areas where only monitoring is needed.

- Members of the public, who are people receiving exposure that is neither occupational nor medical. Comforters and carers are treated separately from the public.
- Patients, who are any individuals exposed by diagnostic, interventional, or therapeutic medical procedures.

There are two types of numerical protection criteria; dose limits, which are individual-related criteria that apply to exposures from all regulated sources in planned exposure situations; and dose constraints and reference levels, which are source-related criteria that apply in all exposure situations (with the slight philosophical distinction that constraints are used in planned exposure situations, while reference levels are used in existing and emergency exposure situations).

The three principles are consolidated and specified:

### *Justification*

Such actions should do more good than harm, and yield an individual or societal benefit that is higher than the detriment caused by the exposure. The ICRP assume that justification is at the political level, but that it can be delegated by government to regulatory authorities. However, it will be shown below that the ICRP goes somewhat beyond this rule by defining unjustified exposures. In justification, radiological considerations are just one input, which is important, but rarely overriding. The justification of medical exposures requires a separate treatment because it is being applied to an individual patient for their specific good.

As mentioned above, while justification is at the political level, the ICRP defines some unjustified exposures:

- The deliberate addition of radioactive material to food, toys, etc.
- Radiological examinations for occupational, legal, health insurances purposes, unless useful information on individual health is obtained.
- Medical screening of asymptomatic population groups, unless expected benefits exceed societal and health detriment is obtained.

This last point will be important to debate, particularly in the context of screening of breast cancers by mammography, screening of lung cancers in heavy smokers.

The ICRP also suggests that radiological examinations for criminal investigations may be justified. The implementation of this will undoubtedly be discussed at the societal level to avoid discrimination.

## *Optimisation*

The aim of optimisation is to maximise the net benefit. This in fact reinforces the notion of keeping all exposures “As Low As Reasonably Achievable (ALARA)” taking into account economic and societal factors. Optimisation is an on-going and iterative process, which is now understood as being broadly part of good radiation safety culture.

The collective dose in optimisation is a key parameter, but a single number is insufficient. Decision makers also need to know the average dose, the number exposed, the range of doses and subgroups with different doses, and other relevant factors depending on the situation being considered. The ICRP suggests that different weighting can be applied to some exposures, such as applying less weight to extremely small doses incurred by a large number of individuals, or to exposures incurred a long time in the future. This could have an impact on the management of the radioactive waste in the long term.

For planned exposure situations, the ICRP emphasises its previous concept of the dose constraint as a tool for optimisation. The dose constraint for planned exposure situations is defined as a prospective and source-related restriction on the individual dose from a source, which provides a basic level of protection for the most highly exposed individuals from a source, and which serves as an upper bound on the dose in the optimisation of protection for that source. For emergency and existing exposure situations, this same concept is used, however here the reference level is defined as the level of dose or risk above which it is judged to be inappropriate to plan to allow exposures to occur, and below which optimisation of protection should be optimised. These definitions have been crafted taking into account the significant discussions of these concepts that took place during other NEA stakeholder conferences (see previous NEA report, Tokyo 2006, Washington 2006 and Prague 2006).

In spite of the ICRP decision to use these terms, there continues to be a linguistic discussion of their translation into languages other than English. The ICRP regrets this inconvenience, but hopes that the “long-hand” definition of the concept will be sufficiently understood to overcome the difficulties with the “short-hand” term that is eventually chosen in other languages.

The ICRP also took some pains to clearly state that the constraint for planned exposure situations represents a level of ambition for operators in a prospective sense, but should not be used as a “regulatory barrier” – this is rather the role of the dose limit. The dose constraint should be used in prospective situations to determine which protection option is the most

appropriate; the resulting dose distribution is compared to the pre-selected constraint. In operation, the dose constraint may be used as a benchmark against which to assess the effectiveness of optimisation procedures, however exceeding the dose constraint should not necessarily be regarded as a failure of protection. This will be important to specify in implementation documents such as the BSS, or in national regulatory requirements.

Constraints should be established at the national or local level by regulators (for the public) and operators (for workers), but the ICRP continues to propose bands of doses for constraints and reference levels; 100-20 mSv for example in case of radiological emergencies, 20-1 mSv for occupational exposures in planned situations or for radon in dwellings and less than 1 mSv for public exposure in planned situations.

The last principle: *dose limits*.

It applies in planned exposure situations, and refers to the total dose to an individual from all regulated sources. Dose limits do not apply in emergency or existing exposure situations. The Commission noted that in emergency exposure situations, it was recommended that women not be used as volunteers for potentially extremely high exposure circumstances (e.g. life-saving or serious consequence mitigation) because of risks to the foetus. Because of anti-discrimination legislation in some countries, this stance by the ICRP did not have unanimous support. In any case, additional guidance will be provided for emergency exposure situations by extending the existing guidance in ICRP publication 63.

The limits on effective dose in planned exposure situation are not changed, remaining at 1 mSv in a year for public, and 100 mSv in 5 years, with no single year exceeding 50 mSv for occupational exposure. The flexibility described in the ICRP 60 is maintained.

Exposure to radon generally falls into the category of existing exposure situations (although in some mining situations this can be considered as occupational exposure). The Commission now fixes dose constraints for radon exposure at 600 Bq.m<sup>-3</sup> for dwellings, and 1 500 Bq.m<sup>-3</sup> at work. The ICRP suggests that national regulatory authorities may wish to select lower constraints.

A major point of the new text is the redefinition of the use of effective dose (E) and collective effective dose (S):

- *Effective dose (E)* is for compliance and prospective planning, not for detailed retrospective dose and risk assessments after exposure of individuals and for epidemiological studies.

- *Collective dose (S)* is for optimisation, for comparing technologies and protection options, but not for epidemiologic risk assessment and not for predicting the number of cancer deaths due to trivial exposures to large populations.

The three key ICRP principles are maintained for medical exposures, but are more clearly restated. Justification of exposures are needed, taking into account that radiation is a tool and needs specific procedures and individual justification for specific patient exposures. When exposures are justified, the ICRP recommends the use of diagnostic reference levels, which are not constraints. However, radiotherapy is still seen as being very patient specific. While the effective dose could be used for comparing clinics, etc. it should not be used for the assessment of detriment.

Concerning exclusion and exemption, the commission largely refers to several years of inter-agency dialogue, and does not wish to interfere in these discussions. The principles presented by the ICRP recommend that legislators should exclude from the legal system those situations or exposures that are not amenable to regulation, and should exempt those situations or exposures that do not warrant regulation. These are both judgemental decisions.

For the protection of the environment, the new question raised by the ICRP is “How can we demonstrate that the environment is adequately protected”. This has not been driven by concern of existing radiation hazards, but rather aims to fill a conceptual gap. Some of the issues include the fact that the assumptions of ICRP 26 and 60 are not explicitly demonstrated, humans are likely to be the least exposed species, and not all habitats have a human presence. The Commission is waiting for the results of Committee 5 (Environment) in order to further develop its recommendations for the protection of the environment, and expects that further guidance will be provided in 2008.



### **3. REVISION OF THE INTERNATIONAL BSS**

Before the publication of the new recommendations the international organisations co-sponsoring the international safety standards (BSS 115) launched a revision process under the IAEA leadership. This was possible thanks to the open policy of the ICRP, and the various forums organised by the NEA which allowed the beginning of discussions on those areas where revision would be necessary, even before the final text of the recommendations was published.

A key objective of the IAEA and other co-sponsors in this revision process is to ensure that BSS remains the international benchmark for radiation protection in a regulatory format. The revision process seems to be aimed at maintaining the completeness of the BSS across all circumstances of exposure to radiation, to follow the ICRP classification of exposure situations, and to adopt a common structure for each section. The revised BSS will include an introductory section explaining the new ICRP principles as a framework to the new BSS requirements. In spite of the broad agreement on the need to revise the BSS, there are no major changes that would imply significant regulatory impacts foreseen at this point.

A technical meeting was held in July 2007 to provide expert input to the overall drafting process. The technical meeting made several recommendations, including suggestions to develop the concept and application of “constraints” but without setting numbers. Also, because of the importance of education, training and qualification/accreditation of professionals, the technical meeting requested regrouping these topic areas into a single chapter or sub-section. It also requested moving generic material as far as predictable to a general requirements section, leaving only specific items for later sections. The meeting further suggested a general review of the level of detail of each section of the revised BSS, providing suggestions as to what more detailed guidance could be moved to safety guides.

The BSS will include protection of the environment and intends to clarify the transition from emergency situation to existing situation following an accident. The BSS will continue to classify areas rather than workers. Less clear is the recommendation to use the representative person in assessing public exposure, as recommended by the ICRP Publication 101. The previous critical

group approach was not judged to be in need of modification. In response to this, the ICRP chair suggested that the new representative person's approach is broadly equivalent to the critical group's approach, but added guidance for the use of probabilistic habit data in those situations where exact habit data is unavailable. The BSS will retain the existing numerical criteria (dose limits, etc.), except for updates to reference levels for emergencies, putting intervention levels in the context of the new system as a tool for optimisation of individual countermeasures, but not as the primary criteria for decision making. Lastly the BSS will include requirements for involvement of stakeholders.

Several specific points remain under discussion. For example, the co-sponsors and their constituencies are considering whether intake-to-dose conversion factors should remain in the BSS. Text from the previous BSS on veterinary practise, particularly in relation to unsealed sources, is also under discussion, as is the text on exemption/clearance. The co-sponsors feel that the discussion of reference levels for radon in dwellings requires further consideration, as do several areas of medical chapters such as the text covering comforters and carers, release of patients and biomedical research. For pregnancy, the co-sponsors feel that the text should continue to recommend that the worker declaration of pregnancy should be voluntary.

The IAEA recognises that it will be necessary to clarify the relationship between a management by classification of zones and a management by classification of workers.

The production schedule for the BSS currently suggests approval by the IAEA, and subsequently by all co-sponsoring organisations, in the 2009/2010 timeframe. This is seen as somewhat optimistic, but remains the objective of the revision process.



#### **4. COMMENTS ON AND CRITICISMS OF THE NEW RECOMMENDATIONS**

After a clear and precise description of the new recommendations, the floor was given to different representatives of stakeholders from the Asian and Pacific regions.

We must recognise that the discussion has not significantly changed since the third forum held in July 2006 in Tokyo, and that the determined adversaries of the concept of constraint have maintained their position. However, this point is really the only one on which there is significant disagreement, all the other significant aspects evoked at the time of the third forum, having been taken into account by the ICRP, are now well accepted. The last draft, issued for discussion in early 2007, represents a considerable improvement over previous versions, including the incorporation of comments from Asian countries, more specifically from Japan, China and South Korea.

All the participants of this Asian Conference have appreciated that the ICRP and the NEA have worked together to achieve consensus with regard to the development of new recommendations. It is also appreciated that the NEA and the Japanese NSC and MEXT have organised dedicated conferences dealing with Asian views.

The president of the American National Council on Radiation Protection and Measurements (NCRP) also appreciated this considerable effort of dialogue organized by NEA.

As previously mentioned, these new recommendations are welcome and well accepted, yet the forum has pointed out the key issues of the new concepts introduced in new recommendations, summarised here, that will need some clarification as they are translated into international recommendations and national regulations:

- The 1990 recommendations only concerned the protection of humans; the new recommendations extend to the environment.

- The 1990 recommendations described two situations, practice and intervention; the new recommendations describe more clearly planned; existing and emergency exposure situations.
- The 1990 recommendations described the three principles of justification, optimisation and limitation; the new recommendations continue to emphasise these three principles, but clearly focus on the use of optimisation, including the use of dose constraints and reference levels, in all exposure situations.
- For assessment of public exposure, the 1990 recommendations described the “critical group”; the new recommendation has updated this concept as the “representative person”, adding further precision on statistical descriptions when actual data is not available.

It should also be mentioned that the selection of terminology (i.e. dose constraints, reference levels, planned exposure situations, etc.) raised some concern in countries that are not of English mother-tongue. Considering the importance of these new recommendations, many such countries will need to make an effort to translate these concepts into their own language.

#### **4.1 Strengths to the constraints**

The ICRP recalls that this concept was introduced in the past. The constraint is not a limit but a tool for the optimisation, which is now more clearly the key process of the radiological protection process. The ICRP recalls that many nuclear utilities around the world have used this concept with satisfaction for some time, contributing to a considerable drop in worker doses. Today, new nuclear power plants and facilities will be built with this concept as part of their procedures.

In spite of these reiterated explanations, doubts persist based on the simultaneous existence of two numerical values, one for the limit and one other for the constraint. Those not in favour of the ICRP expansion of this concept, mostly the nuclear utilities, fear confusion at worker and regulatory levels. The question remains “how to apply the dose constraints in regulation, while dose constraints are not to be used or understood as prescriptive regulatory limits?”

For the protection of the public the new ICRP publication recommends the same source-related dose constraint, 0.3 mSv, recommended in publication 82; it should be noted that Japan already uses 0.05 mSv, taking into account best available techniques. The ICRP recalls that values for public dose constraints will have to be validated by the national regulators, which pose the question of how much, if any, international harmonisation of these values would be desirable or achievable.

In conclusion, some users of the radiological protection system fear that the new concept of dose constraints will increase confusion among stakeholders. In again addressing this concern, the ICRP repeated that optimisation is currently well implemented for practices, now called planned situations, in the nuclear world, but the aim of these new recommendations is to extend the use of optimisation beyond what were called practices to all other situations involving radiation exposure; now called existing and emergencies exposures.

However, in moving from the ICRP recommendations to more regulatory text, such as the revision of the BSS, it will be important for the ICRP and the BSS co-sponsors to maintain a dialogue such that the new ICRP system, in particular the concept of dose constraints and their application, can be appropriately implemented in the revised BSS. Some examples of questions to be resolved that were raised during discussions include:

- Definition of a “single source”. Does it mean a single unit or site, an owner or a licensee?
- Many times the situation is more complex than described by ICRP, for example one site can have different activities. How is this addressed in practice?
- Should dose constraints be fixed at the national or local level?
- How should constraints be managed if a site changes (e.g. a new nuclear power plant unit is built on an existing site), or if the reference individual is suddenly exposed to a new source (e.g. a new nuclear power plant is built on a river where another or other power plants already operate)?
- How should the constraint be applied in occupational exposures where it is simultaneously necessary to regulate and manage source-related exposures and total exposures?
- How should the end of the optimisation process, below which no further actions are warranted, be defined and handled?

All in all, one can say that the participants well understood the concept of dose constraints, and that they accept it. However, the translation of dose constraints into regulatory text may pose practical problems for radiological protection and discussions and sharing of experience will be necessary. The success of the NEA dialogue, and the long history of the NEA/CRPPH work in this area, suggest that this topic is particularly well placed to be the subject of a subsequent NEA/CRPPH forum.

## 4.2 Time for implementation

Although the IAEA has already begun the revision of the BSS to accommodate the new ICRP recommendations, as well as other evolution, this does not mean that the transposition of the new ICRP recommendations into national regulatory text will be a quick process. The experience of the ICRP 60 implementation showed that ten years were necessary in many countries.

There is a consensus on the level of many countries, which have just finished the implementation of the ICRP 60, to say that there is not urgent need to change the existing system, and this is seen as particularly true for occupational exposure. This is consolidated by the fact that the values for dose limits values remain the same. Since the overall risk coefficient taken by current international safety standards should be retained, why did the ICRP take such a long time for publishing its new recommendations? Which would be the cost of a modification of the laws for an identical degree of protection? Then, some people raise the question: is it necessary to change a system which has been a success?

While the ICRP is not putting pressure on countries to update their regulatory standards, it is making it clear that the new approach will result in an improvement in planning and implementation for emergency and existing exposure situations. In fact, the desire to transplant the success of the optimisation approach in planned exposure situations to existing and emergency situations is one of the key motivations for developing the new ICRP recommendations. As such, the ICRP suggests that the new system be strongly considered for implementation as soon as possible. As far as the revision of the international Basic Safety Standards is concerned, countries expressed the clear wish that the new ICRP recommendations be reflected in the new BSS. The implementation of this will, of course, need much dialogue and discussion.

However, a great effort will have to be made for NORM industries, where in many cases no radiological protection system really exists. In this field of activity, some flexibility seems useful. It should be important to clearly explain the concept of dose constraints and reference levels for these new industries. Taking again the comments of the ICRP, these recommendations aim to extend well to other sectors the experience gained on the level of nuclear industry.

It is suggested that the CRPPH should consider addressing many of these implementation issues through a meeting, or series of meetings with stakeholders (e.g. regulatory authorities, utilities, relevant ministries, NGOs, public representatives) to specifically discuss these important questions.

### **4.3 Radon and NORM**

The problem of radon continues as the years pass. Radon risks are always the subject of sharp discussions. It goes without saying that the conservatism of the ICRP on radon is the subject of opposing comments depending on whether radon is or is not present in the country. Here again, much dialogue will be needed when translating the ICRP recommendations into regulatory text.

NORM is an important problem for many countries and more especially for countries having significant mining and ore processing industries. These activities moreover increase in some areas the radon concentration in air. Many documents addressing these subjects already exist. What is lacking is a framework document allowing a better comprehension for these “new” industries in terms of radiological protection.

### **4.4 Environment**

The most appropriate approach to handling the radiological protection of the environment continues to be the subject of debate among the Asian Regional Conference participants. The ICRP was at the forefront of progress in the past and today is reconsidering a more consensual position: proposing its new concept, reference animals and plants (RAP), as a tool (one of many) that can be used as a common basis for inter-comparison of results.

Conference participants agreed that this is an important topic, and were pleased that the ICRP did not make any strict recommendations in this area. This being said, the topic remains controversial and will require additional dialogue as the ICRP continues its development, in its Committee 5, of the RAP approach. Many at the Conference agreed that it will most likely be necessary to widen the debate to include consideration of other pollutants and human activities. Some participants asked if it would be useful to develop an economic indicator in this area? It is certain that radiological protection of the environment will be a major factor in what some already call the rebirth of nuclear power.

The problem does not arise solely on the level of protection of animal species, but also for man in the context of global climatic change. Industrial representatives at the Conference strongly suggested that countries will need to consider any additional efforts in radiological protection of the environment in the context of the global need for clean generation of electric power.

### **4.5 Weighing factors**

The new ICRP recommendations have updated some of the tissue and radiation weighing factors, and this may take some time to implement in

national regulations. One reason for this is that the ICRP will not publish its new dose conversion factors, which will supersede the values published in ICRP 30, 54 and 78, until 2008 or 2009. In addition, the ICRP is now using male, female and child voxel phantoms to develop its sex and age averaged dose equivalent factors. All this will most likely take some time to be effectively absorbed and implemented through the scientific, dose-assessment community and regulators.

For some countries implementing these new weighting factors and dose assessment models represent a key issue for the next years. Although the use of these new models and weighting factors should not, in general, result in significant changes in dose assessment, these updates should none the less be implemented in national regulations.

Another issue to be addressed is that reference man (now referred to as reference parameters) has been established by the ICRP based on a Caucasian model. This is not fully representative of the Asian populations. Today, a Korean phantom (HDKR-Man) exists, and Japan, Korea and China could collaborate to develop Asian models. This approach existed in the past, with older dose assessment techniques. As the ICRP did with the revision of the ICRP 23, publishing ICRP 70 and 89, it is suggested that Asian countries consider updating their former models to develop more representative reference parameters.

A recurring question that has been put to the ICRP is, although these weighting factors are “selected conventions”, without uncertainty, how uncertainty should be addressed in the broader sense when using the ICRP approach needs to be addressed.

#### **4.6 Medical exposure**

The participants agree to say that the ICRP is correct to be very active in this field. Without wanting to minimise the benefit of the ionising radiations in medicine, one can question how well its use has been optimised when in some countries, such as the United States, medical exposure per capita has increased from 0.53 mSv in the early 1980s to 3.2 mSv in 2006. Here, more than elsewhere, the justification and optimisation are required. For optimisation, diagnostic reference levels are very important to develop and implement.

#### **4.7 Reference levels and emergency exposure situations**

The ICRP has changed its approach to accident situations because, for example, the Chernobyl populations have not accepted that countermeasures to reduce exposures at the “10 mSv level” may not be justified (Publication 82).

Rather, the new system emphasises that now the residual doses (calculated after the overall protection strategy has been implemented) should be compared to the new reference levels when judging optimisation, as opposed to the use of intervention levels for single countermeasures and their averted dose as proposed by the previous system.

Again in terms of implementation, the ICRP will have to provide further guidance and recommendations as to the use of this new approach, as well as to the use of single countermeasure intervention levels, which remain in many national regulations. In particular, the intervention level for iodine, because of the risk of thyroid cancer in case of a reactor accident, is significant and thus the single-countermeasure intervention level appears to retain its utility.





## 5. IMPLICATIONS FOR THE CRPPH

The quality of the debate and the numerous constructive and positive proposals and criticisms encourage the CRPPH to continue this open dialogue between the ICRP and stakeholders. It can be said that the 4<sup>th</sup> Asian Regional Conference very largely endorsed the new recommendations, and gave a general feeling of acceptance. As described in the historical document of the CRPPH, the action of the former ICRP chairman, Roger Clarke, was some time ago but none the less very important. His provocative statement in 1999 was finally very important because it forced the radiological protection community to consider which aspects of its system were good and should be kept, and which were too complicated and should be simplified. The CRPPH input in this revision has been very significant.

The Asian forum underlines some new action for the CRPPH:

1. The CRPPH is an open forum, and one of its key roles is to anticipate emerging issues, and to dialogue with its constituents and other stakeholders. The Villigen meeting series on the implications of stakeholder involvement is an example of this, as are various working groups, such as the EGIS on the possible implications of emerging radiological protection science.
2. It is clear that the CRPPH is a good forum for developing approaches for the practical implementation of the concept of dose constraints. The ICRP has finished its job of developing a solid radiological protection framework, and the IAEA will continue to work with other international organisations to develop the new BSS. However it will be important to share our experiences in implementation of constraints and reference levels when we will extend optimisation to all situations.

The implementation of the concepts of dose constraints and reference levels should be addressed by the CRPPH, including:

- Definition of a “single source”. Does it mean a single unit or site, an owner or a licensee? How should constraints be managed if a site changes (e.g. a new nuclear power plant unit is built on an existing site), or if the reference individual is suddenly exposed to

a new source (e.g. a new nuclear power plant is built on a river where another or other power plants already operate)?

- Many times the situation is more complex than described by the ICRP, for example one site can have different activities. How is this addressed in practice?
  - Should dose constraints be fixed at the national or local level?
  - How should the constraint be applied in occupational exposures where it is simultaneously necessary to regulate and manage source-related exposures and total exposures?
  - How should the end of the optimisation process, below which no further actions are warranted, be defined and handled?
3. The ICRP recommendation for a single reference level for optimisation of emergency situations should be revisited for its application in situations where thyroid exposure could be high, in which case a reference level related to the thyroid organ dose should be used. This subject could be discussed by the CRPPH.
  4. Lastly, this Asian meeting, and others, reinforce the continued need for collaboration between the ICRP and the NEA. The CRPPH had facilitated the stakeholder dialogue concerning the new recommendations. The next period will be focused on interpretation and implementation.

## 6. REFERENCES

Clarke, R. (1999), “Control of low-level radiation exposure: time for a change?”, J. Radiol. Prot. 19, No 2.

IAEA (1996), “International Basic Safety Standards for Protection against Ionizing Radiation and for the Safety of Radiation Sources”, IAEA, Vienna, Safety series No. 115.

ICRP (1959), “Recommendations of the International Commission on Radiological Protection”, Oxford, Pergamon Press, ICRP Publication 1.

ICRP (1964), “Recommendations of the International Commission on Radiological Protection”, Oxford, Pergamon Press, ICRP Publication 6.

ICRP (1966), “Recommendations of the International Commission on Radiological Protection”, Oxford, Pergamon Press, ICRP Publication 9.

ICRP (1977), “Recommendations of the International Commission on Radiological Protection”, Oxford, Pergamon Press, ICRP Publication 26.

ICRP (1981), “Limits for Intakes of Radionuclides by Workers”, Oxford, Pergamon Press, ICRP Publication 30.

ICRP (1988), “Individual Monitoring for Intakes of Radionuclides by Workers: Design and Interpretation”, Oxford, Pergamon Press, ICRP Publication 54.

ICRP (1991), “1990 Recommendations of the International Commission on Radiological Protection”, Oxford, Pergamon Press, ICRP Publication 60.

ICRP (1993), “Principles for Intervention for Protection of the Public in a Radiological Emergency”, Oxford, Pergamon Press, ICRP Publication 63.

ICRP (1998), “Individual Monitoring for Internal Exposure of Workers: Replacement of ICRP Publication 54”, Oxford, Pergamon Press, ICRP Publication 78.

ICRP (2006), “Assessing dose of the representative person for the purpose of radiation protection of the public” and “The optimisation of radiological protection: broadening the process.” Oxford, Pergamon Press, ICRP Publication 101.

ICRP (2008), “*The 2007 Recommendations of the International Commission on Radiological Protection*”, Oxford, Pergamon Press, ICRP Publication 103.

NEA (2007), *Fifty Years of Radiological Protection – The CRPPH 50<sup>th</sup> Anniversary Commemorative Review*, OECD, Paris, France.

NEA (2007), *Radiation Protection in Today’s World: Towards Sustainability*, OECD, Paris, France.

NEA (2007), *Scientific Issues and Emerging Challenges for Radiological Protection – Report of the Expert Group on the Implications of Radiological Protection Science*, OECD, Paris, France.

NEA (2008), *A Stakeholder Dialogue on the Implications of the ICRP Recommendations – Summary of the Three NEA/ICRP Conferences*, OECD, Paris, France.

Preston, D.L., Ron, E., Tokuoka, S., *et al.* (2007), “*Solid cancer incidence in atomic bomb survivors: 1958-1998*”, *Radiation Research* 168, 1-64.

*Appendix A*

**AGENDA**

**Day 1 – Thursday 13 December 2007**

**Welcome Addresses**

---

Dr. Shizuyo KUSUMI

Commissioner of NSC, Japan

Mr. Shinichi KAWARADA

Senior Deputy Director-General, Science and Technology Policy Bureau,  
MEXT, Japan

Ms. Janice Dunn-Lee

Deputy Director-General, OECD Nuclear Energy Agency

**Session 1: The New ICRP General Recommendations**

---

Chair: Dr. Yasuhito SASAKI

Co-Chair: Mr. Peter A. BURNS

**The New ICRP System of Radiological Protection**

Dr. Lars-Erik HOLM, Chair, ICRP

**Dialogue with the ICRP Chair**

Questions and answers for clarification of the new ICRP recommendations

**Session 2: Special Session on the International Basic Safety Standards**

---

Chair: Dr. Toshiso KOSAKO

Co-Chair: Dr. Ho-Sin CHOI

**The Situation of the Revision Work for the International Basic Safety Standards**

Dr. Renate CZARWINSKI, Head, Radiation Safety and Monitoring  
Section, Division of Radiation, Transport and Waste Safety, IAEA

### **Session 3: Challenges in the Implementation of the New Recommendations: Views from National Authorities**

---

Chair: Mr. Jacques LOCHARD  
Co-Chair: Dr. Ohtsura NIWA

#### **Views from the Japanese Regulatory Authority**

- Mr. Masahiro AOKI, Director, Radiation Protection and Accident Management Division, Secretariat of NSC, Japan
- Dr. Yasuo KIRYU, Director for Radiation Protection Policy, MEXT, Japan

#### **Views from the Korean Regulatory Authority**

Dr. Ho-Sin CHOI, Director, Radiation Safety Regulation Division Korea Institute of Nuclear Safety

#### **Views from Australian Regulatory Authority**

Mr. Peter A. BURNS, Director, Environmental & Radiation Health Branch, Australian Radiation Protection and Nuclear Safety Agency

#### **Views from Chinese Authorities**

- Dr. Zi Qiang PAN, ICRP Main Commission, Science and Technology Commission, China Atomic Energy Authority
- Dr. Yihua XIA, Dept of Health Physics, China Institute of Atomic Energy

#### **Views from Indonesian Regulatory Authority**

Dr. SYAHRIR, Head of Radiation Safety and Environmental Division, Radioactive Waste Management Center, National Nuclear Energy Agency

### **Session 4: Views from the Japanese Nuclear Industry and Radiation Protection Professionals on the ICRP Recommendations**

---

Chair: Dr. Zi Qiang PAN  
Co-Chair: Dr. Michiaki KAI

#### **Views from Radiation Protection Professionals**

Dr. Kazuo SAKAI, Chair of Committee for International Correspondence, Japan Health Physics Society

#### **Views from the Medical Profession**

Dr. Tsuneo ISHIGUCHI, Japan Radiological Society (JRS), Aichi Medical University

#### **Views from Japanese Industry**

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

**Day 2 – Friday 14 December 2007**

**Session 5: Challenges in the Implementation  
of the New Recommendations: Views from the NCRP (USA) and Russia**

---

*Chair:* Dr. Lars-Erik HOLM  
*Co-Chair:* Dr. Takashi NAKAMURA

**Views from the NCRP**

Dr. Thomas TENFORDE, President of the National Council on Radiation Protection and Measurements, NCRP, USA

**Views from Russia**

Mr. Petr RUBTSOV, Head of radiation safety division, Scientific and Engineering Center for Nuclear and Radiation Safety, Russia

**Session 6: Panel Discussion**

---

**Topic: Issues of Implementation of the New Recommendations**

*Moderator:*

Dr. Hans RIOTTE, NEA

*Panel members:*

Dr. Ho-Sin CHOI, KINS, Korea  
Dr. Kazuo SAKAI, JHPS, Japan  
Mr. Peter A. BURNS, ARPANSA, Australia  
Mr. Petr RUBTSOV, SECNRS, Russia  
Mr. Sakae MUTO, FEPC, Japan  
Dr. SYAHRIR, BATAN, Indonesia  
Dr. Thomas TENFORDE, NCRP, USA  
Dr. Zi Qiang PAN, CAEA, China  
Mr. Yasuhiro AWATSUJI, MEXT, Japan

**Session 7: Synthesis of the Meeting**

---

**An Asian Perspective**

Dr. Yasuhiro YAMAGUCHI, JAEA

**Feedback of ICRP Developments**

Dr. Lars-Erik HOLM, ICRP Chair

**The CRPPH Perspective**

Mr. Jacques LOCHARD, CRPPH Chair





*Appendix B*

**LIST OF SPEAKERS AND PANELISTS**

**AUSTRALIA**

BURNS, Peter A. Australian Radiation Protection and Nuclear Safety  
(ARPANSA)

**CHINA**

PAN, Zi Qiang China Atomic Energy Authority (CAEA)  
XIA, Yihua China Institute of Atomic Energy (CIAE)

**INDONESIA**

SYAHRIR Indonesia National Nuclear Energy Agency  
(BATAN)

**JAPAN**

AOKI, Masahiro Secretariat of Nuclear Safety Commission,  
Radiation Protection and Accident Management  
Division  
AWATSUJI, Yasuhiro Ministry of Education, Culture, Sports, Science  
and Technology (MEXT)  
ISHIGUCHI, Tsuneo Aichi Medical University, Japan Radiological  
Society (JRS)  
KAI, Michiaki Oita University of Nursing and Health Sciences  
KAWARADA, Shinichi Ministry of Education, Culture, Sports, Science  
and Technology (MEXT)  
KIRYU, Yasuo Ministry of Education, Culture, Sports, Science  
and Technology (MEXT)  
KOSAKO, Toshiso University of Tokyo  
KUSUMI, Shizuyo Nuclear Safety Commission (NSC)  
MUTO, Sakae Federation of Electric Power Companies (FEPC)  
NAKAMURA, Takashi Tohoku University

NIWA, Ohtsura	National Institute of Radiological Sciences (NIRS)
SAKAI, Kazuo	National Institute of Radiological Sciences (NIRS)
SUZUKI, Magao	Tokyo Electric Power Company
YAMAGUCHI, Yasuhiro	Japan Atomic Energy Agency (JAEA)

## **KOREA**

CHOI, Ho-Sin	Korea Institute of Nuclear Safety (KINS)
--------------	--

## **RUSSIA**

RUBTSOV, Petr	Scientific and Engineering Center for Nuclear Radiation Safety (SECNRS)
---------------	---

## **UNITED STATES**

TENFORDE, Thomas	National Council on Radiation Protection and Measurements (NCRP)
------------------	--

## **INTERNATIONAL ORGANISATIONS**

CZARWINSKI, Renate	International Atomic Energy Agency (IAEA)
HOLM, Lars-Erik	International Commission on Radiological Protection (ICRP)
SASAKI, Yasuhito	International Commission on Radiological Protection (ICRP)

## **OECD Nuclear Energy Agency**

DUNN-LEE, Janice	Deputy Director-General
HIDAKA, Tomonori	Administrator, Radiation Protection and Waste Management Division
LAZO, Ted	Administrator, Radiation Protection and Waste Management Division
LOCHARD, Jacques	CRPPH Chair
METIVIER, Henri	CRPPH, Conference Rapporteur
RIOTTE, Hans	Head, Radiation Protection and Waste Management Division



HIGASHI, Kunio	Nuclear Safety Commission (NSC), Cabinet Office
HIGUCHI, Hideo	Secretariat of the Nuclear Safety Commission, Cabinet Office
HOMMA, Toshimitsu	Japan Atomic Energy Agency (JAEA)
HORIKAWA, Yoshihiko	Kansai Electric Power Co., Inc.
HOSONO, Makoto	Kinki University
IGUCHI, Yukihiro	Japan Nuclear Energy Safety Organization (JNES)
IIMOTO, Takeshi	The University of Tokyo
IIZUKA, Teruyoshi	Toshiba Corporation
IKAI, Masami	Central Research Institute of Electric Power Industry (CRIEPI)
IKEDO, Kouki	Chubu Electric Power Co., Inc.
IMAMURA, Keiko	St. Marianna University School of Medicine
INABA, Jiro	Secretariat of the Nuclear Safety Commission, Cabinet Office
INOMATA, Ichiro	Japan Nuclear Technology Institute
ISHIBASHI, Makoto	Japan Atomic Energy Agency (JAEA)
ISHIKAWA, Noriko	Secretariat of the Nuclear Safety Commission, Cabinet Office
IWAI, Satoshi	Mitsubishi Research Institute, Inc.
IWASAKI, Tamiko	Nuclear Safety Research Association (NSRA)
IWASAKI, Toshiyasu	Central Research Institute of Electric Power Industry (CRIEPI)
KANEKO, Masahito	Radiation Effects Association
KASHIMOTO, Yasuyuki	Shikoku Electric Power Co., Inc.
KATOH, Kazuaki	Professor Emeritus of KEK
KAWABATA, Daigo	Nuclear and Industrial Safety Agency, Ministry of Economy Trade and Industry (METI)
KAWAKAMI, Yutaka	Nuclear Safety Research Association (NSRA)
KAWATA, Yosuke	Mitsubishi Materials Corporation
KIRIHARA, Masami	Japan Atomic Industrial Forum, Inc.
KISHIDA, Tetuji	Kansai Electric Power Co., Inc.
KIUCHI, Shigeaki	Radiation Effects Association
KOBAYASHI, Hirohide	Japan Atomic Energy Agency (JAEA)
KOGA, Sukehiko	Nuclear Safety Research Association (NSRA)
KONISHI, Toshio	Secretariat of the Nuclear Safety Commission, Cabinet Office
KUBA, Michiyoshi	Radiation Effects Association
KUMAGAI, Tetsuyuki	Chugoku Electric Power Co., Inc.
KUMAZAWA, Shigeru	Secretariat of the Nuclear Safety Commission, Cabinet Office
KURATA, Yasutaka	Radiation Effects Association
KUROTAKI, Katsumi	Radiation Effects Association

KUSAMA, Keiji	Japan Radioisotope Association
KUZUYA, Nobushige	Ministry of Education, Culture, Sports, Science and Technology (MEXT)
MASHIKO, Akira	Ministry of Education, Culture, Sports, Science and Technology (MEXT)
MATSUBARA, Junko	Radiation Effects Association
MATSUDAIRA, Hiromichi	Radiation Effects Association
MIKAJIRI, Motohiko	Radiation Effects Association
MIKAMI, Satoshi	Secretariat of the Nuclear Safety Commission, Cabinet Office
MIKHAIL, Morev	Tokyo University
MITANI, Shinji	Japan Nuclear Energy Safety Organization (JNES)
MIYAZAKI, Shinichiro	The Kansai Electric Power Co., Inc
MIZUMACHI, Wataru	Japan Nuclear Energy Safety Organization (JNES)
MORIMYO, Mitsuoki	Radiation Effects Association
NAGATAKI, Shigenobu	Japan Radioisotope Association
NAKAMURA, Kayoko	Keio University
NAKAMURA, Toshitaka	The Kansai Electric Power Co., Inc
NAKANO, Masanao	Japan Atomic Energy Agency (JAEA)
NARITA, Hiroto	The Japan Association of Radiological Technologists
NOMURA, Masashi	The Japan Atomic Power Company
NOMURA, Tamotsu	Radiation Effects Association
NUMAKUNAI, Takao	Institute of Radiation Measurements
OGISO, Zen-ichi	Japan Nuclear Energy Safety Organization (JNES)
OHNO, Kazuko	Kyoto College of Medical Science
OHSHIMA, Iwao	Nuclear and Industrial Safety Agency, Ministry of Economy Trade and Industry
OHSHIMA, Sumio	Radiation Effects Association
OISHI, Tetsuya	Japan Atomic Energy Agency (JAEA)
OKUTSU, Hikaru	Radiation Effects Association (REA)
ONISHI, Yuko	Japan Nuclear Energy Safety Organization (JNES)
SASAKI, Keiichi	Secretariat of the Nuclear Safety Commission, Cabinet Office
SATO, Nobuhide	Tokyo Electric Power Company
SHANG QING, Sun	Tokyo University
SHIBATA, Masahiro	Ministry of Education, Culture, Sports, Science and Technology (MEXT)
SHIRAO, Takayuki	National Institute of Radiological Sciences (NIRS)
SOEJIMA, Tadakuni	International Public-relations System
SUGIURA, Nobuyuki	Kinki University
SUGIYAMA, Daisuke	Central Research Institute of Electric Power Industry (CRIEPI)

SUGIYAMA, Akihiro	National Personnel Authority
SUZUKI, Akira	Tokyo Electric Power Company
TACHIKAWA, Hirokazu	Nuclear Safety Research Association (NSRA)
TADA, JunIchiro	Riken Yokohama Institute
TAKAHARA, Shogo	Japan Atomic Energy Agency (JAEA)
TAKAHASHI, Fumiaki	Japan Atomic Energy Agency (JAEA)
TAKANO, Atsuko	Nuclear Safety Research Association (NSRA)
TANABE, Hiromi	Radioactive Waste Management Funding and Research
TANAKA, Shunichi	Atomic Energy Commission, Cabinet Office
TASAKI, Takashi	Japan Atomic Energy Agency (JAEA)
TATEMATSU, Atsushi	Office of Atomic Energy Policy, Cabinet Office
WADA, Shigeyuki	Japan Nuclear Energy Safety Organization (JNES)
WAGATSUMA, Makoto	Japan Nuclear Fuel Ltd.
WATANABE, Omou	Mitsubishi Heavy Industries Ltd.
YAMAGUCHI, Ichiro	National Institute of Public Health
YAMAGUCHI, Kazuya	Osaka University Hospital
YAMAGUCHI, Takenori	Japan Atomic Energy Agency (JAEA)
YAMAMOTO, Masafumi	Radioactive Waste Management Funding and Research
YASUDA, Hiroshi	National Institute of Radiological Sciences (NIRS)
YONEHARA, Hidenori	National Institute of Radiological Sciences (NIRS)
YONEKURA, Yoshiharu	National Institute of Radiological Sciences (NIRS)
YOSHIDA, Satoshi	National Institute of Radiological Sciences (NIRS)
YOSHINAGA, Shinji	National Institute of Radiological Sciences (NIRS)
YOSHIYUKI, Segawa	Takagi School
YOSHIZAWA, Yuji	Nuclear Waste Management Organization of Japan (NUMO)
YOSHIZAWA, Michio	Japan Atomic Energy Agency (JAEA)
ZHIPING, Luo	Tokyo University

## **KOREA**

SEO, Kyuseok	Korea Institute of Nuclear Safety (KINS)
--------------	--

## **UNITED STATES**

HOBBS, Ayana	Embassy of the United States
--------------	------------------------------

## **INTERNATIONAL ORGANISATION**

SAINT-PIERRE, Sylvain	World Nuclear Association
-----------------------	---------------------------

OECD PUBLICATIONS, 2 rue André-Pascal, 75775 PARIS CEDEX 16  
Printed in France.



# Evolution of the System of Radiological Protection

The evolution of the system of radiological protection is of great interest to governments and regulatory authorities, in particular in Asia. In this context, the Japanese government hosted a series of NEA conferences on this subject. The 4<sup>th</sup> Asian Regional Conference, held in Tokyo in December 2007, included key discussions of Japanese, Korean, Chinese and Russian views on the new International Commission on Radiological Protection (ICRP) recommendations, and on their interpretation in the international Basic Safety Standards and national regulations. This report summarises the most significant aspects of these discussions, providing keen insight into governmental and regulatory approaches to radiological protection in Asia.

OECD Nuclear Energy Agency  
Le Seine Saint-Germain – 12, boulevard des Îles  
F-92130 Issy-les-Moulineaux, France  
Tel.: +33 (0)1 4524 1015 – Fax: +33 (0)1 4524 1112  
E-mail: [nea@nea.fr](mailto:nea@nea.fr) – Internet: [www.nea.fr](http://www.nea.fr)

ISBN 978-92-64-99088-3

