Radiation Protection

OECD

The Future Policy for Radiological Protection

Workshop Proceedings
Lanzarote, Spain
2-4 April 2003

NUCLEAR • ENERGY • AGENCY

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A Stakeholder Dialogue on the Implications of the ICRP Proposals

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In collaboration with the
International Commission on
Radiological Protection (ICRP)

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NUCLEAR ENERGY AGENCY
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, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, Luxembourg, Mexico, the Netherlands, Norway, Portugal, Republic of Korea, 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 recent years, the International Commission on Radiological Protection (ICRP) has conducted an open consultation 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 is to develop a new generation of ICRP recommendations that are as widely understood and accepted as possible and can thus be efficiently implemented.

The new ICRP recommendations being developed are intended to replace Publication 60 (ICRP, 1991). As part of this process, the ICRP has also identified the need to clarify and update its views on the radiological protection of non-human species. Both of these areas are of great interest to the member countries of the OECD Nuclear Energy Agency (NEA).

Already at an early stage, the NEA Committee on Radiation Protection and Public Health (CRPPH) began examining how the system of radiological protection could be made more responsive to decision makers, regulators, practitioners and the public. The first publication from the CRPPH in this area was *A Critical Review of the System on Radiation Protection*, which was issued in May 2000 and presented to the ICRP and the international community for consideration. This work identified several specific areas of ICRP Publication 60 that could usefully be revisited.

To further refine this work, the CRPPH commissioned the Expert Group on the Evolution of the System of Radiation Protection (EGRP) to suggest specific modifications to the current system which would result in improvement and simplification. A synthesis of the results of this work were published as *The Way Forward in Radiological Protection* (OECD/NEA 2002) for consideration by the ICRP and the international community, and have contributed to the ICRP's development of draft recommendations.

Continuing along these pragmatic lines, the CRPPH established the Expert Group on the Implications of ICRP Recommendations (EGIR) to identify the possible implications of the ICRP's new draft recommendations concerning the overall framework of the system of radiological protection as well as the radiological protection of non-human species. This group examined the implications of ICRP proposals and suggested ways that the final ICRP Recommendations could best serve the needs of national and international policy makers, regulators, implementers and other stakeholders. The group's final report was published in 2003 as *Possible Implications of Draft ICRP Recommendations*.

In support of this work, the NEA proposed to contribute to the debate on radiological protection of non-human species by promoting and helping to establish a broadly informed recommendation. This approach was also designed to foster information exchange between various initiatives. To this end, the first NEA forum in collaboration with the ICRP on "Radiological Protection of the Environment: The Path Forward to a New Policy?" was held on 12-14 February 2002 in Taormina, Italy. This forum brought together some 80 participants from 22 countries, including national regulatory executives, experts from intergovernmental and non-governmental organisations, politicians, scientists, sociologists and industry representatives. The ongoing work of the European

Commission (EC) and the International Atomic Energy Agency (IAEA) were essential components in understanding the current status of knowledge and in developing assessment approaches and guidance.

The forum was seen as a significant step in building consensus on major issues requiring attention when defining a new radiological protection policy for non-human species. These included defining an international rationale in this area; assessing the availability of scientific information to develop a broadly accepted recommendation; and evaluating the socio-political dynamics of this endeavour. The proceedings of the forum and a summary report were published in 2003.

The second NEA/ICRP forum on "The Future Policy for Radiological Protection" represents the culmination of the work of the EGRP, the EGIR and the results of the first forum. This second forum was held in Lanzarote, Canary Islands, Spain on 2-4 April 2003 and was kindly hosted by the Spanish *Consejo de Seguridad Nuclear* (CSN). It was attended by about 80 participants, including decision makers, regulators, operators, radiological protection professionals, scientists, politicians, individuals from intergovernmental organisations, unions and other non-governmental organisations (such as WANO, WNA and environmental NGOs). The list of forum participants is provided in annex. The members of the Forum Programme Committee were as follows:

Prof. Dr. Roger Clarke, NRPB, United Kingdom
Mr. Carlos Gimeno, CSN, Spain
Dr. Lars-Erik Holm, SSI, Sweden
Mr. C. Rick Jones, DOE, United States
Dr. Ted Lazo, OECD/NEA
Mr. Jacques Lochard, CEPN, France
Mr. Sigurdur Magnusson, Iceland
Dr. Stefan Mundigl, OECD/NEA
Dr. Hans Riotte, OECD/NEA
Ms. Paloma Sendin, CSN, Spain
Mr. Yasuhiro Yamaguchi, JAERI, Japan

The objectives of the second forum were to:

- evaluate and discuss the implications of draft ICRP recommendations on policy, regulation, industry, the workforce, the public and environmental protection;
- discuss how new ICRP recommendations could best serve the needs of national and international radiological protection policy makers, regulators, operators, workers and the public;
- continue the open and broad dialogue between stakeholders to reach a common level of understanding of the issues at stake and contribute to the evolution of new ICRP recommendations.

In order to facilitate stakeholder dialogue, the forum included two sets of breakout sessions. The first session discussed the key concepts of the new ICRP General Recommendations; the second session focused on the identification of implications of the ICRP General Recommendations and of the Draft Proposal for the Protection of Non-Human Species from Ionising Radiation. Breakout sessions were chaired by non-ICRP members to broaden and stimulate discussions. Participation in each breakout session represented the wide spectrum of stakeholders participating in the forum.

These proceedings include all the presentations that were made at the second NEA/ICRP forum in Lanzarote. A detailed analysis of the presentations, an evaluation of the discussions held after each presentation, and the results of the breakout sessions will be published in a separate summary report.

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WELCOME ADDRESS AND EXPECTATIONS OF THE NEA

Luis Echávarri
Director General, Nuclear Energy Agency

I would like to welcome you all, on behalf of the OECD Nuclear Energy Agency, to this important Forum on the future policy for radiological protection. I would like to thank our Spanish hosts for the professional and efficient preparations they have made, and for what I am sure will be their active participation in discussions. I would also like to thank the ICRP, in particular Professor Roger Clarke, for close collaboration with the NEA that, I am sure, will help lead to the development of effective radiological protection recommendations. And finally I would like to thank the NEA Committee on Radiation Protection and Public Health, the CRPPH, for its active contribution of new ideas and concepts to be discussed and debated.

Throughout its existence, the CRPPH has been involved in the development of radiological protection recommendations. The NEA issued its "Radiation Protection Norms", which served for many years as standards for national regulations, in 1963. More recently, the CRPPH has been very active in this area, developing concepts, ideas and suggestions to simplify and clarify the system of radiological protection. The ICRP has been very receptive to this work, and the CRPPH has become an active partner with the ICRP to provide the views of regulators and experts from the NEA's 28 member countries.

The CRPPH feels that the current system of radiological protection, as presented in ICRP Publication 60 and subsequent documents, is robust and fairly comprehensive. However, certain areas could be made more clear, the bases of certain aspects of the recommendations could be more transparent, and certain aspects present some incoherence. These aspects could be modified to yield a "new" system that would better meet the needs of those who implement the system.

To assist in moving in this direction, the CRPPH has been following several pathways. First, the Committee organised, in collaboration with the ICRP, the First NEA/ICRP Forum in Taormina early last year. Many of you took part in this meeting, which discussed how the ICRP was proposing to develop new recommendations for the protection of non-human species. Based on the feedback I have had, I think that this Forum was very useful in helping the NEA's member countries, and the international radiation protection community, to better understand the approach proposed by the ICRP, and to provide input to the ICRP on how the direction it is taking could be refined.

A second pathway of CRPPH investigation has led to the organisation of this meeting, the Second NEA/ICRP Forum. In early 2000 the CRPPH published its "Critical Review of the System of Radiological Protection", providing its views of where the current system as described in ICRP Publication 60 could be improved. As a follow-up to this, the Committee published "The Way Forward in Radiological Protection" in 2002, suggesting concrete new approaches to improve radiological protection. These suggestions have been "road-tested", showing that they would result in

an improved approach, and regional and cultural views on the path forward have been collected from Asia through a recent Asian Regional conference on this subject.

For its part, the ICRP has been actively seeking advice on how the system could be improved, and provided the CRPPH, in late 2002, with early draft versions of documents describing the conceptual frameworks of its new general recommendations, and of its new recommendations for the protection of non-human species. The CRPPH, with contributions from other technical committees within the NEA, has studied these draft documents, focusing on the possible implications of the concepts and approaches that they recommend. The results of this study will be presented and debated at this meeting. I am sure that the discussions of the proposed approach of the ICRP, and of the views of the CRPPH and of other stakeholders will be of great help to move us towards better understanding and consensus in this important area.

What do we expect from this second NEA/ICRP forum on "The Future Policy for Radiological Protection"? The objectives of this second NEA/ICRP Forum are

- to evaluate and discuss the implications on policy, regulation, industry, the workforce, the public and non-human species in progressing in the development of draft ICRP recommendations;
- to discuss how new ICRP recommendations could best serve the needs of national and international radiological protection policy makers, regulators, operators, workers, the public and non-human species; and
- to continue the open and broad dialogue between stakeholders to reach a common level of understanding of the issues at stake, and to contribute to the evolution of new ICRP recommendations.

On behalf of the NEA, I would like to wish you a very successful meeting, and I look forward to continued close co-operation with ICRP on this and future matters.

WHAT DOES ICRP EXPECT FROM THIS FORUM?

Roger H. Clarke
Chairman ICRP

Taormina was the first Forum and was successful in formulating ideas on protection of the environment.

The idea developed there to have a second Forum on both the environment and the next recommendations – now identified as the 2005 recommendations.

I am grateful to the NEA for facilitating this meeting and to CSN colleagues for hosting this meeting and for thinking of such a delightful venue where we can concentrate on the work without any distraction.

So what do I expect? The answer is "TEXT". I want written input to the ICRP work.

We, ICRP, are aiming to have draft Recommendations later this year.

The intention is that these will be short and concise, making use of supporting reports by Task Groups. It is also our intention to make clear where ICRP will make Recommendations and where international Agencies have a role, or where national authorities take responsibility.

Our ideas are firming up and the CRPPH comments are valuable because it shows items that we have missed and where there has been a fundamental misreading of our intent. We are looking for agreement on the way forward.

Basically, we want input.

The Breakout Groups have been designed to address basic Task Group topics in the Recommendations. The Task Group Chairmen and Annie Sugier, who chairs Committee 4 now, will be looking to you to focus on what is required in these areas.

What I want is text to go directly into draft Recommendations. I hope you will respond to this and take the discussion seriously with the positive intention to achieve consensus this week. Your efforts will be rewarded when the outcome is seen in the 2005 draft Recommendations seen by the Committees of ICRP this autumn, and then presented to IRPA 11 in Madrid in May 2004.

Then there is the work on non-human species that will be introduced by my Vice-Chairman, Lars-Erik Holm. As a result partly of the Taormina meeting, he and his task Group finalised the report and the main Commission adopted it this last January. Again, breakouts will lead to ideas for the text that is incorporated in the draft Recommendations.

As Chairman designate he is preparing the programme of work and structure of ICRP that he believes will be needed from 2005. Once again you have the opportunity to influence his ideas on that programme and I urge you to contribute positively. The result will determine the direction of the ICRP programme in the period 2005-2009.

Nothing like thinking ahead! But that is what we have to consider. It is already 14 years since we released the draft of what was to become the 1990 Recommendations.

How are we best able to express protection philosophy for the next 10-15 years from 2005?

SESSION 1

The New ICRP General Recommendations

Chair: Commissioner Paloma Sendin, CSN, Spain

THE EVOLUTION OF THE SYSTEM OF RADIOLOGICAL PROTECTION: THE JUSTIFICATION FOR NEW ICRP RECOMMENDATIONS

Roger H. Clarke
Chairman ICRP

Abstract

ICRP has been encouraging discussion, during the past few years, on the best way of expressing radiological protection philosophy in its next Recommendations, which it plans to publish in 2005. The present Recommendations were initiated by Publication 60 in 1990 and have been complemented by additional publications over the last twelve years. It is now clear that there is a need for the Commission to summarise the totality of the number of numerical values that it has recommended in some ten reports. This has been done in this paper and from these, a way forward is indicated to produce a simplified and more coherent statement of protection philosophy for the start of the 21st century. A radical revision is not envisaged, rather a coherent statement of current policy and a simplification in its application.

Introduction

The 1990 system of protection, set out in Publication 60, was developed over some 30 years. During this period, the system became increasingly complex as the Commission sought to reflect the many situations to which the system applied. This complexity involved the justification of a practice, the optimisation of protection, including the use of dose constraints, and the use of individual dose limits. It has also been necessary to deal separately with endeavours prospectively involving radiation exposure, "*practices"*, for which unrestricted planning was feasible for reducing the expected increase in doses, and existing situations for which the only feasible protection action was some kind of "*intervention"* to reduce the doses. The Commission also considered it necessary to apply the Recommendations in different ways to occupational, medical, and public exposures. This complexity is logical, but it has not always been easy to explain the variations between different applications.

The Commission now strives to make its system more coherent and comprehensible, while recognising the need for stability in international and national regulations, many of which have relatively recently implemented the 1990 Recommendations. However, new scientific data have been produced since 1990 and there are developments in societal expectations, both of which will inevitably lead to some changes in the formulation of the Recommendations.

The previous 1977 Recommendations were made in Publication 26, which established the three principles of the system of dose limitation as Justification, Optimisation and Limitation. Assessments of the effectiveness of protection can be related to the source that gives rise to the individual doses (source-related) or related to the individual dose received by a person from all the

sources under control (individual-related). Optimisation of protection is a source-related procedure, while the individual-related dose limits provide the required degree of protection from all the controlled sources.

Optimisation of protection was to be applied to a source in order to determine that doses are "as low as reasonably achievable, social and economical considerations being taken into account", and decision-aiding techniques were proposed. In particular, the Commission recommended cost-benefit analysis as a procedure to address the question, "How much does it cost and how many lives are saved?" The Commission recommended that the quantity Collective Dose should be used in applying those optimisation techniques to take account of the radiation detriment attributable to the source in question. This quantity was unable to take account of the distribution of the individual doses attributable to the source. Attempts were made to address this problem in Publications 37 and 55, by suggesting a costing of unit collective dose that increased with individual dose received, the procedure was essentially never adopted internationally.

The 1990 and subsequent recommendations

The issue was partially resolved in the 1990 Recommendations: while it was still stated, as in 1977, that in relation to any particular source within a practice, the doses should be as low as reasonably achievable, social and economic factors being taken into account, it then continued:

> *"This procedure should be constrained by restrictions on the doses to individuals* ***(dose constraints)****, or the risks to individuals in the case of potential exposures (risk constraints), so as to limit the inequity likely to result from the inherent economic and social judgements"* (Paragraph 112).

The concept of the constraint has not been clearly explained by the Main Commission in its subsequent publications. It has not been understood and, although it has been the subject of debate by international bodies, it has not been sufficiently utilised nor has it been implemented widely. The Commission now aims to clarify the meaning and use of the constraint.

The dose constraint was introduced because of the need to restrict the inequity of any collective process for offsetting costs and benefits when this balancing is not the same for all the individuals affected by a source. Before 1990, the dose limit provided this restriction, but in Publication 60 the definition of a dose limit was changed to mean the boundary above which the consequential risk would be deemed unacceptable. This was then considered to be inadequate as the restriction on optimisation of protection and lower value constraints were required to achieve this.

This introduction of the constraint recognised the importance of restricting the optimisation process with a requirement to provide a basic minimum standard of protection for the individual.

The principles for intervention set out in Publication 60 are expressed in terms of a level of dose or exposure where intervention is almost certainty warranted (i.e., justified), which is followed by a requirement to maximise the benefit of the intervention (i.e., the protection level should be optimised). This is effectively an optimisation process and therefore it may be seen in exactly the same terms as for practices, i.e., there is a restriction on the maximum individual dose and then the application of the optimisation process that is itself expected to lead to lower doses to individuals.

It can be seen then that all of the Commission Recommendations since 1990, both for practices and for interventions, have been made in terms of an initial restriction on the maximum

individual dose in the situation being considered, followed by a requirement to optimise protection. This underlines the shift in emphasis to include the recognition of the need for individual protection from a source.

Since the 1990 recommendations there have been nine publications, listed in Table 1, that have provided additional recommendations for what are effectively to be regarded as "constraints" in the control of exposures from radiation sources. When ICRP 60 is included, there exist nearly 30 different numerical values for "Constraints" in the ten reports that define current ICRP recommendations. Further, the numerical values are justified in some six different ways, which include:

- individual annual fatal risk;
- upper end of an existing range of naturally occurring values;
- multiples or fractions of natural background;
- formal cost-benefit analysis;
- qualitative, non-quantitative, reasons; and
- avoidance of deterministic effects.

Table 1. **ICRP Recommendations made since Publication 60**

Publication 62	Radiological Protection in Biomedical Research
Publication 63	Principles for Intervention for Protection of the Public in a Radiological Emergency
Publication 64	Protection from Potential Exposure: A Conceptual Framework
Publication 65	Protection against Radon-222 at Home and at Work
Publication 75	General Principles for Radiation Protection of Workers
Publication 76	Protection from Potential Exposures: Application to Selected Radiation Sources
Publication 77	Radiological Protection Policy for the Disposal of Radioactive Waste
Publication 81	Radiation Protection Recommendations as Applied to the Disposal of Long-lived Solid Radioactive Waste
Publication 82	Protection of the Public in Situations of Prolonged Radiation Exposure

The new Recommendations should be seen, therefore, as extending the Recommendations in Publication 60 and those published subsequently, to give a single unified set that can be simply and coherently expressed. The opportunity is also being taken to include a coherent philosophy for natural radiation exposures and to introduce a clear policy for radiological protection of the environment.

The question to be addressed is whether, for the future, fewer constraints may be recommended that are sufficient to encompass the needs of radiological protection, and whether they can be established on a more uniform and consistent basis.

The 2005 system of protection

The primary aim of the Commission continues to be contributing to the establishment and application of an appropriate standard of protection for human beings and now explicitly for other species. This is to be achieved without unduly limiting those desirable human actions and lifestyles that give rise to, or increase, radiation exposures.

This aim cannot be achieved solely on the basis of scientific data, such as those concerning health risks, but must include consideration of the social sciences. Ethical and economic aspects have also to be considered. All those concerned with radiological protection have to make value judgements about the relative importance of different kinds of risk and about the balancing of risks and benefits. In this, they are no different from those working in other fields concerned with the control of hazards. The restated Recommendations will recognise this explicitly.

The Commission now recognises that there is a distribution of responsibilities for introducing a new source leading to exposures, which lies primarily with society at large, but is enforced by the appropriate authorities. This requires application of the principle of JUSTIFICATION, so as to ensure an overall net benefit from the source. Decisions are made for reasons that are based on economic, strategic, medical, and defence, as well as scientific, considerations. Radiological protection input, while present, is not always the determining feature of the decision and in some cases plays only a minor role. The Commission now intends to apply the system of protection to practices only when they have been declared justified, and to natural sources that are controllable.

The justification of patient diagnostic exposures is included, but has to be treated separately in the Recommendations, because it involves two stages of decision making. Firstly, the generic procedure must be justified for use in medicine and, secondly, the referring physician must justify the exposure of the individual patient in terms of the benefit to that patient. It is then followed by a requirement to optimise patient protection and the Commission has advocated the specification of Diagnostic Reference Levels as indicators of good practice.

Where exposures can be avoided, or controlled by human action, there is a requirement to provide an appropriate minimum, or basic, standard of protection both for the exposed individuals and for society as a whole. There is a further duty, even from small radiation exposures with small risk, to take steps to provide higher levels of protection when these steps are effective and reasonably practicable. Thus, while the primary emphasis is now on protection of individuals from single sources, it is then followed by the requirement to optimise protection to achieve the best level of protection available under the prevailing circumstances.

In order to achieve this, it is proposed that the existing concept of a constraint be extended to embrace a range of situations to give the levels that bound the optimisation process for a single source. The optimisation of protection from the source may involve either, or both, the design of the source or modification of the pathways leading from the source to the doses in individuals. They would replace a range of terms that include intervention levels and action levels since there would be no need to distinguish intervention situations separately, constraints, clearance levels and exemption levels as well as the dose limits for workers and the public.

The system of protection being developed by the Commission is based upon the following principles, which are to be seen as a natural evolution of, and as a further clarification of, the principles set out in Publication 60. Once the source is justified by those appropriate authorities, the radiological principles may be expressed as:

For each source, basic standards of protection are applied for the most exposed individuals, which also protect society: CONSTRAINTS

If the individual is sufficiently protected from a source, then society is also protected from that source.

However, there is a further duty to reduce doses, so as to achieve a higher level of protection when feasible and practicable. This leads to authorised levels: OPTIMISATION

These constraints or basic levels of protection can be recommended by ICRP and accepted internationally. The responsibility for optimisation then rests with the operators and the appropriate national authority. The operator is responsible for day-to-day optimisation and also for providing input to the optimisation that will establish Authorised Levels for the operation of licensed practices. These levels will, of necessity, be site and facility dependent and beyond the scope of ICRP.

Factors in the choice of new constraints

The Commission now considers the starting point for selecting the levels at which any revised constraints are set is the concern that can reasonably be felt about the annual effective dose from natural sources. The existence of natural background radiation provides no justification for additional exposures, but it can be a benchmark for judgement about their relative importance. The worldwide average annual effective dose from all natural sources, including radon, as reported by UNSCEAR is 2.4 mSv.

A general scheme for the degree of concern and the level of exposure, as a fraction or multiple of the average annual natural background, is shown in Table 2. Natural background varies by at least a factor of ten around the world, and even more if the highest radon doses are included. This supports the view that concern should begin to be raised at the higher end of the natural range, a few 10s of mSv in a year.

Table 2. **Levels of concern and individual effective dose received in a year**

HIGH	More than 100 mSv
RAISED	More than a few 10s mSv
LOW	1 - 10 mSv
VERY LOW	Less than 1 mSv
NONE	Less than 0.01 mSv

Global Average Annual Natural Background Effective Dose From All Sources IS 2.4 mSv (UNSCEAR, 2000).

At higher individual doses, of the order of 100 mSv, the risk from a source cannot be justified, except in extraordinary circumstances such as life-saving measures in accidents, or in manned space flights.

At the other extreme, additional doses far below the natural annual dose should not be of concern to the individual. Provided that the additional sources come from practices that have not been judged to be frivolous, these doses should also be of no concern to society. If the effective dose to the most exposed is, or will be, less than about 0.01 mSv in a year, then the consequent risk is negligible and protection may be assumed to be optimised, thus requiring no further regulatory concern.

In the intermediate region, doses between a fraction of mSv and a few tens of mSv, whether they are received either singly or repeatedly, are legitimate matters for significant concern, calling for regulatory action.

The challenge is whether fewer numbers could replace the 20-30 numerical values for constraints currently recommended in the Publications listed in Table 1. Further, could they also be more coherently explained in terms of multiples and fractions of natural background.

Optimisation of protection

The Commission wishes to retain the phrase "Optimisation of protection" and applies them both to single individuals and to groups. However, it is applied only after meeting the restrictions on individual dose defined by the relevant constraint. It is now used as a short description of the process of obtaining the best level of protection from a single source, taking account of all the prevailing circumstances.

The Commission stated in Publication 77 that the previous procedure had become too closely linked to formal cost-benefit analysis. The product of the mean dose and the number of individuals in a group, the collective dose, is a legitimate arithmetic quantity, but is of limited utility since it aggregates information excessively. For making decisions, the necessary information should be presented in the form of a matrix, specifying the numbers of individuals exposed to a given level of dose and when it is received. This matrix should be seen as a "decision-aiding" technique that allows different weightings of their importance to be assigned to individual elements of the matrix. The Commission intends that this will avoid the misinterpretation of collective dose that has led to seriously misleading predictions of deaths.

The concept of collective dose was also previously used as a means of restricting the uncontrolled build-up of exposure to long-lived radionuclides in the environment at a time when it was envisaged that there would be a global expansion of nuclear power reactors and associated reprocessing plants. Restriction of the collective dose per unit of practice can set a maximum future global *per caput* annual effective dose from all sources under control. If, at some point in the future, a major expansion of nuclear power were to occur, then some re-introduction of a procedure may have to be considered to restrict a global build-up of *per caput* dose.

The process of Optimisation may now be expressed in a more qualitative manner. On a day-to-day basis, the operator is responsible for ensuring the optimum level of protection and this can be achieved by all those involved, workers and professionals, always challenging themselves as to whether protection can be improved. Optimisation is a frame of mind, always questioning whether the best has been done in the prevailing circumstances. For the more formal authorisations, which are decided by the regulator in conjunction with the operator, they may in future best be carried out by

involving all the bodies most directly concerned, including representatives of those exposed, in determining, or in negotiating, the best level of protection in the circumstances. It is to be decided how the Commission's recommendations will deal with this degree of societal process. However, the result of this process will lead to the authorised levels applied by the Regulator to the source under review.

Exclusion of sources and exposures

The Commission intends its system of protection to apply to the deliberate introduction of a new controllable source or the continued operation of a controllable source that has deliberately been introduced, i.e., a practice, and to controllable natural sources. Its Recommendations can then be applied to reduce doses, when either the source or the pathways from the source to the exposed individuals can be controlled by some reasonable means. Sources that do not fall within this definition of controllable are excluded from regulatory control. There are sources for which the resulting levels of annual effective dose are very low, or for which the difficulty of applying controls is so great and expensive, that protection is already optimised and the sources are therefore excluded.

In its restated policy the Commission defines what sources and exposures are to be excluded from the system of protection and will not use the term "exemption". Exemption or clearance is seen as a regulatory decision that is applied to non-excluded sources by the appropriate regulatory body. That body has the responsibility for deciding when radioactive material is to be released from its control, which is in effect an "Authorised Release" no different from that specified for effluent discharges after application of the optimisation process.

Apart from these exclusions, the Commission has aimed to make its Recommendations applicable as widely and as consistently as is possible, irrespective of the origin of the sources. The Commission's Recommendations thus will now cover exposures to both natural and artificial sources, so far as they are controllable

Some outstanding issues and proposed timescales

The Main Commission is preparing a number of supporting documents on which the main Recommendations will draw. These include summaries of the health effects of radiation at low doses and the review of RBE values, which together will lead to a document on the decision for revised radiation and tissue weighting factors. Other major issues which are under development and need further discussion are:

- exploration into the possibility of specifying a fewer number of numerical constraints than presently exist and whether they can be more coherently explained;
- clarification of the Exclusion concept and further elaboration of the observation that all releases from regulatory control are "Authorised releases";
- a review of the "critical group" concept as used to represent the hypothetical individual. ICRP has not addressed this since well before the 1990 Recommendations;
- develop methods by which the optimisation of protection can realistically be achieved.

The intention is to have draft Recommendations prepared for discussion with the four Committees late in 2003 so that a well-developed draft is available for the IRPA 11 Congress in May 2004. It is planned to produce the final version in 2005. Table 1 shows a brief compilation of

some of the major topics where there will be changes from present Recommendations to the new proposals.

Table 3. **Brief summary of essential changes expected in the new recommendations**

Topic	Present recommendations	New recommendations
Linearity	Linear Non-Threshold i.e., Proportionality	Clarify concept and applicable range, i.e., above a few mSv/yr
Effective Dose	Yes	Yes
Radiation weighting factor	Publication 60	Revised values for protons and neutrons
Tissue weighting factor	Publication 60	New values based on revised risk factors and a simplified basis
Nominal risk coefficient	Publication 60	Total Cancer Fatality similar, but individual organs changed Hereditary use UNSCEAR 2001
Limits	Worker and public in Publication 60	Incorporated into revised constraints
Constraints	See Table 2	Number and complexity to be reduced
Collective dose	Publication 60	Disaggregated and replaced by weighted matrix
Justification	Publication 60	Retained, extended for patient exposure
Optimisation	Cost-benefit analysis	Stakeholder involvement
Exemption	Publication 60	Replace by Exclusion
Definition of ‘individual’	Publication 29	New consideration
Practice	Publication 60	Retain
Intervention	Publication 60	Incorporate into constraints
Environment (non-human)	Assumed protected in Publication 60	Explicitly addressed
Natural radiation sources	Radon-222 only	Comprehensive treatment

OPTIMISATION: HOW TO DEVELOP STAKEHOLDER INVOLVEMENT

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Introduction

The Precautionary Principle is an internationally recognised approach for dealing with risk situations characterised by uncertainties and potential irreversible damages. Since the late fifties, ICRP has adopted this prudent attitude because of the lack of scientific evidence concerning the existence of a threshold at low doses for stochastic effects. The "linear, no-threshold" model and the "optimisation of protection" principle have been developed as a pragmatic response for the management of the risk. The progress in epidemiology and radiobiology over the last decades have affirmed the initial assumption and the optimisation remains the appropriate response for the application of the precautionary principle in the context of radiological protection.

The basic objective of optimisation is, for any source within the system of radiological protection, to maintain the level of exposure as low as reasonably achievable, taking into account social and economical factors. Methods tools and procedures have been developed over the last two decades to put into practice the optimisation principle with a central role given to the cost-benefit analysis as a means to determine the optimised level of protection. However, with the advancement in the implementation of the principle more emphasis was progressively given to good practice, as well as on the importance of controlling individual levels of exposure through the optimisation process.

In the context of the revision of its present recommendations, the Commission is re-enforcing the emphasis on protection of the individual with the adoption of an equity-based system that recognises individual rights and a basic level of health protection. Another advancement is the

1. The Terms of Reference of the Task Group: *"The principle of optimisation and the requirements or its implementation will be reviewed in relation to the Recommendations for the 21st Century. Particular attention will be given to:*
   - *the number of individuals and the distribution of individual exposures and the role of constraints;*
   - *implementation requirements and techniques;*
   - *operational and managerial aspects, empowerment of the worker and involvement of the public*
   - *Regulatory aspects."*

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role that is now recognised to "stakeholders involvement" in the optimisation process as a mean to improve the quality of the decision aiding process for identifying and selecting protection actions considered as being accepted by all those involved. The paper presents the role of the optimisation principle in the future recommendations. It also underlines the key aspects related to the stakeholder involvement process that these recommendations intend to promote.

Justification, individual dose restriction, optimisation

In the new system of ICRP, the justification principle remains a prerequisite. For any source or exposure that has been declared justified, the first objective is to protect the individual through the application of dose or activity constraints. These constraints apply for an individual exposed to a single source. Protection is then to be optimised below these constraints, to achieve the best level of protection under the prevailing circumstances. In a multiple source situation (i.e., nuclear plant itinerant workers) the responsible authorities may need to make specific arrangements to assure that an individual's total exposure from all sources combined does not exceed the constraint.

The constrained optimisation process applies to all sources and exposure situations that are included in the system of radiological protection. In application, for sources and exposures within the system of radiological protection, constraints are used as planning tools for the optimisation of protection. This includes all sources and exposures that are under control, those that result from a loss of control, or those that are de facto. For loss-of-control situations, constraints are used as planning tools for designing countermeasures. Similarly, constraints in *de facto* situations are upper bounds to the optimisation process. For loss-of-control and de facto situations, the objective of optimisation is a residual dose level moving down, towards pre-situation levels (in loss of control situations), or toward some other agreed-upon target level (in *de facto* situations).

Optimisation of protection and individual dose

Optimisation is a process that, for a given source or exposure situation, addresses all individual exposures, taking into account concurrently the magnitude of individual doses and the number of individuals exposed.

This is implemented by maintaining or reducing, concurrently and in a reasonable fashion: the doses of the most highly exposed individuals; the spread of individual doses in the distribution; the magnitude of individual doses; and the number of individuals exposed. In any optimisation processes priority should be given to the most highly exposed individuals.

The collective dimension of exposures to a given group can be appropriately addressed using the distribution of the group's individual doses (including time and space) in matrix form. The information necessary for such an approach is, today, readily available. These matrix elements used to present group dose are applicable to workers and to the members of the public. The relative importance of each of these elements may vary depending upon the situation being considered. In the implementation of optimisation, weighting factors can be used to reflect concerns over the magnitude of individual exposures, and their time and geographic distributions.

The characteristics of the optimisation process

The optimisation of protection is a source-related and forward-looking process aimed at preventing exposures before they occur. This process must be systematic and structured to ensure that all relevant aspects are taken into account. It requires a continuous questioning attitude in which the question "Has enough been done to keep or reduce doses as low as reasonably achievable?" is asked. It also requires the commitment from all levels of an organisation as well as adequate procedures and resources.

Optimisation of protection is a process that is at the heart of a successful radiological protection program. In application, it involves evaluating and, where practical to do so, incorporating measures that tend to lower radiation doses to individuals of the population and to workers. It incorporates a range of activities from common sense decision making to, in some complex situations, intricate multi-attribute analyses. As commonly used, the process of optimisation takes into account a number of factors, such as technical feasibility, cost, potential adverse impacts, long-term effectiveness, individual and population effects.

The optimisation process is an input to the decision-making process that leads to the achievement of the best level of protection under the prevailing circumstances. It includes not only physical protection measures, but also aspects such as safety organisation and management, safety culture and safety training, many of which are associated with minimal costs and improvements in other areas: In the future this process may best be carried out by involving all the bodies most directly concerned, including the workforce and the public. It is one of the characteristics of stakeholder involvement to be present at the spot, to listen to the various points of view, to better understand the stakes of the involved parties, to participate to the definitions of solutions and to help in their implementation. It should be pointed out here, that many situations will not need large numbers of stakeholders, and will, in fact, result in decisions being made in a very similar way as currently.

ICRP is now giving more importance to processes based on "common sense" and "good practice," including periodic review to ensure that optimisation of protection will benefit from new techniques and procedures. This does not mean however, that methods, procedures and techniques that have been developed in the past are no longer valid. The Commission recognises the complementary roles of qualitative and quantitative approaches that are applied based on their limitations.

Much of the protection is built in during the design phase of a project for controlled sources, when options are evaluated, often for the selection of engineered controls. The process of optimisation of protection must also continue during the operational and termination phases. In the case of loss of control and de facto situations optimisation of protection is an on-going process, taking into account technical and socio-economic developments, which allow with time the progressive reduction of individual doses to the levels that are applicable for controlled situations.

Up to now, occupational radiation protection in the nuclear fuel cycle has received more attention than radiological protection in any other practise. The main driving force for occupational exposure control has been the application of the optimisation (ALARA) principle, which is has become part of the normal job planning. Natural radiation is an inescapable feature of life on earth to which everyone is exposed while at work. Workers exposed to natural radiation should be given the same level of (optimised) protection as those exposed to artificial radiation. There is no doubt that more emphasis should be given to the aspects of optimisation relating to the prevention of accidents.

Optimisation in operation and regulation

The exposures and/or activity concentrations that result from a cycle of the optimisation process represent the levels at which, at a point in time, all stakeholders, including the regulator, are in agreement with a way to move forward. Based on these levels, the proposed actions can be authorised, for example by the regulator or the user. The numerical results of optimisation of protection can be used as indicators, for the regulator and the user, to assure that the best protection under the prevailing circumstances is being achieved.

Only optimised options should be authorised by the regulatory authority. The regulatory framework should specify that the process of identifying the optimised solution be as transparent as possible. Optimisation of protection can be seen as including the necessary dialogue between operators and regulators, who are acting on behalf of society, and society itself.

Regulatory authorities must encourage the development of an "optimisation culture" within their organisations. Elements of this culture include, the knowledge about radiological risk and its consequences, the mastery of the optimisation techniques and procedures, the encouragement of a questioning and learning attitude, the clear definition of the responsibilities and the on-going training of all those involved.

How to develop stakeholder involvement

There is no unique approach and the experience with stakeholder involvement in occupational radiation protection is still very limited. Various techniques have been developed in different areas to structure the process of linking stakeholders to decision making: the spectrum covers classical consultation processes at one end and structured consensus building techniques with or without assistance of a third party at the other end.

In general, flexibility in the process of optimisation is needed, not only due to the increasing emphasis on protection of the individual and the resulting shift to an equity-based system, but also due to the broadening acceptance of stakeholder involvement in the process of decision making. While the extent of stakeholder involvement will vary from one situation to another, there are several key factors that need to be considered at the outset:

- the need for inclusion and consensus of the relevant group of stakeholders for decisions solutions;
- a clear understanding of the distinct roles and input of the various stakeholders in the decision-making process;
- the boundaries between the scientific aspects of risk assessment, the social aspects of risk evaluation and management, and the regulatory aspects of risk management.

The participation of the workforce, particularly through the development of a risk culture is an indispensable first step in the overall process. Key questions have to be taken into account on a case by case basis, such as:

- How can the interests of each party in the decision-making process be balanced?
- How can the involvement of the workforce (or its representatives) be ensured in an equitable way – taking into account potentially lower resources, power, education and information?

- How can the problem of achieving a common understanding of a complex terminology, terminology differences between organisations, conventions, standards be solved?
- How far is it appropriate to give workers a legal right to know and interfere in the decision-making process?
- What can be the role of radiation protection professionals, who represent social interest of implementing a good standard of radiological protection but who may not be fully independent?

What can be regulated? Where are the limits of regulations?

Depending upon national governmental and regulatory structures and schemes, and upon the nature of the situation requiring a decision, different legal systems need different legal solutions. Formalised optimisation procedures may, however, not always lead to efficient solutions.

The regulatory framework of radiological protection should include optimisation of radiological protection at all levels of the radiation protection regulation as a fundamental principle in the radiation protection law and/or in the relevant directives as practical guidance for optimisation procedures in the relevant codes of practice as detailed requirements in the authorisation process. Regulatory guidance should be provided on how an optimisation process could be conducted, and what elements should be included. For example, what considerations should be included in the safety case for the release of a site from regulatory control? Which elements should be presented to demonstrate that the optimum radiation protection solution has been identified and selected for the replacement of a steam generator at a nuclear power plant? How could a research laboratory applying for authorisation to use a new source (accelerator, x-ray machine, new radioisotopes, etc.) demonstrate that its approach to radiological protection is optimum? What aspects should be included in the scientific analysis of releases from a facility, and what decision-aiding scientific aspects should be presented to the decision maker in such cases? Because of the judgmental nature of an optimised protection solution, the concept of and the approach to optimisation must be presented and defined very clearly. There is a strong need for transparency and clarity.

Optimisation of radiological protection applies to all situations where radiation doses can be controlled by protective measures. In the case of authorised practices, optimisation should be applied at all stages of the process, i.e., from the design stage of a project through the operational stages, including maintenance and modifications, to the decommissioning and waste disposal stages. At all stages, decisions have to be made regarding the number and qualification of personnel, the type of individual protection devices used, the organisation of work, the appropriate monitoring equipment required, etc.. The optimisation process should be addressed in a systematic and structured approach in the regulatory framework. Particularly, guidance on optimisation procedures should be part of the authorisation process. When issuing a license, the regulatory authority should set up requirements for the optimisation of radiological protection and, at the same time, provide guidance to the user on optimisation procedures to be used during the authorisation process. The compliance with these requirements is evaluated on a routine basis by the various components of the enforcement system in place, for example by on-site inspections.

At different levels of a company management the responsibilities for the optimisation (ALARA) approach should be defined including ALARA indicators (e.g., definition of the ALARA programme) and associated performance criteria for each indicator (e.g., creation and composition of an ALARA committee and content of an ALARA programme).

The way forward

The next steps with stakeholder involvement in radiological protection are:

- To reflect on how to articulate the previous experience of implementing ALARA with the new perspective opened by stakeholder involvement approaches and techniques for both public and occupational protection. All the developments related to the application of the cost-benefit analysis and the implementation of the ALARA procedure are still valid and must be incorporated in the new approach. The participation of stakeholders in the decision-making process can not ignore their inputs. There is a need at this level to revisit the work done in the last two decades to see how the methods and tools should be transformed and adapted to an approach giving more importance to the participation of the parties involved. In the same perspective, the organisational arrangements that have been developed as part of the ALARA procedure need to be revisited to fit with the new approach.
- To look for opportunities to actually implement stakeholder involvement processes and to accompany these experiences to perform feed-back analysis. The use of the European ALARA and the ISOE Networks could be a means to initiate interesting experiences with voluntary organisations and actors.

As far as ICRP is concerned it seems difficult to go much further in the next recommendations than asserting the role of stakeholder involvement for the implementation of the ALARA principle. It would be certainly a mistake to try to give formal and precise advice about the way to put into practice the stakeholder involvement approach. In fact, the new importance given to the stakeholder involvement approach does not change radically the situation: it remains a deliberation process which is more open, taking account the multiplicity of perspectives brought in by the stakeholder and may be more complex and value driven than the one adopted so far.

DOSE TO INDIVIDUALS: WHO AND HOW

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Thank you, Commissioner Sendin. As you may know, in 2002 the Main Commission established a Task Group on "Characterisation of the Individual for the Purpose of Assessing Compliance with Dose Constraints." My colleagues on the Task Group are Cisza Zuur, David Cancio, John Cooper, Andrew McEwan, and Toshiso Kosako. Mary Clark, Don Cool, and Kaare Ulbak are corresponding members. This paper highlights some of the Task Group's key recommendations and provides a basis for discussion for breakout sessions that follow.

Although the title indicates that I will address "who" the individual is and "how" the individual is characterised, I thought it wise to first mention "why" we are concerned about the individual in the consolidated recommendations. Here are a few reasons why characterising the individual is important. First, the proposed consolidated recommendations place greater emphasis on individual-related criteria rather than societal or collective dose based criteria. This has been explained in the earlier presentation by Dr. Clarke. Also, it is necessary to update guidance on how to identify and characterise critical groups and individuals since this topic has not been thoroughly addressed by The International Commission on Radiological Protection (ICRP) since the publication of ICRP 43 (ICRP, 1985). Finally, the report intends to address additional conceptual and technical issues related to determining compliance with constraints and making decisions in emergency situations.

The scope of the Task Group's work places emphasis on prospective exposure situations. It does not address medical and occupational exposures.

Introduction

There are certain fundamental assumptions that have guided the development of the Task Group's recommendations characterising the individual. Dose criteria are assumed to be applied to a single source. Exposure, doses, and risks are estimated for three distinctive purposes: comparison with individual dose criteria, optimisation, and to aid planning for, and making decisions in, emergency situations. Assessments made to determine compliance with dose criteria guide decisions on acceptability of exposure or help identify actions to be taken to reduce exposure. For example, the results of the comparison with a compliance criterion may determine whether additional effluent control equipment are required. Doses also are estimated in the process of optimisation, where it is not merely sufficient to meet dose criteria but also necessary to show that doses below the recommended criteria have been reduced to "as low as reasonable achievable, social and economic considerations being taken into account." Finally, projected doses are estimated to allow planning for accident situations and actions to be taken in the event of an accident. The ICRP and local regulatory authorities provide guidance on specific levels of dose to be used for this purpose.

The focus on the individual is an extension of the critical group concept previously recommended by ICRP. In the assessment process, one generally first decides on a domain surrounding a source within which the most exposed groups are exposed. Then, through an iterative process, one identifies a group of individuals who represent the most exposed or critical group. The individual is defined based on the characteristics of this group.

There are a number of principles under consideration by the Task Group that we believe will help clarify and simplify how the individual is defined and how compliance is determined. Some of these are reviewed in the following sections.

Age-weighted approach

Dose constraints are specified in the form of an annual dose for regulatory and administrative purposes even though the numerical values are set at least partly on the basis of lifetime risk from exposure. Therefore, it is reasonable in the case of continuing exposures that the dose used as the basis for comparison with such criteria should be the average annual dose over the lifetime of an individual. Annual doses to individuals can vary in an age-specific manner due to changes in body size, lifestyle, and dietary characteristics. To account for this, ICRP has previously issued age-specific dose coefficients for intakes of radionuclides in seven age ranges covering the period from the foetus to age 70 years. These dose coefficients can be used together with the corresponding age-specific intakes of radionuclides to provide an age-weighted annual dose from intakes. When combined with the appropriate age-weighted dose from external exposure, an estimate of annual dose for comparison with dose criteria is provided. This is the age-specific approach.

In another method, the age-weighted approach, the annual dose to each age group for which the Commission has established dose coefficients, is weighted by the corresponding fraction of the individual's life span. The sum of these weighted doses is the age-weighted annual dose (see Tables 1 and 2). It should be noted that for most radionuclides, the age-weighted dose coefficient is well within a factor of two of the corresponding adult value. This difference is generally small compared to the uncertainties in the overall dose calculation process. Therefore, the adult dose coefficient together with the corresponding adult habit data often can be used directly in the calculation of critical group doses as a substitute for using age-weighted data.

Table 1. **Age-specific dose coefficients**

Age-specific dose coefficient	**Age range y**	**Fraction of life span** [1]
Foetus	-0.75 - 0	0.01
3 month	0 - 1	0.01
1y	More than 1 - 2	0.01
5y	More than 2 - 7	0.07
10y	More than 7 - 12	0.07
15y	More than 12 - 17	0.07
Adult	More than 17	0.76 [2]

1. Assuming the 70-year life span used to estimate adult dose coefficient.
2. This fraction is rounded up to 0.76 in order to make the sum of the fractions 1.0.

Table 2. **Calculated Age-weighted annual doses**[1]

	Pathway	Explicit calculation	Using age-weighted dose	Maximum dose to any group
^{3}H	Ingestion	$5.0\ 10^{-9}$	$5.1\ 10^{-9}$	$2.2\ 10^{-8}$ (3 mon)
	Inhalation	$1.5\ 10^{-7}$	$1.4\ 10^{-7}$	$2.0\ 10^{-7}$ (foetus)
^{137}Cs	Ingestion	$3.1\ 10^{-6}$	$3.1\ 10^{-6}$	$7.4\ 10^{-6}$ (3 mon)
	Inhalation	$3.3\ 10^{-5}$	$3.3\ 10^{-5}$	$3.7\ 10^{-5}$ (adult)
^{210}Po	Ingestion	$4.7\ 10^{-4}$	$5.1\ 10^{-4}$	$9.1\ 10^{-3}$ (3 mon)
	Inhalation	$2.8\ 10^{-2}$	$2.6\ 10^{-2}$	$2.9\ 10^{-2}$ (15 y)
^{239}Pu	Ingestion	$7.4\ 10^{-5}$	$8.0\ 10^{-5}$	$1.5\ 10^{-3}$ (3 mon)
	Inhalation	$3.7\ 10^{-1}$	$3.7\ 10^{-1}$	$4.0\ 10^{-1}$ (adult)

1. Calculated using UK age-specific habit data for inhalation and milk consumption.

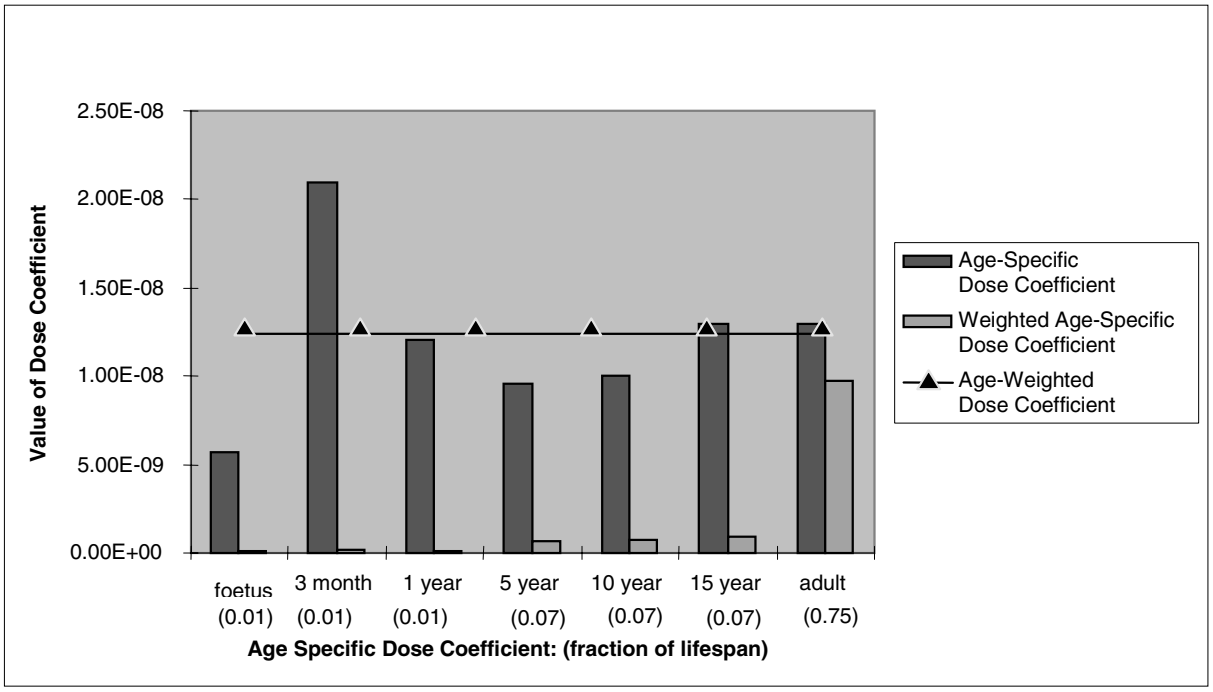
The approach has a number of advantages. First, it provides a method for calculating dose that is consistent with the conceptual foundation of lifetime risk. Second, it would not be unduly sensitive to changes in the habits of any individual age groups or to any future changes in age-specific dose coefficients.

For example, for ^{137}Cs, the age-specific dose coefficients and age-weighted dose coefficient are illustrated in Figure 1. The dark bars indicate the magnitude of the dose coefficients for each age category. The light bars indicate the dose coefficient, weighted by the fraction of time they apply. The black line (noted with triangles) is the value of the age-weighted dose coefficient.

Characterising the individual

For dose assessment purposes in establishing the characteristics of the individual, due regard should be given to the need for adopting cautious, but reasonable, assumptions about critical group habits. Information related to the behaviour of individuals often has been used to derive average critical group behaviour or to provide an estimate of individual behaviour distribution. For example, data on individual habits (e.g., consumption of foodstuffs, location, use of local resources) are typically used to establish, quantitatively, the characteristics of a particular group for an assessment. This does not mean, however, that behaviour of a single individual can properly be used in isolation. Indeed, whereas the full set of results of a particular habit may be regarded as an indicator of an underlying distribution, the values adopted for assessment purposes should not be unduly influenced by the discovery of one or two individuals with extreme habits. Therefore, the question of reasonableness in selection of characteristics of the critical group is related to that of homogeneity because the constraints are intended to apply to doses derived from the mean characteristics in a reasonably homogeneous group.

Figure 1. **Example of age-weighted vs. age-specific dose coefficients for Cesium-137**



If specific information is not available for the consumption of the particular dietary items that are the dominant contributor to dose from a source (e.g., fish consumption from a coastal area with a local discharge of radionuclides into the marine environment), values may be derived from general population data. In this situation, the Task Group recommends using at least the 67th percentile, but no more than the 95th percentile, of diet and habit data of the general population. The selection of this value is primarily the responsibility of regulators, facility managers, and other stakeholders.

In addition to homogeneity, another important criterion to be considered in relation to reasonableness in selection of a critical group is that of sustainability. The characteristics of the critical group need to be sustainable over the years that a practice is conducted so, for example, some extreme intake values that might be found on one occasion in a very few individuals do not dictate the intake characteristics of the group. Likewise, the total dietary intake also should be consistent with credible calorific requirements. In addition, it would be considered unreasonable to assume in an area of high environmental radioactivity concentrations that all foods consumed in the area by the critical group were grown within the area if it was apparent that the residence location and land area available to the critical group could not support their dietary intake. Similarly, the intakes of a critical group of hunters taking wild game from an area should not exceed feasible game capture rates. In the case of significant contributions to dose from external exposure, reasonable estimates of times spent in areas of elevated exposure rates are required.

In assessing individual doses in prospective situations, it may be appropriate to assume that institutional controls on land use (e.g., designation as a national park or wilderness area) will be in effect. These might preclude types of activity (e.g., residential use or arable cropping) in the designated area so that a critical group obtaining staple food supplies from the area would not be possible. Climatic conditions also might preclude or dictate potential for future habitation and locally

produced foodstuffs (e.g., in an arid zone, availability of water might preclude both extended residence and sustainable food production). Therefore, the selection of appropriate characteristics should take these restrictions into account.

Time frames and spatial distributions

A special situation comes from the disposal of long-lived solid radioactive waste in which the public exposure, if any, will take place in the far future due to the long period of isolation provided, for example, by a deep geological repository. It is not possible to make a precise identification of a particular population group exposed at some time in the far future. Guidance for the protection of future individuals is provided in ICRP Publication 81 (ICRP, 2000). The guidance contained in this report on age-weighted dose estimates could be applied in exposure situations in these prospective time frames.

The spatial distribution of radionuclides and the build-up of long-lived radionuclides from current discharges have to be taken into account when identifying the critical group. One example of this build-up is the accumulation in river or lake sediments of radionuclides from liquid releases. Such build up could result in the most exposed group being distant from the facility.

Uncertainties

Guidance and clarification will be provided in the Task Group report on estimating and using uncertainties. ICRP draws a distinction between quantities having a value that is measured or estimated and quantities that have values that are selected, either by the Commission or by other organizations. Dose constraints and dose coefficients within the System of Protection are, therefore, not uncertain. They are assumed to be point values. The Commission recognises uncertainties in the models linking detriment to dose and considers this uncertainty in establishing selected values of quantities such as constraints, levels for intervention, and other values that form the foundation of the System of Protection.

It is recognized that uncertainties are inherent in any process of defining individuals and in estimating their doses. Whether doses are estimated using measurement data, by applying mathematical models, or through a combination of measurements and calculations, the uncertainty for a given annual dose estimate may cover a distribution of possible values. Uncertainty in the dose estimation process is a result both of the random nature of some of the processes involved and a lack of knowledge about specific data that are needed for evaluating the process.

Uncertainties associated with estimation of dose, such as the source term or environmental transport, may be taken into either account through probabilistic analysis that incorporates distributions for parameter values or using a deterministic approach. Either methodology may be applied. If uncertainty analysis is employed, the goal should be to perform a realistic evaluation that gives an accurate assessment of the uncertainties and consequences.

In general, the Task Group believes that the inclusion of uncertainties in estimating doses to individuals is the responsibility of the operators and regulators although some guidance is needed to explain how these uncertainties might be estimated and used within the ICRP System of Protection.

For prospective assessments, in developing scenarios of exposure for comparison with a dose constraint, the characteristics associated with the scenario (e.g., lifestyle, diet, and physiological parameters such as breathing rate) also should be considered to be fixed values and not represented by

a distribution of possible values. The rationale is that for exposures that may occur in the future, the individual is represented by a scenario that is assumed to exist with a given set of distinguishing characteristics without uncertainty. Therefore, assumptions about the scenario and parameters describing it are assumed to be fixed.

When using a deterministic approach for estimating doses, care should be used to select parameter values that are reasonable and not extreme, taking account of homogeneity and sustainability criteria. The compounded use of extreme values in a deterministic calculation leads to results that grossly overestimate dose and is inconsistent with the concept of critical group.

When a probabilistic approach is used for estimating environmental transport of radionuclides and doses to individuals, the Commission recommends using at least the 67th percentile, but no more than the 95th percentile from the distribution, for comparison to the dose criteria. However, there may be local circumstances or considerations that regulators and facility managers wish to consider that would result in a more conservative choice on the distribution of dose to be made. One example of this is when working with stakeholders to decide on an acceptable level of cleanup for a site. Nevertheless, it should be recognised that in selecting characteristics for the critical group, resulting doses are already expected to represent the highest exposed members of the population, and using a dose value on the extreme end of the distribution for decision-making purposes could lead to undue restrictions.

Summary

In summary, I have pointed out some of the key issues being addressed by the Task Group. Hopefully these provide a basis for our discussions to follow. The Task Group plans to have a draft report to Committee 4 before its meeting in November 2003.

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EXCLUSION AND AUTHORISATION

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1. Introduction

"Everyone in the world is exposed to radiation from natural and artificial sources. Any realistic system of radiological protection must have a clearly defined scope if it is not to apply to the whole of mankind's activities". This quote, from ICRP Publication 60 (ICRP, 1991), remains apposite.

The main tool for defining scope is the concept of **exclusion**: situations, sources or exposures that are excluded from the system of radiological protection are, to all intents and purposes, ignored. Sources and exposures that are not excluded are within the scope of the system of protection and by inference within regulatory systems implementing ICRP recommendations. These sources and exposures should be subject to appropriate **authorisation** by the relevant regulatory authority. In order to avoid excessive regulatory procedures, however, provisions should be made for granting an **exemption** in cases where it is clear that regulatory provisions are unnecessary. Exemption is a regulatory tool intended to facilitate efficient use of regulatory resources. Nevertheless, the regulatory act of granting exemptions is, in itself, a form of authorisation and the material or situation so exempted remains within the regulatory system. This distinction between exclusion and exemption is an important one.

Historically, the concept of exclusion has been applied to sources or exposures that are essentially unamenable to control because of their widespread nature. The usually quoted examples are cosmic radiation at ground level and ^{40}K in the body. Clearly, many exposures from natural sources could fall into this category. The challenges are firstly to establish a sound basis for deciding which should be excluded and which should be controlled, and secondly to see if the concept could or should be applied to artificial sources and exposures. These two questions are the subject of this paper.

2. Natural sources

The overwhelming majority of the sources to which the average inhabitant of this planet is exposed are natural in origin. But which of these requires control and which can be excluded? Numerical criteria would clearly be useful in providing a consistent basis for excluding sources. Below these levels, termed exclusion levels, sources would be ignored for the purposes of radiological protection; they would not enter the radiological protection system nor the corresponding regulatory system. The Commission is proposing to establish constraints in terms of activity concentrations of natural radionuclides in materials that would represent upper bounds on the range of possible exclusion levels. These constraints would be established by the Commission from consideration of the

distribution of concentrations of natural radionuclides in natural materials (soil, rock, building materials, etc). A value towards the upper end of the range would be chosen which, it is anticipated, would result in a manageable number of situations requiring regulatory attention and which would not, in the Commission's opinion, imply an unacceptable exposure. National authorities would take account of conditions in their country in an optimisation exercise to establish national exclusion levels, which would necessarily be set at values at or below those of the Commission's constraints. Factors that would be taken into account in the optimisation process would include the range of activity concentrations in materials in the country concerned and the possibilities for control.

Possible values for the Commission's constraints could be of the order of 0.5 Bq g^{-1} to 1 Bq g^{-1} for ^{238}U and ^{232}Th chains to be applied to the head of chain or any of the daughter radionuclides if the chain is not in secular equilibrium (not including ^{222}Rn in air for which separate values would be proposed as at present). A value of around 5 Bq g^{-1} may be appropriate for ^{40}K.

3. Artificial sources

Can the concept of exclusion be applied to artificial sources? Certainly, some artificial radionuclides are ubiquitous in man's environment; ^{137}Cs from weapons fallout and Chernobyl fallout is one example. Levels are very low in many parts of the world but may reach levels that could cause concern in areas associated with the sources. Exclusion of these nuclides at some chosen level could cause problems in circumstances where there are contributions from fallout, which could be regarded as unamenable to control, and controlled discharges that could be expected to be within the radiological protection system. Furthermore, if "amenability to control" is going to be used as a criterion for exclusion or artificial radionuclides, how would this be applied to radionuclides that are not detectable in fallout? Such difficulties have led to the suggestion of using a dose criterion to establish exclusion levels for artificial radionuclides.

There have been recent attempts under the auspices of the International Atomic Energy Agency (IAEA) to use a dose criterion of 10 μSv y^{-1} as a basis for deriving exclusion levels for artificial radionuclides. The rationale is that in the case of sources giving rise to lower exposures, exclusion is the radiologically optimum solution; put simply, the hazards posed would not warrant regulatory attention. There are two problems with adopting this approach. Firstly, it would mean that there was not a common basis for establishing exclusion levels for natural radionuclides and for artificial radionuclides. Secondly, the dose criterion of 10 μSv y^{-1} was developed many years ago for exemption of radiation sources and there is the possibility of confusing two concepts, exclusion and exemption. Thus, no coherent basis has been established so far for exclusion of sources containing artificial radionuclides.

4. Conclusions

Exclusion means outside the system of protection. The commonly agreed basis for exclusion is "unamenability to control". Excluded sources, situations and exposures are ignored for the purposes of radiological protection. Sources, situations or exposures that are not excluded are within the system of protection; they should be subject to the appropriate regulatory authorisation. In providing recommendations on the scope of its system of protection, ICRP is essentially defining the scope of regulatory systems that are based upon its recommendations.

Sources that are within the system can be exempted from regulatory requirements if it can be shown that the hazard they pose is sufficiently small. Importantly, exempted sources remain within the system of protection. Exemption should be viewed as a form of authorisation.

The concept of exclusion can be directly applied to natural radionuclides. ICRP is proposing to set constraints in terms of activity concentrations of natural radionuclides. The constraints will be set on the basis that the vast majority of exposures from natural sources are not amenable to control and thus should be excluded. National authorities would set "exclusion levels" at levels of activity at or below the values of these constraints. Sources of activity concentration lower than these exclusion levels would be excluded from the system of protection.

The situation with artificial radionuclides is more problematic. A coherent basis for applying the concept of exclusion to these radionuclides has yet to be established, although attempts are being made at using a dose criterion of 10 $\mu Sv\ y^{-1}$ to derive exclusion levels for artificial radionuclides. Given that this is the same dose criterion that has been used for exemption of sources in the past, there appears to be two possibilities for relaxing radiological protection requirements in the case of artificial radionuclides.

(i) exclude below a defined activity level based on 10 $\mu Sv\ y^{-1}$

(ii) exempt below a defined activity level based on 10 $\mu Sv\ y^{-1}$

The levels would be the same in both cases but the regulatory implications are different. In the first case, sources of lower activity concentrations would be outside the system; in the second case, these sources would be within the system. This, it appears, is the choice.

The origin of artificial radionuclides is relevant to this choice. Artificial radionuclides in the environment result either directly or indirectly from deliberate human actions. At some stage either the process generating the nuclides or the nuclides themselves were under a control system implementing at least some radiological protection considerations. By default, this argues for the "exemption" option (ii above) because exclusion defines that which does not enter the system in the first place. The corollary is that exclusion applies only to natural radionuclides. All artificial radionuclides would, in principle, be within the system of protection and subject to regulatory requirements. Exemption from some or all regulatory requirements could be granted where regulatory controls are not warranted.

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SELECTION OF NEW CONSTRAINTS

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The selected new constraints should be consistent with the scale of concern *i.e*. be expressed roughly as fractions or multiples of the average annual background. They should take into account risk considerations and, as far as possible include the values of the current limits, constraints and other action levels. Finally, the rationale behind the establishment of the corresponding quantified values should be clear enough so that one should easily choose the relevant constraint to apply according to the situation of exposure.

The recommendation is to select four "leading values" for the new constraints: 500 mSv (single event or in a decade) as a maximum value, 0.01 mSv/year as a minimum value; and two intermediate values: 20 mSv/year and 0.3 mSv/year.

The quantified values of the current system are effectively included between the highest and the lowest leading constraints (see Table below) with the exception of one current value: the 100 mSv/year level for prolonged exposure situations where intervention is almost always justified. The recommendation is to abandon this level of action as it is inconsistent with the 500 mSv maximum value for the constraint (acute or in a decade).

The rationale for applying one value or another for the constraints would be the following:

- The upper value of 500 mSv either acute or in a single decade, is taken as the maximum value to be received by an individual, and should be considered when dealing with emergency phase after an accident. This value is coherent with the scale of concern (high level of concern). It is also coherent with previous ICRP publications giving values between 20 mSv/year and 500 mSv on a single event: 50 mSv for sheltering, 500 mSv for evacuation.
- The value of 20 mSv/year, from a single source is taken as a maximum to deal with any kind of sources. This dose constraint should be considered in situations where there is a direct benefit or compensation for individuals, and/or situations where there is an individual surveillance and/or situations where individuals benefit from information and training and/or situations where exposures are difficult to control. This value is coherent with the scale of concern (raised level of concern) and the need to avoid stochastic risk. It is also coherent with previous ICRP publications giving values between 10 and 20 mSv/year: Radon (10 mSv/y), Occupational exposure (20 mSv/y), relocation (1 Sv lifetime, 10 to 20 mSv/year).
- The value of 0.3 mSv/year, from a single source is taken as a maximum value to deal with controlled exposure from controllable sources introduced deliberately for public

exposure. This dose constraint should be considered in situations where there is neither direct benefit for individuals nor compensation, but a societal benefit and/or situations where there is a surveillance of the environment but no individual surveillance and/or situations where individuals receive information but no training. This value is coherent with the scale of concern : it represents a marginal increase of the natural background (1/10 of natural background), which can be considered as a low level of risk. It is also coherent with previous ICRP publications (1 mSv all sources, 0.3 mSv source related constraint for public, 0.1 mSv source-related for long-lived radionuclides,…).

The value of 0.01 mSv/year is indicating that any situation leading to this level of dose or lower is considered as being optimised. This value correspond to a very low level of risk, that should not call for actions from authorities

This new set of dose constraints, representing basic minimum standards of protection for the individuals taking into account the specificity of the exposure situations are thus coherent with the current values which can be found in ICRP Publications. A few warning need however to be noticed :

- There is no more multi-source limit set by ICRP.
- The coherence between the proposed value of dose constraint (20 mSv/year) and the current occupational dose limit of 20 mSv/year is valid only if the workers are exposed to one single source. When there is more than one source, it will be necessary to apportion.
- The value of 1000 mSv lifetime used for relocation can be expressed into annual dose, which gives approximately 10 mSv/year and is coherent with the proposed dose constraint.

The reasoning for applying the system should be as follow for a specific exposure situation: (1) estimation of what would be the level of individual exposure if no optimisation is applied; (2) selection of the appropriate dose constraint; (3) implementation of optimisation below the constraint (except if the estimation gives a dose equal or lower than 0.01 mSv/year).

ICRP

CURRENT VALUES

Source-related system

Situation 1 *Normal operation of a practice*	Situation 2 *Prolonged exposure*	Situation 3 *Biomedical research*	Situation 4 *Single events*
			(1000* Relocation)
			500* Evacuation warranted
	100 Intervention Always justified		
			50* Sheltering warranted
20 Limit for workers		20 Substantial level of societal benefit	
10 for Max constraint for Rn 222 workers	10 - Optional Intervention level - Max constraint for Rn 222 at home	10 Moderate societal benefit	10* Optimised value for foodstuffs
2 Surface abdomen Pregnant W			
1 - Foetal dose - Limit for public	1 Intervention exemption level	1 Intermediate societal benefit	
0.3 Max constraint for public			
0.1 Constraint for LL RN		0.1 Minor societal benefit	
0.01 Exemption			

« Four Leading » values

SESSION 2

The Protection of Non-human Species from Ionising Radiation – Where Are We Heading?

Chair: C. Rick Jones, CRPPH Chair

ICRP'S VIEW ON PROTECTION OF NON-HUMAN SPECIES FROM IONISING RADIATION

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Abstract

The International Commission on Radiological Protection (ICRP) is currently reviewing its existing recommendations for radiological protection. Up till now, it has not published any recommendations as to how assessment or management of radiation effects in non-human organisms should be carried out. The Commission set up a Task Group in the year 2000 to address this issue, and recently adopted the Task Group's report. The report addresses the role that ICRP could play in this important and developing area, building on the approach that has been developed for human protection.

ICRP will develop a small set of Reference Fauna and Flora, plus their relevant databases to serve as a basis for the more fundamental understanding and interpretation of the relationships between exposure and dose, and between dose and certain categories of effect. The concept of Reference Fauna and Flora is similar to that of Reference Man used for human radiological protection, in that it is intended to act as a basis for calculations and decision-making. The decision by the Commission to develop a framework for the assessment of radiation effects in non-human species has not been driven by any particular concern over environmental radiation hazards. It has rather been developed to fill a conceptual gap in radiological protection, and to clarify how ICRP can contribute to the attainment of society's goals of environmental protection by developing a protection policy based on scientific and ethical-philosophical principles.

Introduction

Environmental protection has made substantial progress since the preparation of Publication 60 of ICRP (1). The increasing public concern over environmental hazards has led to the emergence of a variety of national and international legal commitments for protection of the environment. These commitments demonstrate a generally held view that an explicit means of demonstrating protection of biota and ecosystems from harmful effects of ionising radiation is needed, and may often be legally required (2,3).

ICRP has not previously dealt explicitly with protection of the environment. Exposures of non-human organisms to radionuclides have been considered only in so far as they affect the protection of humans. Hence, there are no ICRP recommendations as to why or how explicit protection of the environment with respect to radiation should be carried out. The present position of ICRP is set out in Publication 60: "*The Commission believes that the standards of environmental*

control needed to protect man to the degree currently thought desirable will ensure that other species are not put at risk. Occasionally, individual members of non-human species might be harmed, but not to the extent of endangering whole species or creating imbalance between species. At the present time, the Commission concerns itself with mankind's environment only with regard to the transfer of radionuclides through the environment, since this directly affects the radiological protection of man" (1). In more explicit terms, this means that the current system of protection provides protection for humans, and that the application of the system may sometimes damage or kill individual members of non-human species. Although ecological information is incomplete, the full application of the system of protection is not thought to endanger whole species or to create imbalance between species. It also follows that the Commission has not dealt explicitly with radiological protection of the environment, although non-human organisms may well have been afforded an indirect measure of protection as a result of the controls on radionuclide concentrations in environmental media established as part of the radiological protection of humans. Although there are currently methods and approaches already available or being developed by individual countries (4-8), there have been no ICRP recommendations on appropriate assessment philosophies, methodologies or guidelines on how radiological protection of the environment should be carried out.

The human habitat has been afforded a certain level of protection through the application of ICRP's current system of protection. However, it is difficult to convincingly demonstrate that the environment has been or will be adequately protected in different circumstances, since there are no explicit sets of agreed assessment approach, criteria, standards or guidelines with international authority or endorsement. Different approaches have been used to address the many questions raised with respect to the application of ICRP's position on environmental protection, ranging from arguments that when man is protected, all other organisms are protected, to systematic frameworks to assess environmental impact of radiation in specific ecosystems. This could lead to different national approaches and makes harmonisation with other systems used for environmental protection difficult.

The ICRP Task Group on environment

In the year 2000, the Commission decided to set up a Task Group to advise it on the development of a policy for the protection of the environment, and to suggest a framework – based on scientific and ethical-philosophical principles – by which it could be achieved. This work was new ground for the Commission, because it had previously considered exposures of other organisms to ionising radiation only in so far as they related to the protection of human beings.

The Task Group consisted of five people from Canada, Norway, the Russian Federation, Sweden, U.K. and U.S.A. There were also 21 corresponding members from 12 countries, EU, UNSCEAR, IUR and Greenpeace. The Task Group's report addresses the role that the Commission could play in this developing area, building on its approach for the radiological protection of humans (9). The report does not address what steps or measures could be implemented at a national level, or how any particular industry or environmental circumstance should be managed or regulated. Instead, it examines and suggests what could be done by ICRP – given our present state of knowledge – to provide an underpinning set of concepts, and reference methodologies, models and data bases, that could serve to provide a common basis for developing more detailed approaches to addressing the many issues that do, and will, arise with regard to the assessment of radiation impact on non-human species.

A large number of animals, plants, and areas are already afforded legal protection from harm from all kinds of activities, including radiation, and many of these organisms are being protected at the individual level. Therefore, the question is not whether or not we should protect individuals or

populations from harmful effects of radiation, but how operators and regulators can comply with already existing environmental requirements. Radiation acts at the individual level, and effects at higher orders are mediated through individuals. Also, impacts on the individual may not necessarily result in population effects. It is therefore relevant to focus on the individual level when developing a framework for protection of non-human organisms.

In order to calculate dose, a set of reference values is required to describe the anatomical and physiological characteristics of an exposed individual. These reference values define a reference individual. Reference Man (10) is the primary reference for dose assessments in humans. It will not be possible to provide a general assessment of the radiation effects on the environment as a whole. The ICRP Task Group has concluded that a systematic approach for radiological assessment of non-human species is needed in order to provide the scientific basis to support the management of radiation effects in the environment (9). It recommends that the Commission develop a framework for radiological assessment of non-human species that is similar to the proposed approach for the protection of humans. The Task Group further recommends that ICRP develop a limited set of Reference Fauna and Flora, plus their relevant data bases – similar to that of Reference Man – to serve as a basis for the more fundamental understanding and interpretation of the relationships between exposure and dose, and between dose and certain categories of effect, for a few but clearly defined types of animals and plants. It has chosen the approach proposed by Pentreath (11,12), that uses a reference set of *dosimetric models* and a reference set of *environmental geometries*, applied to *Reference Fauna and Flora.* This approach will allow judgements about the probability and severity of radiation effects, as well as an assessment of the likely consequences for either individuals, the population, or for the local environment.

The Task Group recommends that the radiation-induced biological effects in non-human organisms be summarised into three broad categories: early mortality, reduced reproductive success, and scorable DNA damage. These categories comprise many different and overlapping effects and recognise the limitations of the current knowledge of such effects. The magnitude of doses relating to these effects could be set out in a banded fashion, "Derived Consideration Levels", in a manner similar to the "Levels of Concern" being considered for human beings. Such a set of information could then serve as a basis from which national bodies could develop, as necessary, more applied and specific numerical approaches to the assessment and management of risks to non-human species as national needs and situations arise.

The proposed system does not intend to set regulatory standards. It is a framework that can be a practical tool to provide high-level advice and guidance and help regulators and operators demonstrate compliance with existing legislation.

The Task Group received a large number of comments, made at various stages of its drafts, from informal contacts, presentations at meetings, etc. (13-14). It also received information by liaison/ membership of other working groups (IAEA, NEA, IUR, FASSET, etc.). Its draft report was subjected to international consultation via ICRP's website on the Internet. From this consultation, the Task Group received 25 comments mainly from national and international organisations (e.g., the Nuclear Energy Agency and the World Nuclear Association). The comments were, with a few exceptions, generally supportive.

ICRP'S future commitment regarding the environment

At its meeting in January 2003, the Commission adopted the Task Group's Report (15), and decided that a systematic approach for radiological assessment of non-human species is needed in

order to provide the scientific basis to support the management of radiation effects in the environment. This decision to develop a framework for the assessment of radiation effects in non-human species has not been driven by any particular concern over environmental radiation hazards. It has rather been developed to fill a conceptual gap in radiological protection and to clarify how the proposed framework can contribute to the attainment of society's goals of environmental protection by developing a protection policy based on scientific and ethical-philosophical principles.

ICRP's framework will be designed so that it is harmonised with its proposed approach for the protection of human beings. To achieve this, an agreed set of quantities and units, a set of reference dose models, reference dose-per-unit-intake data and reference organisms will be developed. As a first step, a limited number of Reference Fauna and Flora will be developed by ICRP, and others can then develop more area- and situation-specific approaches, as necessary, to assess and manage risks to non-human species. In contrast to ICRP's unique position in relation to human radiological protection, from which it has played a major role in influencing legal frameworks and objectives at international and national levels, the subject of protection of other species is a more complex and multi-faceted one, with many international and national environmental legislative frameworks and objectives already in place.

ICRP's small set of Reference Fauna and Flora and their relevant data bases will serve as a basis for the more fundamental understanding and interpretation of the relationships between exposure and dose, and between dose and certain categories of effect, for a few but clearly defined types of animals and plants (15). This concept is similar to that of the reference individual (Reference Man) used for human radiological protection, in that it is intended to act as a basis for calculations and decisions. Each reference organism could serve as a primary point of reference for assessing risks to organisms with similar life cycles and exposure characteristics. Other organisations could compile more locally relevant information for any other fauna and flora; but each such data set would then have to be related in some way to ICRP's Reference Fauna and Flora. The magnitude of doses relating to effects will be set out in a "banded" fashion, such as the proposed Derived Consideration Levels, in a manner similar to the Levels of Concern being proposed for humans. Such a set of information could then serve as a basis from which national bodies could develop, as necessary, more applied and specific numerical approaches to the assessment and management of risks to non-human species as national needs and situations arise.

It is necessary that a system for radiological protection of non-human organisms be harmonised with the principles for the radiological protection of humans. The Commission proposes that the objectives of the radiological protection of non-humans organisms are to safeguard the environment by preventing or reducing the frequency of effects likely to cause early mortality or reduced reproductive success in individual fauna and flora to a level where they would have a negligible impact on conservation of species, maintenance of biodiversity, or the health and status of natural habitats or communities (15).

A framework for radiological protection of the environment must be practical and simple. Ideally, a set of ambient activity concentration levels would be the simplest tool. There is thus a need for international standards of discharges into the environment. This could be a task for other international organisations, such as the International Atomic Energy Agency. In order to transparently demonstrate the derivation of ambient activity concentration levels or standards, the use of reference organisms will be helpful.

A considerable challenge for ICRP will clearly be that of integrating any approach to protection of the environment with that of the protection of human beings, bearing in mind that the latter is also the subject of a current, in-depth, review. It is therefore of relevance that a number of

different concepts have been developed recently with respect to radiological protection of the environment, both at national and international level. Much progress has been made in the last few years in the development of a variety of means for estimating exposures to a wide variety of animals and plants in different habitats. There has also been a high degree of co-operation amongst different researchers across many countries, encouraged by the IUR and financially supported in some cases by international bodies such as the EC. A number of national programmes have also been significantly developed, and at least in the USA a legal basis has been established for applying dose limit values in relation to certain nuclear sites. There is, therefore, already much being done but, although such programmes have many similarities, they also have the potential to diverge considerably and ultimately to be based on different principles, approaches, and scientific interpretation. Nevertheless, a common feature of many of these is, again, the concept of "reference" models and data sets.

ICRP can and is prepared to play the key role with respect to ionising radiation in the environment, both in advising on a common international approach, and in providing the basic interpretation of existing scientific information – and identifying where further research is necessary – in order for such a common approach to be delivered. In January 2003, the Commission decided to establish a new Task Group to continue the work with defining effects end-points of interest, the types of reference organisms to be used by ICRP, and defining a set of reference dose models for assessing and managing radiation exposure in non-human species. This new Task Group will consist of the following members:

Lars-Erik Holm (Chairman), Vice-Chairman of ICRP

Jan Pentreath, University of Reading, UK

Norman Gentner, UNSCEAR

Carl-Magnus Larsson, Swedish Radiation Protection Authority (co-ordinator of the FASSET programme), Sweden

Mary E Clark, Environmental Protection Agency, USA

The Commission's system of protection has evolved over time as new evidence has become available and as our understanding of underlying mechanisms has increased. Consequently the Commission's risk estimates have been revised regularly, and substantial revisions made at intervals of about 10-15 years. It is therefore likely that any system designed for the radiological protection of the environment would also take time to develop, and similarly be subject to revision as new information is obtained and experience gained in putting it into practice.

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A PERSPECTIVE ON THE ICRP APPROACH TO RADIATION PROTECTION OF THE ENVIRONMENT

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Abstract

The ICRP, in response to concerns by the environmental community, has begun the process of addressing radiation protection of non-human species. Concerns have been raised that the current framework for radiation protection fails to adequately protect the environment. Although most everyone agrees that some change to the ICRP radiation protection framework is called for, the extent of the revision is debatable. In May 2000, the ICRP set up a Task Group to provide advice on the development of a policy for the protection of the environment and to suggest a framework for environmental protection based on scientific, ethical, and philosophical principles. Based on Task Group input, ICRP intends to develop a framework for protection of the environment that can be integrated into an overall system of protection. This paper explores four major issues that serve to identify questions that ICRP should consider in its 2005 recommendations regarding radiation protection of the environment: (1) the role of ICRP, (2) defining the environment and criteria for protection, (3) the framework for environmental protection, and (4) risk management.

1. Introduction and Background

Concerns have been raised in the scientific community that the current framework for radiation protection fails to adequately protect the environment (Stone, 2002). Although most everyone agrees that some change to the ICRP radiation protection framework is called for, the extent of the revision is debatable. Proponents argue that the current anthropocentric system short-changes the environment. There is greater concern for the protection of the environment from chemical contaminants than from radioactivity. The effects of radioactivity on the environment are not fully understood, and without a conventional set of criteria, objectives, or biological end points, it is difficult to demonstrate whether the environment is adequately protected (Pentreath, 2002). Opponents argue that there is no evidence that the current system of protection has resulted in harm to the environment. Additional regulations will increase compliance costs and make the system of protection even more complex than it already is. There is also the concern that this exercise is nothing more than an attempt by scientists to resuscitate radioecology (Stone, 2002).

The current ICRP position on environmental protection is set out in paragraph 16 of Publication 60 (ICRP, 1991). ICRP's anthropocentric system is assumed to be protective of the environment although no specific supportive evidence is offered. ICRP recognises that in the course of

protecting mankind individual members of non-human species may be harmed but not to the extent that whole ecological communities would be seriously affected. The environment is of concern to the ICRP only to the extent that environmental transfer of radionuclides may adversely affect humans. Pentreath argues that the current system fails to appropriately apply the principles of *justification* and *optimisation* to members of the general public in an environmental context, and it also fails to address potential impacts on the environment *per se* (Pentreath, 2002). To address these problems, a system for radiological protection of the environment has been proposed (Pentreath, 1999).

In May 2000, the ICRP set up a Task Group to provide advice on the development of a policy for the protection of the environment and to suggest a framework for environmental protection based on scientific, ethical, and philosophical principles. Based on advice and recommendations from the Task Group, ICRP intends to develop a framework for protection of the environment that can be integrated into an overall system of protection. The Task Group report (ICRP, 2003) was adopted by the ICRP Main Commission on 27 January 2003. However, the report recommendations have not been specifically accepted by the Main Commission:

- develop a comprehensive approach to the study of the effects on, and protection of, all living matter with respect to the effects of ionising radiation;
- develop a system of radiological protection that includes protection of nonhuman species with a clear set of objectives and principles, and an agreed set of quantities and units applicable to all living things;
- interpret basic knowledge of radiation effects in species other than humans so that they can be used in an environmental context, for example, in setting criteria or benchmarks of protection at the appropriate level of hierarchy (individuals or populations)**;**
- develop a small set of primary reference fauna and flora, plus their relevant data bases so that others can develop more area and situation specific numerical approaches to assessment and management of risks to non-human species;
- show its commitment to protection of non-human species and lets this be reflected in the organisation of work and in the composition of experts;
- plan regular reviews and revisions of this new system as new knowledge develops.

The critical question before the Commission is whether the current anthropocentric system of protection is also adequate to protect the environment (Pentreath and Mossman, 2002). The ICRP Task Force has drafted a report that argues that ICRP needs to develop a comprehensive system of radiation protection for the environment supported by an extensive research data base of reference flora and fauna. ICRP should carefully consider the conclusions and recommendations of the Task Force report and decide to what extent the current system of radiological protection actually needs to be extended to protect biota. At a minimum, ICRP's year 2005 recommendations should explicitly include principles for radiation protection of the environment, and the conceptual foundations for any environmental recommendations that may be published in the future.

2. Issues

The following issues are presented in no particular order of importance but serve to identify questions that ICRP should consider in its year 2005 recommendations regarding radiation protection of the environment: (1) the role of ICRP, (2) defining the environment and criteria for protection, (3) the framework for environmental protection, and (4) risk management.

2.1 What should the role of ICRP be in environmental radiation protection?

ICRP should provide broad policy and guidance by way of formulating recommendations and advice. The goal of ICRP should be the establishment of a balanced, comprehensive, and coherent system of radiation protection that includes protection of the environment recognizing that specific environmental protection goals are established by national authorities. Development of a system of environmental radiological protection should be driven by the need to fill gaps in the current system of protection. In support of this effort, ICRP should recognise the substantial amount of work that is ongoing to monitor environmental impacts from nuclear technologies in a number of countries. For instance, in the U.S. just over 100 nuclear power plants supply 20% of the electricity to homes and businesses. Each of these plants routinely conducts environmental monitoring and reports results to the U.S. Nuclear Regulatory Commission. Monitoring results indicate that routine operations from nuclear technologies do not adversely affect the environment. The environment would appear to be already well protected under the current system of protection. However, a careful analysis of existing worldwide environmental data may be helpful in identifying gaps in the current system of protection and in identifying examples of situations in which adequate protection is lacking.

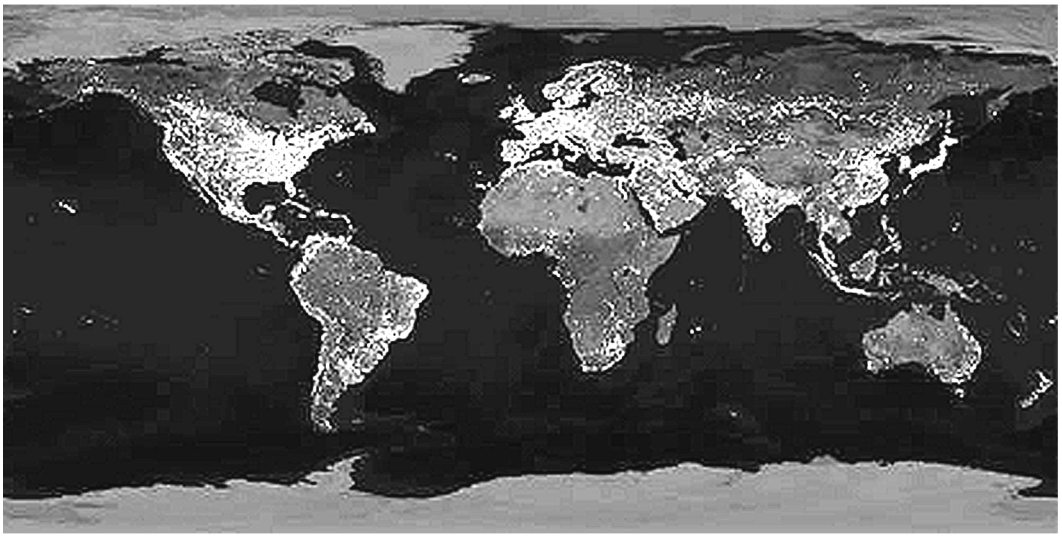
The Task Force proposes that ICRP take the responsibility for defining and developing sets of data for a small number of primary reference flora and fauna as a basis for establishing a framework for environmental radiation protection (in a manner analogous to the current reference man system for protection of the human population). The purpose and objective of the primary set would be to develop as complete a data base as possible of the basic biology and radiation effects on selected faunal and floral species. The Task Group's recommendation, with detailed specifics for its implementation, appears to have been conceived without sufficient analysis to justify its need. The proposed recommendation presumes that the case has been made that protecting man does not protect the environment. It is premature for the ICRP to proceed with a complex, comprehensive biota research and dosimetry development program based on the current level of justification provided in the Report (ICRP, 2003).

Furthermore, the ICRP should avoid establishing a position on research needs or promoting a particular research agenda in its recommendations on environmental radiation protection. Setting research agendas is the province of national regulatory and research organizations that would use such research in support of specific regulations and address specific environmental issues of national and regional interest. Individual countries may not wish to pursue a common research strategy or to use research data in the same way as a basis for national guidance or regulations. Although the ICRP Constitution provides for a research support function, the intent is support of research that addresses specific ICRP recommendations. ICRP has yet to develop specific recommendations or guidance on radiation protection of the environment. ICRP's role should be to provide recommendations and advice to governments based on its own analysis of published scientific data or on analyses provided by other scholarly organizations. ICRP neither conducts research in-house nor funds research at other institutions. This is not to say that ICRP should not address research issues. On the contrary, ICRP advice and recommendations on research needs should be seriously considered by governments in establishing research priorities and research programs.

2.2 How should "environment" be defined? What criteria should be used to establish protection?

Clearly, the scope and nature of protection depends on how "environment" is defined. The human habitat has been afforded a good level of protection through the ICRP's system of protection (ICRP, 2003). However, other environments not occupied by humans may nevertheless be impacted by human activities. Humans may not be directly affected by these environmental impacts but flora and fauna that normally occupy these environments may be. The ICRP Task Force argues that there are clearly circumstances where the Commission's current view is insufficient to protect the environment, or even incorrect (ICRP, 2003). However, there is no evidence to suggest that non-human environments are adversely affected at this time. This should not be interpreted to mean that environmental impacts have or will not occur; evidence is lacking to support the view that the current ICRP system of protection is inadequate. The widespread environmental contamination resulting from the Chernobyl accident in 1986 serves as an example of potential environmental consequences of uncontrolled releases of radioactivity. Figure 1 illustrates how little of the earth's surface is inhabited by humans. Nevertheless human activities can result in environmental effects much broader than the human habitat.

Figure 1. **Global city lights**



The Eastern U.S., Europe, and Japan are brightly lit by their cities, while the interiors of Africa, Asia, Australia, and South America remain (for now) dark and lightly populated. Urban areas (where >50% of people live) account for 2-4% of the land surface which is a smaller percentage of the total earth surface. (Image from NASA Goddard Space Flight Center based on data from the Defense Meteorological Satellite Program.)

Until specific environmental impacts from radiological hazards can be identified, it is unclear what actually needs to be protected, and which environmental exposure scenarios need particular attention. Beyond that, decisions need to be made regarding the focus of protection-individual organisms, populations and communities, or whole ecosystems. In contrast to radiation protection of humans where the goals of protection are quite clear, it is difficult at this time to clearly state what the goals and objectives of a system of environmental protection might be. A strategy based on protection of whole populations or communities of flora and fauna would appear to be appropriate

for the environment. Nevertheless, without clearly articulated goals and objectives, an effective system of environmental protection cannot be implemented.

A central question in the environmental protection debate is what criteria should be used to measure protection? There is little agreement as to how protection can be defined, nor is there any consistent view as to the appropriate assessment endpoints for determining if the environment is "adequately protected" (ICRP, 2003). An array of ecological end points can be used, including DNA damage, morbidity, mortality, and reproductive success, but it is unclear what the relevance of specific end points may be in defined exposure situations. For instance, under what circumstances might scorable cytogenetic damage have relevance as an indicator of adverse environmental impact? Population morbidity and mortality would appear to be the most appropriate determinants of environmental detriment because they can be readily quantified and are direct measures of detriment. The ICRP needs to decide what criteria should be used to evaluate protection and the extent to which the environment is currently not protected. The choices are particularly important for risk assessment and risk management purposes.

2.3 What should the framework for environmental protection look like?

The ICRP is reviewing its system of radiation protection and developing new recommendations that will replace the 1990 recommendations (Clarke, 1999; ICRP, 2001). The ICRP Main Commission is now considering what it views as a simpler approach to radiation protection based on an individual oriented philosophy. The principal change involves emphasis on the dose to an individual from a controllable source. This represents a shift from the utilitarian philosophy emphasising societal-oriented criteria that are the basis of the current framework. However, it is unclear that diverting completely from a utilitarian perspective simplifies radiation protection. The proposed radiation protection framework is still unnecessarily complicated. The dosimetric and protective quantities introduced in the 1990 Recommendations (ICRP, 1991) are slated for retention but the next recommendations will clarify differences in quantities. The ICRP admits that the current set of radiation and tissue weighting factors is more complex than can be justified and the next set of recommendations will attempt to simplify the weighting factors (ICRP, 2001). The proposed system also introduces a complex generalised structure of individual doses linked to protective actions. The various protective actions are linked to levels of concern (called "Bands") that are defined in terms of multiples and sub-multiples of the natural background radiation dose (ICRP, 2001).

Developing a system of protection for the environment introduces an additional layer of complexity. Ideally a common approach to radiation protection should be developed. It is necessary that a system for radiological protection of non-human organisms is harmonised with the principles for the radiological protection of humans. The objectives of a common approach to the radiological protection of humans and other living organisms, as suggested elsewhere (Pentreath, 2002), might be to safeguard human health by preventing the occurrence of deterministic effects and by limiting stochastic effects in individuals and minimising them in populations; and to safeguard the environment by preventing or reducing the frequency of effects in faunal or floral populations to a level where they would have a negligible impact on conservation of species, maintenance of biodiversity, or the health and status of natural habitats or communities.

The ICRP Task Force recommends a "nominal approach" for the protection of non-human species by establishing a system of reference flora and fauna similar to the "Reference Man" concept that is the basis for developing regulations and standards for human radiation. Clearly, much is yet to be learned about radiation effects on biota. A reference biota framework should facilitate the development of a research agenda that approaches the problem in an organized and effective way. The

research will be long-term and expensive. It is, however, unclear at this time what impact the research may have in providing guidance and advice for protection of the environment.

Table 1 illustrates a common structure for a system of protection for humans and the environment derived by combining proposed systems of protection from ICRP (2001) and Pentreath (2002). Six bands of concern are provided. Bands are expressed as multiples or submultiples of natural background radiation levels. Levels of concern are expressed only in a qualitative sense. Specific public health or environmental actions would be based on more definitive information regarding nature of exposure and dose (including near-and long-term projections). Although significant differences exist in approaches to public health and environmental protection, there are important common elements that can be used to establish a comprehensive and coherent system of protection.

Table 1. **A system of protection for humans and the environment**

Dose level[1]	**Protection of humans**	**Protection of the environment**[2]
>100 x Normal	LIKELY EFFECTS: deterministic effects, mortality possible at high doses; significant risk of cancer CONCERN: serious	LIKELY EFFECTS: early mortality at high doses; reduced reproductive success CONCERN: possible remedial action at high doses; concerns dependent on flora, fauna affected
> 10 x Normal	LIKELY EFFECTS: theoretical to low risk of cancer CONCERN: high	LIKELY EFFECTS: scorable cytogenetic effects CONCERN: concern dependent on size and nature of area affected
Normal	LIKELY EFFECTS: theoretical risk of cancer CONCERN: normal	LIKELY EFFECTS: none CONCERN: some action considered
> 0.1 x Normal	LIKELY EFFECTS: insignificant CONCERN: low	LIKELY EFFECTS: low CONCERN: slight concern
>0.01 x Normal	LIKELY EFFECTS: insignificant CONCERN: trivial	LIKELY EFFECTS: trivial CONCERN: possibly of little concern
<0.01 x Normal	LIKELY EFFECTS: insignificant CONCERN: negligible	LIKELY EFFECTS: trivial CONCERN: possibly of little concern

1. Dose level refers to incremental annual doses as multiples or submultiples of natural background. Normal is typical background of 1-10 mSv/y.
2. Reference terrestrial mammal.
   Sources: ICRP (2001); Pentreath (2002).

The system of "Derived Consideration Levels" is attractive since it offers a framework for combining protection of humans and the environment. The use of dose levels based on multiples and submultiples of natural background would seem to address a troublesome issue in radiation protection – how to avoid the problem of quantifying radiogenic risk at small doses based on scientifically questionable predictive theories (e.g., linear no-threshold theory). However, the concept requires further maturation before it can be implemented effectively. ICRP needs to clarify the relationship between the levels of concern and detriment to individuals, populations and communities,

and ecosystems. Further, levels of concern need to be better coordinated in the human and environmental systems (Table 1). The ICRP's primary goal, however, is providing guidance on the interpretation and use of "Bands of Concern" and how this concept can be used in policy decision making.

The Task Force has recommended that quantities and units applicable to protection of the environment be established. The advisability of this recommendation is questionable. The current system of quantities and units used in radiation protection is already too complex and cumbersome. There are numerous dose-related quantities (categorised as either dosimetric or protection quantities) in use in radiation protection. Debate continues about the stability of radiation protection quantities and units and the appropriateness of protection quantities like equivalent dose. Recent name changes in quantities have generated confusion within the scientific and technical community and the general public. The ICRP's change from effective dose equivalent to effective dose and the shift from dose equivalent to equivalent dose have created chaos in the nomenclature. Further, the same units are used for multiple quantities. The sievert is a unit common to both equivalent dose and effective dose. Unless the specific quantity is identified, use of sievert is problematic. The failure of the U.S. to adopt the modern metric system only adds to the confusion. The ICRP may be well advised to abandon sievert-based quantities and use absorbed dose as the basic dose quantity in radiation protection (Mossman, 2003).

ICRP should structure a practical system of radiation protection in the simplest way possible and base it on sound scientific assumptions in order to apply it effectively and efficiently. Serious consideration should be given to simplifying quantities used in radiation protection. The proposed use of submultiples and multiples of the natural background as a basis for protective actions is a sound basis for developing a system of dose limits based on natural background radiation levels.

2.4 Risk management

The Task Force report (ICRP, 2003) provides very little discussion of risk management related to protection of the environment. Optimisation (the ALARA principle) is a pillar of the ICRP framework of protection of humans and should also be the basis for risk management in radiation protection of biota.

An important consideration in the establishment of a comprehensive framework of protection is the appropriate balancing of competing risks to humans and non-human species with the economic and social costs of regulatory compliance. Many risk management approaches including ALARA, best available technology, and the precautionary principle have been implemented in radiation protection either implicitly or explicitly. The optimization (ALARA) principle balances the goal of reducing radiation doses to as low a level as possible against social and economic constraints.

Implementation of a precautionary approach to risk management can be problematic. Over the past decade, the precautionary principle has been incorporated into an ever-increasing number of international agreements and domestic statutes. Essentially the precautionary principle states that when an activity or technology may harm human health or the environment, precautionary measures should be taken even if some cause and effect relationships are not fully established scientifically. Notwithstanding the proliferation of the precautionary principle, it remains vague and ill-defined. While there have been some attempts to better define and "operationalise" the precautionary principle, most notably by the European Commission, substantial ambiguity remains about the applicability and requirements of the precautionary principle (Mossman and Marchant, 2002). A key conclusion of a consensus conference on radiation protection of the environment held in Oslo in 2001 was that

precautionary measures to reduce the potential risks to the environment should be applied within reasonable cost constraints (IUR, 2001).

No version of the precautionary principle is clear on when the precautionary principle applies, and just as importantly when does the principle not apply. For example, is the principle triggered by the magnitude of a risk, the uncertainty associated with that risk, or some combination of both magnitude and uncertainty? How much of each is necessary to trigger the principle? If the principle applies only to "serious" or "irreversible" risks, how are such risks defined? If the principle is not so limited to serious or irreversible risks, how can the principle be applied in a principled and feasible manner, given that every product presents some risks in some scenarios (Mossman and Marchant, 2002).

The precautionary principle is implicit in existing radiation safety practice but is not explicitly required. An "as low as reasonably achievable"(ALARA) philosophy is used to minimise radiation dose in occupational and environmental settings with appropriate considerations for social and economic costs. When used appropriately, the ALARA philosophy balances the goal of maintaining doses as low as possible against economic and other costs of achieving specific dose targets. Moreover, any residual risks remaining after a prudent application of ALARA would likely be in the acceptable risk range (Mossman and Marchant, 2002).

Is a more stringent approach to radiation protection premised on the precautionary principle necessary and appropriate? Ionising radiation does not meet the criteria identified by the EC Communication for recourse to the precautionary principle. In the first place, the existing scientific database for radiation is neither inadequate nor imprecise, requirements identified by the EC for triggering application of the precautionary principle. To the contrary, ionising radiation is one of the most thoroughly studied environmental agents. Perhaps even more critical to the issue of whether the precautionary principle should apply to ionizing radiation is the question of acceptable risk. The EC Communication states that the precautionary principle should only be triggered by activities with the potential to impose unacceptable risks (Mossman and Marchant, 2002).

These arguments suggest that application of the precautionary principle is neither necessary nor appropriate for radiation protection given existing protections and policies in place. Even if the precautionary principle were applicable to ionizing radiation, many of the actions based explicitly or implicitly on the precautionary principle are inconsistent with the policies in the EC Communication governing application of the principle. For example, the principles of proportionality and cost-benefit evaluation argue against regulatory action for very low radiation exposures. This guidance appears inconsistent with some extreme and inappropriate applications of ALARA (premised on the precautionary principle) in which doses are reduced to the lowest levels possible (if not zero) with little, if any, benefit-cost considerations (Mossman and Marchant, 2002).

3. Discussion

The conceptual development of a system of radiation protection for the environment is at a very preliminary stage. Accordingly, it would be premature for the ICRP to offer specific recommendations regarding environmental protection for inclusion in the planned year 2005 recommendations that will replace the 1990 recommendations. However, at this time ICRP should consider laying the philosophical and conceptual foundations for a system of protection that is inclusive of the environment. Some issues that should be considered are as follows:

1. the need to carefully define the role of ICRP in developing a system of protection of the environment given that goals for environmental protection are nation-specific;
2. the need to establish a framework for protection of the environment that is congruent with general concepts of environmental protection and general concepts of radiological protection;
3. the need for a comprehensive framework in radiation protection that includes protection of the environment;
4. the need for a framework that is as simple as possible – for instance, avoid a separate set of quantities and units for environmental protection;
5. the need to develop common risk management approaches (including appropriate consideration of economic and other societal constraints) for protection of humans and the environment.

The goal of establishing a comprehensive framework of protection and the goal of maintaining framework simplicity may be at cross-purposes. Part of the effort in justifying a more comprehensive approach to the protection of all living things will be establishment of criteria that are specific for certain species and certain biological end points. A detriment (e.g., cancer mortality) that is an important benchmark for protection of humans may not be relevant for the protection of other species. Developing an array of criteria and standards increases framework complexity.

The principal role of the ICRP, therefore, is to re-examine the existing system of protection and determine to what extent changes are needed to address environmental protection issues. If there is evidence of environmental impacts, a considerable challenge for the ICRP will be integrating a framework of protection of the environment with the existing framework for protection of human beings such that framework complementarity and coherence are maximized and social and economic costs associated with risk assessment and risk management are optimised.

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IMPLICATIONS OF NEW POLICIES ON PROTECTION OF THE ENVIRONMENT FOR THE IAEA SAFETY STANDARDS

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1. Introduction

Many of the IAEA's safety standards are concerned with the control of nuclear activities that can affect the environment and therefore any significant change in international policies that could influence the levels of radionuclides allowed in the environment or the ways in which controls are exercised is likely to necessitate the revision of the standards. The current developments towards establishing an explicit framework for the protection of the environment from the effects of ionizing radiation may be expected to bring about changes that will require such revision (1-3).

In this paper, some of the safety standards that will be affected by the advent of a new environmental protection framework are examined and the implications for the control strategies contained in the Standards are explored. By this means it is possible to comment on the form that the protection framework might take so that it can be most effectively applied to real environmental control issues.

2. IAEA Safety Standards and the environment

2.1 The Safety Standards

The IAEA is authorized in its statute to establish safety standards and it has done so since its creation in 1957. The safety standards are established with the help of national experts in the relevant fields and then approved by a process which involves review by committees of nationally appointed senior experts drawn mainly from regulatory bodies, by the appropriate national authorities and finally, for the upper categories of safety standards, by the IAEA's Board of Governors. By means of this process the requirements and guidance contained in the safety standards reflect international consensus at a high level between the governments of IAEA Member States.

2.2 Safety standards with environmental elements

Some of the important safety standards that relate to the control of radionuclides in the environment are listed below:

Control of discharges of radioactive substances to the environment

International Basic Safety Standards for Protection against Ionizing Radiation and for the Safety of Radiation Sources [Safety Series 115 (1996)].

Regulatory Control of Radioactive Discharges to the Environment [Safety Standards Series, WS-G-2.3 (2000)].

Remediation of land areas affected by radioactive contamination

Remediation of Areas Contaminated by Past Activities and Accidents, Safety Standards Series, WS-R-3 (2003).

Release of Sites and Buildings from Regulatory Control upon the Termination of Practices, Draft Safety Standards Series (DS-332).

Potential release of radionuclides into the environment in the far future.

Near Surface Disposal of Radioactive Waste, Safety Standards Series, WS-R-1 (1999).

Geological Disposal of Radioactive Waste, Draft safety Standards Series (DS-154).

All of these safety standards contain criteria for the control of radionuclides in the environment based on limiting radiation exposure to humans. The criteria are expressed in terms of radiation doses to critical groups of individuals in the exposed population. In some cases guidance is given on methods for deriving limiting concentrations of radionuclides in environmental materials, but the setting of limits in terms of environmental concentrations is usually left to national authorities.

The evolution of new and explicit criteria for protection of the environment is likely to necessitate the modification of the radiological criteria in all of these documents to accommodate consideration of species other than humans.

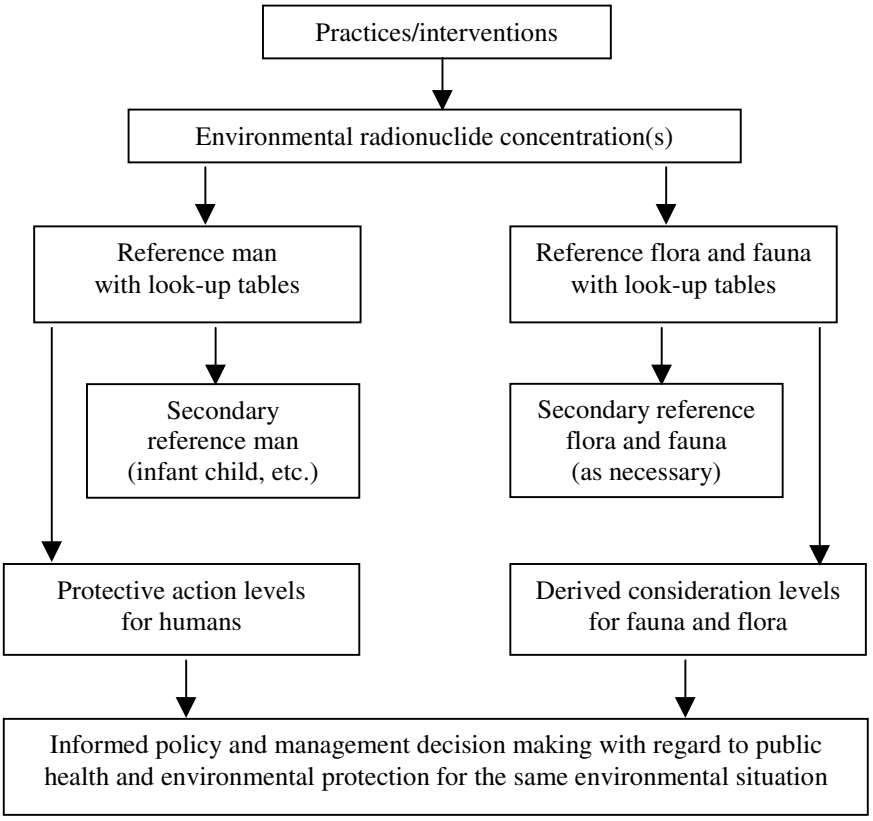
By giving some consideration to the practical implications of introducing new criteria into these documents it is possible to indicate the most suitable form that they should take.

3. Possible form of the criteria

It seems likely that, because of the different considerations in protecting non-human species as compared with those for human species, separate protection structures will emerge as indicated in Figure 1.

In each structure, there will be basic dose criteria and reference organisms (humans vs. flora and fauna) against which measured or calculated values for each environmental situation being assessed will have to be compared. This implies significant additional elements in the assessment as compared with the current situation in which only doses to humans have to be assessed.

Figure 1. **Protection structures for humans and other organisms**



If, however, the basic parameter used for determining compliance is a *reference environmental concentration* materials, such as, soil, vegetation and water, instead of radiation dose, the need for separate comparisons of dose for each assessment situation can be avoided. The *reference environmental concentration* would be determined by considering doses both to humans and to flora and fauna.

The advantages of a reference *environmental concentration approach* can be summarised as follows. Such an approach:

(i) allows human and environmental protection criteria to be expressed within a single entity;

(ii) provides for ease of demonstration of compliance by measurement;

(iii) provides for improved comparability with other pollutants (similarity to *environmental quality criteria)*;

(iv) facilitates understanding by non-experts.

Of course, in order to determine the *reference environmental concentrations,* their relationship to radiation doses to reference humans/flora and fauna will have to be determined. In many countries this is already done in relation to human exposures; the quantities, often termed "derived environmental limits", are regarded as secondary standards. However, with the current proposal the *reference environmental concentrations* would be the **primary indicators of safety.**

4. Application of reference environmental concentrations

Discharge control

The discharge level would be set so that the *reference environmental concentrations* are not exceeded. Compliance would have to be shown in advance of the discharge event by modelling methods and after or during the discharge by measurement of radionuclide concentrations in relevant environmental media. Optimisation of radiation protection at individual sites may require that the actual environmental concentrations due to the discharge practice are well below the *reference environmental concentration*.

Design of radioactive waste repositories

Compliance with the *reference environmental concentrations* would be shown by means of the predictive modelling of the release of radionuclides to the biosphere in the far future.

Release of sites on the termination of practices

Sites could be released from regulatory control when measurement shows that the residual environmental concentrations are below the *reference environmental concentrations*. However, at a given site, the optimisation of radiation protection considerations may indicate that more restrictive targets are set for site release.

Generic or site specific reference environmental concentrations

Generic international *reference environmental concentrations* could be established based on agreed sets of models, parameters and data sets. They would have the advantage of being universally applicable and could add to the public's confidence in relation to radioactive materials in the environment. However, they would necessarily be conservatively derived in order to take account of the wide variety of environmental situations that could occur.

In addition, site or country specific values could be more realistically derived but would require a specific derivation by local operators and regulators.

Situations with existing environmental contamination from past events or accidents

In these unplanned situations it would not normally be appropriate to apply the *reference environmental concentrations*, since they will be derived based on radiological considerations relevant to controlled situations.

The guidance on reference levels for application to intervention situations developed by ICRP (4) apply to human exposures only and it is not obvious how, or if, analogous reference levels can be determined for application to the protection of non-human species. Even if such values were to be derived and associated environmental concentrations could be calculated, it would be difficult to explain to the public the difference between these and the *reference environmental concentrations*.

Instead, it is proposed that a case-by-case approach should be taken to forming judgements in these situations. Factors to be taken into account in making judgements on the need or otherwise for remediation include:

- a determination of whether humans are likely to be present;
- international guidance on intervention criteria for humans;
- the nature of flora and fauna in the affected area;
- the perceived value and prevalence of the affected species;
- the potential for harm to species and ecosystems from radiation and also from the potential remediation options;
- the cost of remediation.

5. International roles

The international organisations have co-ordinated their work well so far in this area and this is expected to continue.

The United Nations Committee on the Effects of Atomic Radiations (UNSCEAR) is expected to continue its work on examining the effects of ionising radiations on humans and non-human species. Other international activities in this area are being sponsored by the European Commission (EC) and by the International Union of Radioecologists (IUR). It is clear now that the ICRP has decided to go forward and to develop the over-arching policy and guidance on protection of the environment. It may be expected that the NEA will continue to play a role in organising for the peer review of the new proposals. The IAEA will focus its attention on examining how to apply the new protection policy for the regulation of real environmental situations and to provide guidance for the use of regulators. At the appropriate time, the IAEA and EC will use their mechanisms to obtain the formal views of national governments on the proposals as part of the process of establishing agreed international standards for protection of the environment.

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PROSPECTS FOR THE DEVELOPMENT OF AN ENVIRONMENTAL ACTION PROGRAMME UNDER THE EURATOM TREATY

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1. Introduction

I was very pleased with the invitation to present at this Conference our experience with a Stakeholder Conference in Luxembourg in December 2002. The title of my presentation is the same as the one I presented on that occasion, on behalf of the Commission, in view of confronting it with stakeholders' views.

At our Conference we discussed not only the Commission's view on an Environmental Action Programme (EAP), but Roger Clarke also presented the evolution of the International Radiation Protection System (IRPS), on which the Commission paper itself also reflected. I will present briefly the Commission's views on the new International Radiation Protection System and how these relate to the planned Environmental Action Programme, the main findings of the Conference and the perspectives for further development of the Environmental Action Programme.

2. The International Radiation Protection System

The Commission's views at the Conference did not so much relate to the latest drafts of the new system, but rather to the question of whether there was at all a need for a change in the system and, if so, for whom (who is the stakeholder?), when and how.

The Commission welcomed the debate on the International Radiation Protection System because it permitted clarification of a number of issues that are generally regarded as not being well addressed in ICRP-60. The distinction between practices and intervention is not always clear, and the principles of intervention, while perfectly rational, do not seem to match societal reality. Natural sources are adequately dealt with in the EU Basic Safety Standards, but in a way that was neither foreseen in ICRP-60 nor in the Inter-Agency Basic Safety Standards. There has been misuse of the concepts of justification and of collective dose.

The Commission also welcomed the initiative to look into the ethical basis of the system, in particular with regard to the protection of the natural environment, but wondered whether ICRP's views on society are representative.

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1. This paper reflects the author's personal viewpoint and should not be regarded as an official document of the European Commission.

It is not clear for whom ICRP has undertaken a review of the system. Much effort has been put into this debate and, while experts often felt lost, one could wonder whether the pursued simplification would yield better public acceptance. From a regulatory perspective, we have spent the past decade discussing the concepts of exemption and exclusion, for which the new system, at the end of last year, still had not given a satisfactory framework.

With regard to timing, the Commission wondered whether it was the right time for a change, given that fundamental research on radiation effects, which is vigorously pursued in the Commission's 6th Framework Programme, may shed new light on our understanding of radiation detriment in a few years. Also, the Commission was inclined to give priority to the implementation of the Basic Safety Standards and in particular to the new areas of application, natural radiation sources and clearance.

Such priority was emphasised by an examination of the role of the EU and the Commission in terms of subsidiarity and proportionality of its programme of work, in particular in the light of the forthcoming enlargement. It seemed that the new system would not have major implications for the Basic Safety Standards, but we wondered how the new dose constraints (at that time still labelled "protective action levels") would be incorporated. The only major change was the introduction of a system of protection of non-human species. The European Commission was a strong supporter of this development, in particular through the FASSET and EPIC research projects. There were indeed strong driving forces for us to allow for the protection of the natural environment. Being part of the Directorate-General Environment (DG ENV), we were very much exposed to the main environmental principles, in particular the Precautionary Principle and Sustainable Development. I must admit that I still have reservations, not about the Precautionary Principle itself, but about interpretations focusing on uncertainties rather than on whether these imply a possible serious **and** irreversible detriment.

I believe the ICRP Task Group on the protection of the natural environment has done excellent work. Nevertheless, it may not really respond to those aspects of environmental policy which are driven by concerns for preservation of an undisturbed environment, as is reflected for instance in OSPAR's objective to achieve concentrations "close to zero". The Commission is contracting party to the OSPAR Convention, and together with EC environmental legislation this implies a commitment to the protection of the environment.

OSPAR is a political forum, stakeholders are Member States, NGOs, industry. The OSPAR strategy on radioactive substances is a good example of the fact that scientific rationality does not answer all public concerns, nor political concerns which are basically the same.

This encouraged us to follow the path of stakeholder involvement ourselves. We felt it was important to start from scratch, to abandon all paradigms, not just the one that "the environment is protected if man is", and to write our Environmental Action Programme without looking too much for guidance from the international system and listening instead to the various stakeholders:

- industry;
- workers;
- environmental organisations;
- consumer organisations;
- health profession.

3. Environmental Action Programme

The main incentive for writing an Environmental Action Programme under the Euratom Treaty was that radiation protection is not included in the 6th Environmental Action Programme, which was adopted last year in a co-decision procedure by the European Parliament and the Council. This procedure is not foreseen under the Euratom Treaty and hence the 6th Environmental Action Programme could not cover our activities. The Environmental Action Programme being the "bread and butter" of all work in DG ENV, our activities suffered from being excluded.

By and large we felt that the 6th Environmental Action Programme could very well be transposed to radiation protection. The key priorities are:

- climate change;
- nature and bio-diversity;
- environment and health and quality of life;
- natural resources and wastes.

Among these, climate change does not apply: we do not want to be involved in the debate on nuclear versus fossil in reaching Kyoto targets. Nature and bio-diversity relate to our ambition to protect the natural environment. This could, in fact, proceed under the EC Treaty but then putting at risk the coherence with radiation protection of man under the Euratom Treaty. We were part of the Environment and Health Directorate and it was ironic that environmental policy was then giving priority to the health dimension, which we had been doing for over 40 years. Natural resources are not so much an issue, but radioactive waste management is of course one of the main problems of the nuclear industry.

Among the means identified in the 6th Environmental Action Programme:

- raising awareness;
- dialogue with stakeholders;
- analysis of benefits and cost (internalise environmental costs);
- improving scientific knowledge;
- data and information (on the state and trends of the environment);

you will note the importance given to the dialogue with stakeholders. We should have no problems with any of the instruments, with the possible exception of the collection of data on the state and trends of the environment. The hidden message is that there should be a strategy towards substantial improvement of the quality of the environment in a relatively short time span. We need to develop Environmental Quality Criteria also in the framework of OSPAR, but it is still not clear how to do so. Environmental criteria, e.g., concentrations, have never been the starting point of radiation protection.

Also with regard to strategies:

- voluntary agreements with enterprises;
- environmental quality criteria;

- definition of health and environment indicators;
- vulnerable groups (children);
- waste prevention initiatives;

it is not clear on which basis we should define suitable indicators to monitor the trends in the environment. By health standards alone we would tend to conclude that there is no need to further improve the environment. The paradigm of environmental policy is, however, that a status quo is not quite acceptable. It is also not well understood that resources are needed to preserve a good status, where it has already been achieved.

4. Stakeholders' conference

The work towards an Environmental Action Programme started with the Stakeholders' Conference in December 2002. It was the continuation of a series of "standing conferences" (1987, 1989, 1996), called "Health and Safety in the Nuclear Age", started after Chernobyl. We chose to limit the scope of this conference to the environmental aspects, postponing a discussion on occupational and medical exposures. One of the problems of stakeholder involvement is that NGOs are essentially focusing on nuclear energy, a campaign that indeed gave rise to many of the green movements. So we made it very clear from the start that we could not allow a discussion on nuclear energy as such.

The Stakeholders' Conference was prepared by a Programme Committee, under the Chairmanship of K. Collins, former Chairman of the Environment Committee of the European Parliament. The Programme Committee selected keynote speakers to cover the state of the art on current radiation protection approaches, with a focus on new developments, and to give expert views on aspects that were believed to be an issue for stakeholders. A number of case studies were also presented, in particular the Nord Cotentin study and the MARINA Study, which was formally handed over to OSPAR at the Conference. The presentations took up a lot of time but still left enough room for discussion. They were organised in different sessions as follows:

Session 1:	Radiation and Environmental Policies	(Paloma Sendin)
Session 2:	Radioactivity in Different Foods	(Gerald Kirchner)
Session 3:	Assessment of Population Exposure	(Annie Sugier)
Session 4:	Protection of the Natural Environment	(George Hunter)
Session 5:	Risks	(Ian McAulay)

The session Chairmen then summarised the main points of the presentations, as well as the input from stakeholders, which was again debated.

You can read the full proceedings, with the sheets that were drafted by the Chairmen, on our website (http://europa.eu.int/comm/environment/radprot/). I will highlight only a few, skipping the first session, in which ICRP and EC views were presented and which has already been discussed earlier.

The session on food, both marine and terrestrial, confronted the stakeholders with facts that were expected to raise discussions, such as the predominance of NORM discharges to the North East Atlantic, especially from the oil industry, and the fact that current discharges from reprocessing plants,

while still being the major source of artificial radionuclides, do not add very much to the effect of historical discharges.

We also had interesting presentations on consumer attitudes, drawing lessons not only from Chernobyl but also from other accidental food contamination. The meaning of "risk" in "risk perception" is very different from the concept of risk dealt with in radiation protection.

The stakeholders held the view that consumers would rather trust NGOs or consumer organisations than scientific opinions: one cannot tell them that it is reasonable to take a small risk when eating contaminated food, they make their own choices and want "clean" food. This explains why intervention levels in the order of 1 000 Bq/kg are perceived to be high, and why some conclude that our approach must be wrong, since it does not rule out high ^{99}Tc concentrations in seafood.

With regard to the assessment of population exposure, we had just adopted guidance on "realistic assessment", known under the acronym RAIN, and this was presented. Interesting points were made with regard to variability and uncertainty analysis, to a large extent on the basis of the Nord Cotentin study, and on communication of uncertainties.

Some of the stakeholders argued that the uncertainty analysis was not convincing as long as the main uncertainty, the dose-effect relationship, was not included. Surprisingly, we had no debate on collective dose. Earlier in 2002 we had a hot debate in the European Parliament at a hearing on reprocessing. The WISE Study used by the European Parliament focused very much on collective doses and we had expected this discussion to be repeated.

I will not dwell on the session on protection of the environment, again because it repeats a lot of what has already been said here. We had included a presentation, however, by Carmel Mothersill on possible effects of radiation that were not considered in the ICRP framework. Predictably, this was a basis for some stakeholders to conclude that the concept of dose breaks down at low doses, so that one should look into concentrations rather than doses.

We had interesting expert views on risk management and risk perception. I found it interesting to note that the stakeholders essentially emphasised the need for stakeholder involvement to address risk management. We would agree with that, except where stakeholders want to have a part in the final decision. Empowerment of stakeholders is needed to make the process credible, but it should also be made clear who in the end decides.

The Conference concluded with what the Commission had learned from it, in view of the drafting of its Environmental Action Programme. Stakeholders did not really challenge the position paper of the Commission: we were even congratulated on the new line that was taken. The EC was criticised for not involving the European Parliament in the decision making process, but this is not a matter of choice, the rules are in the Treaty. We have hopes of resolving this soon in the framework of the Convention on the future of the EU.

Stakeholders criticised the Commission for its approach on invitations to the Conference. We proceeded with an open invitation to attract NGOs different from those we had already met but, despite massive advertising, relatively few turned up. Funding was a problem and, while we had funds available, we did not advertise that in order not to distort the representation. So before the next Stakeholders' Conference we would like to set up a mechanism for identifying the most representative NGOs and involve them more actively.

There is one point on the new ICRP approach which was heavily debated at the Stakeholders' Conference and which I would like to record. At the time of the Conference it was not as clear as it is now that natural background is seen merely as a reference, not a justification of the scale of PALs or constraints. It was argued that in addition one should not hide, in the "big bag" of effective dose, the fact that while external radiation from artificial and natural sources should have the same effect, this is not so obvious for radon nor for ingestion or inhalation of natural and artificial radionuclides.

Food Standards rightly got a lot of attention and the Commission's view is that we are still not well prepared for a future emergency. We need to understand consumer response. In the research programme of the Commission there is an interesting network of stakeholders, FARMING, looking into this issue.

With regard to the assessment of population exposure I retained that the uncertainties do not invalidate demonstration of compliance with the standards. Realism does not mean complexity; we need comprehensive, simple, transparent assessments, while putting a reasonable effort into uncertainty analysis.

5. Prospects

Now what about the future? Our original plan was to draft the Environmental Action Programme by the end of this year, and confront it again with stakeholders in spring 2004. Since 2-3 December 2002, however, a lot has happened and I would need a crystal ball to predict the consequences.

In December the Court of Justice ruled that Chapter III of the Euratom Treaty conferred upon the Commission a right to set standards for nuclear safety and waste management, in addition to radiation protection. This prompted the Commission to propose two Directives in this area. The Article 31 Group of Experts gave an opinion before Christmas and the Commission adopted the proposal in January.

One consequence of this development, amongst other grounds, is that our radiation protection unit is now no longer part of the Environment and Health Directorate of DG ENV, but incorporated into the Safety and Security Directorate of DG TREN (Energy and Transport).

This may have implications for the future of the Environmental Action Programme and, if it proceeds, on its scope. There are a lot of question marks, possibly also an opportunity for extending the scope to nuclear safety and waste management.

I would welcome such an opportunity because, as already stated at the Stakeholders Conference, the radiation protection system does not seem to give clear answers on important waste management issues. I believe, for instance, that while we all agree that dilution to meet clearance levels for recycling or reuse should be avoided, I find no basis for this in our justification/optimisation principles, so that additional ethical principles must be included in the system.

The future is uncertain, the expectations of the new management may differ from those of DG ENV.

I would like to conclude that this situation puts new emphasis on the need for international guidance as offered by ICRP.

SESSION 3

Stakeholder Views on the Implications of the New ICRP Recommendations

Chair: Roger Coates, WNA, London

THE EVOLVING SYSTEM OF RADIOLOGICAL PROTECTION: THE NUCLEAR INDUSTRY PERSPECTIVE

Roger Coates
World Nuclear Association

Executive Summary

The World Nuclear Association (WNA) believes that the case for a significant change to the system of protection is not compelling, and any rationalisations need to be carefully judged. We have concern at some apparent over-simplification and vagueness by ICRP in its furtherance of the search for simplicity and coherence. Any changes should be evolutionary, allowing reasonable regulatory stability, and should assure adequate protection of human health and safety and the protection of the environment, promote optimal use of public and private resources and help build public trust and confidence.

The proposal for a maximum constraint of 20 mSv pa on occupational exposure is too inflexible. The control of exposures in the range 20-50 mSv pa should take account of exceptional circumstances and is a matter best left for discussion and agreement between the local stakeholders – i.e., the regulators, the operator and the workforce.

Our principal concern is the proposal for a maximum constraint of 0.3 mSv pa on public exposure. This level, equivalent to one tenth of average natural background exposure, cannot be justified on public health grounds or in comparison with the range of exposures from background or other practices (e.g., medical). It represents a major and unjustified change from the current limit of 1 mSv pa, and its application in a regulatory regime would have a very significant impact on the nuclear industry, particularly on uranium mining and milling and many other current major nuclear sites. There would be significant cost implications with insignificant consequential gains in health protection.

To carefully examine the issue of practical implications, one must look beyond the very low off-site impacts from routine radioactive discharges from typical nuclear facilities. In particular, there is a wide range of specific situations in the nuclear industry for which a maximum constraint of 0.3 mSv pa set at the international level would be unduly unrestrictive. (A set of key examples is listed herein.) In our view, the current system comprising of the dose limit (1 mSv pa) and the ALARA Principle provides the necessary flexibility and tools to regulators for addressing any country specific or site specific settings, and there are already good examples of this. Again, we believe that this matter is best left for discussion and agreement between the local stakeholders rather than at an international level.

We strongly support the need to establish an international approach to defining a level of dose below which society may legitimately maintain that an individual is adequately protected, and hence the allocation of further resources to control the source on radiological health grounds would be inappropriate. WNA considers that this dose is not less than a few tens of microsieverts. This approach should be supported by guidance on the appropriate level of conservatism within dose assessments, both in the context of exclusion/clearance/exemption and critical groups in general.

WNA supports the continued use of the term "ALARA, economic and social factors being taken into account". Collective dose is a useful concept in the optimisation of occupational exposure: in addition it needs to be supplemented by the consideration of the number of workers exposed at the higher levels and by wider pragmatic experience. Public collective dose is of very limited utility in decision making, and little if any weight should be given to exposures at long timescales and exceedingly trivial levels of individual exposure.

WNA welcomes both the lead taken by ICRP to bring the protection of non-human biota into a coherent overall framework addressing the totality of radiological protection, and the recognition that the current system has in practice provided an appropriate standard of environmental protection. On this basis the development of the future system of protection must not impose a disproportionate burden on operators. The focus for protection of non-human biota should be at the species and ecosystems level whilst endorsing that humans are protected at the individual level. Noting that all energy sources give rise to environmental detriments of different kinds, the fundamental issue is not simply how to avoid environmental harm, but how to balance and optimise the totality of benefits and detriments.

Introduction

The objective of radiological protection is to provide a framework which facilitates the safe and responsible use of radiation sources which provide very significant benefits to society. These benefits cover many fields, including medical diagnosis, cancer therapy and food preservation. The area of particular interest to the World Nuclear Association (WNA) is the generation of electricity by means of nuclear fission.

Nuclear power provides 16% of the world's electricity and is a major sustainable non-fossil means of providing continuous, reliable supplies of electricity on a large scale. There are currently 440 nuclear power plants in over 31 countries worldwide, with more than 15 countries utilising nuclear power for 25% or more of their electricity. Nuclear power can generate electricity with no carbon dioxide or other greenhouse gas emissions. In fact, unlike many forms of electricity generation most health and environmental costs from nuclear electricity are internalised in the price to the customer. With world energy consumption predicted to double by 2050, nuclear power offers clean, reliable energy to meet this demand.

As an organisation fully involved in the world energy debate, the WNA is aware that there are no risk-free methods of energy generation, nor are there any generation activities which do not have an environmental impact. It is therefore important to ensure that in the ongoing debate on the future system of radiological protection, the emphasis is firmly focused on assessing the benefits and detriments of radiation sources in a balanced, coherent way rather than simply addressing a system of protection which seeks continually to reduce or minimise actual or perceived risks from radiation. This latter approach could serve to foreclose options with the greatest overall advantage to society.

International and national radiation protection organisations including ICRP are presently engaged in updating, clarifying and enhancing radiation protection principles – and rightly so, given our culture of pursuing excellence in radiation safety through a process of continuous improvement.

Accordingly, the nuclear energy industry appreciates the opportunity to provide its perspective on this effort.

The nuclear energy industry's perspective is shaped in several ways – as an operator, we carry out a primary responsibility for protecting human health and safety and the environment; as a licensee, we are responsible for complying with government regulations; and as an energy producer, we are responsible for the safe, reliable, and economic generation of electricity for consumers. Our objective in regard to improving radiation protection principles is to help promote an outcome that has a clearly articulated basis in science, is flexible in regard to how it might be applied to a very wide range of current and future regulated activities, and is practical and cost-effective in terms of how it can be implemented and maintained.

Why change?

In WNA's view the current radiological protection system has provided an adequate basis for protecting workers, the public and the environment. We are not aware of any significant changes in scientific knowledge which would indicate a need for a change in approach, although we recognise the need to fill a conceptual gap regarding the protection of non-human biota. However, we note the view that the current ICRP system of protection is complex and difficult to understand, with potential inconsistencies and unnecessary duplication across the various fields of application. In this sense we welcome the general idea of simplifying the system and making it clearer for practical use, particularly where this could help a wider perception and understanding of radiation. It would also be helpful if ICRP could seek to clarify the reasons why it advocates common internationally relevant numerical constraints, particularly where it could be argued that social judgements (for example on the acceptability of risk) form a significant input. ICRP should also consider the practical implications of specific numerical choices for key constraints.

However, in reviewing the recent presentations and discussion documents by ICRP we have some concerns that ICRP may become too vague and generalised in this quest for simplicity and coherence, and hence lose the value of much of its previous work as expressed in ICRP 60. In our experience most practical interactions and debates on radiological protection take place within specific components of the system, and relevant detailed considerations should not unnecessarily be lost or sacrificed simply to achieve a perceived wider coherence or simplicity.

Whilst not primarily a matter for ICRP, the WNA has concerns that a significant change to ICRP recommendations can unnecessarily and inappropriately reopen regulatory approaches and interpretations. Recent experience has shown that in such situations there is very rarely a tendency to rationalise towards a higher level of allowable exposure, no matter what rational arguments exist: "the same level or lower" is a common approach when faced with public debate.

Based on the above, it is WNA's view that it is right to explore whether the system of protection can be simplified, provided that any changes to its application in practice are evolutionary in nature, based on adapting and re-emphasising current processes rather than wholesale change. In particular there should not need to be any major consequent change to the regulatory regime. Proposed changes should arise from an expectation of substantive improvement to the level of radiation safety provided and should not unnecessarily restrict societal access to the vast benefits of nuclear technology. In total, changes should meet the following objectives:

- assure adequate protection of human health and safety and the environment with sound scientific underpinning;

- promote optimal use of public and private resources through practicable implementation; and
- help build public trust and confidence.

System of protection

The nuclear industry can in principle accept the proposed conceptual change to the system of protection, based on justification, a source-related upper constraint, with optimisation below this level leading to authorised levels. The generation of electricity by nuclear means is a practice with well-controlled sources. We anticipate that our sources will continue to be regulated within numerical levels relating to assumed occupational and public risk and environmental protection. These numerical levels have usually been referred to as "limits", but terminology which avoids any implication of a safe/unsafe boundary would be welcome.

The principle of justification is accepted as an underpinning component of risk protection philosophy. As indicated by ICRP, radiation protection is only one part of the overall picture: society must judge the totality of benefits from a practice against the totality of risks. The problem with the concept arises through its implementation in regulatory systems, usually solely in the context of radiological protection legislation. This creates additional burdens for activities with radiation risks compared to other activities. It is therefore essential for ICRP to emphasise that the justification principle is not specific solely to radiation risk and that its application in practice should be in the context of the totality of risk management.

In considering the concepts of constraints and optimisation, which are addressed in detail below, ICRP should also note that practical decision making rarely occurs within the confined world of radiological protection. Most real decisions involve trade-offs between radiological and other risks as well as between workers and the public, etc. ICRP should ensure that the system of protection is capable of linking into this wider context and should consider what substantive guidance could be developed in these areas to supplement the general thrust of stakeholder involvement.

Constraints

WNA strongly supports ICRP's proposal to use comparisons with the range of natural background exposure to give a context for the selection of constraints on exposure. In creating decade "bands of concern" it would however be more appropriate to base the boundaries on the concept of "a few" (e.g. a few mSvs etc) rather than the rather precise multiples of 10 as currently indicated. This would more accurately reflect the linkage to natural background.

In previous ICRP recommendations some limits/constraints have been justified by comparison with risk acceptance in society. However, this creates difficulties on an international scale because of national and regional differences, although it is nonetheless a factor which national stakeholders may take into consideration in order to help achieve an appropriate balanced use of national resources in managing societal risks.

ICRP's comments on the large number of currently defined constraints are noted. Each had some value and utility within the system in which they were derived. Any simplification of the overall system must not lead to a choice of inappropriate numerical values purely in pursuit of rationalisation. WNA offers particular comment on the following key proposed constraints:

- 20 mSv pa occupational exposure:

  Given that there are no changes in risk estimates since ICRP's previous recommendations, WNA can see no reason to change from the previous 50 mSv pa upper limit for any year, subject to 100 mSv in 5 years. The need to give priority ALARA focus to the highest exposures is fully supported, but the application of a limit (or upper constraint) at 20 mSv pa will present significant practical difficulties to some parts of the nuclear industry, particularly in some uranium mining operations and specialist reactor maintenance activities, without realising significant benefit. The detailed control mechanism for exposures in this highest dose range should be a matter for discussion and agreement between the local stakeholders – primarily the regulators, the operator, and the workers.

- 0.3 mSv pa public exposure:

  WNA notes with great concern that ICRP are proposing that a source-related constraint of 0.3 mSv pa should in effect replace the 1 mSv pa dose limit for public exposure from all sources (which itself was a contentious change from the previous limit of 5 mSv pa). We cannot understand why a further factor of 3 reduction should now be applied – this implies an enormous conservatism of overlapping sources whereby an individual would be a critical group member for three or more independent sources. In practice there is very rarely more than one relevant contributor to dose at the level of a significant fraction of a mSv, hence the choice of a maximum constraint of 0.3 mSv pa for public exposure represents a very significant and unjustified change in the ICRP recommendation. Such a change would in effect create a limit on public exposure from specific sources at a dose level of one tenth of average natural background and an even smaller fraction of the typical range of background exposures; this cannot be justified on public health grounds.

In practical terms there are many situations where activities are currently indicated to exceed 0.3 mSv pa, usually within the range up to 1 mSv pa. These include the following examples where:

- doses from historic discharges are included within the consideration;
- doses from discharges are assessed at authorised level values using conservative modelling assumptions;
- doses from some uranium mines and mills are assessed, particularly where these are in the presence of enhanced and variable natural background;
- "non-exposed" workers at nuclear facilities are classed as members of the public for dose control purposes;
- hypothetical doses are assessed at the boundary of some nuclear sites due to on-site activities or storage;
- public doses are assessed from the transport of radioactive materials based on maximum allowable package dose rates and conservative modelling assumptions.

Hence the use of a public dose constraint at 0.3 mSv pa, if applied as currently anticipated within regulatory systems, would have very significant cost implications for the nuclear industry with insignificant consequential gains in health protection. WNA notes that there has been no consideration of the impact of this proposal, nor of the merits of alternative numerical values for this constraint. With the current value of 1mSv pa and the ALARA Principle, regulators have the necessary flexibility and tools to address any site-specific issues. The choice of a public dose constraint below 1 mSv pa should be subject to discussion and determination at national rather than international level and should take account of its context for current activities.

Exclusion, exemption and clearance

The nuclear industry agrees with the view that clearance and exemption are in effect generic authorised releases from the system of protection. However, they are nonetheless extremely important issues and there are strong philosophical and practical reasons for ensuring alignment between clearance, exemption and exclusion so that material, once outside the system of protection, remains outside. Also given the movement of materials in trade, there is a need to secure an internationally based underpinning of these concepts.

The key issue here is the link to the level of dose which is sometimes referred to as trivial or Below Regulatory Concern. This is a complex area which interacts with judgements about the acceptability of specific sources or practices and where differences in national cultures and approaches can be significant. However, it is important that ICRP moves to establish an international approach to defining a level of dose below which society may legitimately maintain that an individual is adequately protected, and hence the allocation of further resources to control the source on radiological health grounds would be inappropriate. Any further consideration of the source taking account of non-radiological issues could, if necessary, be a matter for local stakeholders at national level, and in this case it would be essential to clearly distinguish where social or political factors influenced the decision.

Noting previous comments above on the link between natural background and the choice of constraints, WNA strongly believes that this low level of dose should not be less than "a few tens of μSv pa" rather than the unduly precise 10 μSv pa currently advocated by some parties. In addition, further consideration needs to be given to obtaining greater coherence between the treatment of natural (i.e. NORM) and artificial nuclides. This more flexible approach must also be supported by more realistic assessment models for defining derived quantities (e.g. Bq g^{-1}). Current approaches often involve multiple conservatisms which bias the derived quantities to unnecessarily restrictive levels. Whilst not primarily an issue for ICRP, it would be helpful to have clear advice on the level of conservatism appropriate for such models.

Optimisation

The WNA considers that optimisation is the vital cornerstone of practical radiological protection, and that the new recommendations should build on and strengthen this position. We are concerned at the proposed re-working of the well-recognised term "As Low As Reasonably Achievable, economic and social factors being taken into account". Whilst supporting the involvement of appropriate stakeholders in the optimisation process, we are concerned about the vagueness of some of the ICRP discussion on this topic which seems to ignore some well established practical inputs into optimisation.

Occupational exposure

Collective dose has been a useful management tool for promoting and measuring improvement in repeated tasks (e.g. steam generator replacement) and for monitoring temporal changes in the performance of working groups. It is also a useful tool for stimulating increased focus on specific key tasks and activities (e.g. maintenance work). The doses are received within a clearly defined exposure scenario with a relatively narrow range of individual exposures and time periods (in comparison with public exposure – see below). The industry expects collective dose to continue to play an important role in occupational protection practice. It is acknowledged that collective dose does not give the complete picture – in particular it is necessary to take account of the higher levels of individual exposure, for example by considering the number of workers exposed in the higher level dose bands: priority in focusing ALARA efforts on these higher exposures is certainly important. (NB: average dose is not necessarily a good indicator: its utility in practice is often confounded by a relatively large number of low dose individuals).

However, collective dose is only one component of workforce dose optimisation. It is important to address all the three widely recognised components of a balanced ALARA programme i.e. engineering options, management system controls and safety culture/awareness. In this latter respect, the importance of fully involving the workforce (i.e. the key stakeholders) in contributing to the ALARA programme cannot be overstated, particularly noting their detailed knowledge of the work being undertaken, the importance of self-awareness in reducing individual exposure and the power of peer evaluation and peer pressure. There is also much experience and common sense guidance on practical optimisation approaches which has been codified in guides and "best practice" codes at international, national and industry/company level. This practical experience is the key to effective optimisation implementation.

Public exposure

WNA shares ICRP's concern over the difficulties experienced in using collective dose in the optimisation of public exposure. Emotive "deaths" assessments have received much publicity, although the assessments are usually based on minute doses aggregated over hundreds of thousands of years, way beyond the validity of the radiation risk estimates and realistic modelling capability and the normal societal decision making considerations. Such work also usually omits to mention that alternative technologies which could give equivalent benefits also have similar detriments which are far less visible and quantifiable.

Hence it is clear that collective dose cannot be a key determinant in decision making when choosing between a wide choice of options such as in the energy field. It is accepted that collective dose may have some limited utility in comparing between related radiological options, provided that as advised by ICRP the dose is not over-aggregated. In particular the presentation of data should give greatest emphasis to near-term exposures and also place low emphasis on individual dose components received at small fractions of the internationally-accepted "trivial" dose rate as discussed above. These weightings would more closely align with normal decision-making considerations in wider fields beyond radiological protection. Further consideration should be given to concepts inherent in the valuation of detriment delivered at very low risk levels, including the option of declaring a zero weighting for such low exposures.

Looking at the broader picture of public dose optimisation, we recognise the importance of involving appropriate stakeholders including, for example, representatives of the local communities and wider interested parties. The nuclear industry has extensive and growing experience of such

exercises, and recognises that there are many ways in which such involvement can be achieved. It is important to match the process to the local circumstances and cultures, and avoid prescription, although it is important to ensure segregation of scientific and factual inputs from social and political judgments so that the basis of any consensus or decision is transparent.

The critical group concept

The critical group concept is a well-established and important component of the existing system of protection, although the use of 'reference group' may perhaps be more appropriate terminology. The key issue to be addressed is the extent of conservatism which is necessary in the assessment of critical group dose. The wider context here is the need to pursue the societal benefits from practices whilst achieving an adequate level of protection of the individual: excessive conservatism within assessment regimes can foreclose radiological options and hence distort the overall societal balance of risk, giving rise to the inefficient use of resources.

In further refining the critical group concept, WNA believes that the following issues should be taken into account:

- The need for transparency is paramount so that the assessment regime is clear to all stakeholders.
- Assessments should as far as reasonably practicable be based on realistic data and reasonably foreseeable scenarios, avoiding extreme habits and hypothetical scenarios which are unlikely to be relevant within the period of validity of the assessment. The bottom line is that the assessment should be representative of "real people" living normally in proximity of a nuclear site.
- Assessments should be primarily based on models that account for the behaviour of radioactive emissions into the environment and for the multiple ways by which it can lead to incremental public doses. Where appropriate, such models can potentially benefit from site-specific data. Environmental measurements serve the purpose, amongst other things, of verifying indirectly that the radiological levels are not incoherent relative to the dose estimates obtained by models. However, in many cases they are not adequate to thoroughly assess public doses due to the difficulty of measuring the very small incremental radiological levels into the environment.
- Scenarios and assessments should have a robustness and constancy which give a firm basis for forward planning i.e. they should not be subject to very significant short term variation or be open to manipulation.
- In particular, retrospective assessments of doses must be based on real scenarios.
- Care must be taken in the choice of model parameters to avoid the excessive build up of multiple conservatisms.

Protection of the environment

WNA supports the lead taken by ICRP to bring the protection of non-human biota into a coherent overall framework addressing the totality of radiological protection. We welcome the recognition that the current system has in practice provided an appropriate standard of environmental protection, although there is a need to close a conceptual gap. Given this fact it is important to ensure

that the future system of protection, and any consequential burden placed on industry through its likely incorporation into regulatory processes, is not in disproportion with this evidence.

However, in moving towards a common framework, we believe that it is essential to recognise differing emphases for the protection of human and non-human organisms: humans are protected at the level of the individual whilst non-human biota are protected at the population and ecosystem level. Such an approach is consistent with other fields of environmental protection. The development of the framework for protection should assist in focusing the science on more clearly establishing the linkage between effects at the individual and population/ecosystem levels.

Beyond the protection of populations and ecosystems, we recognise that approaches to conservation do in practice in many cases address issues at the level of individual organisms. However, these are special cases which need to be addressed on a case by case basis, and are entirely inappropriate for the basis of a general framework.

As we have stated earlier, all alternative energy sources give rise to environmental detriments of different kinds, and indeed the lack of energy would give the greatest dis-benefit to society. The fundamental issue therefore is not how to avoid environmental harm, but how to balance and optimise the totality of benefits and detriments. A key challenge for ICRP is now to move forward and develop an approach to optimisation which includes environmental effects. The inclusion of non-human effects in such considerations should in general only be necessary at the higher levels of exposure where these could be manifest – in effect a threshold approach.

Given the wide range of natural background levels and organism sensitivities to radiation, together with the lack of clarity on how individual effects contribute at the population/ecosystem level, it is at best premature to move forward with the concept of Derived Consideration Levels linked to natural background. Whilst requiring some further work, scientific evidence does not indicate the likelihood of significant ecosystem or population effects at a level of dose one order of magnitude above background.

Conclusions

The current system of radiological protection is generally effective and well-regarded, and has facilitated the development of many benefits to society from the controlled use of radiation sources. Whilst there are some simplifications, clarifications and rationalisations which could and should be achieved, it is important that these are addressed in an evolutionary manner which avoids significant and unnecessary change to the practical implementation of radiological protection at the working level.

The greatest concern of the nuclear industry within the current developments is the proposal to set the public exposure constraint at 0.3 mSv pa. This has not been adequately considered and would result in very significant issues and cost which cannot be justified.

VIEWS FROM THE INTERNATIONAL LABOUR OFFICE (ILO)

David Owen
Consultant to the International Labour Office (ILO)

The International Labour Office (ILO), based in Geneva, is one of the major UN organisations, and has overall responsibility for occupational safety and health.

As part of this overall responsibility, the ILO has adopted a Convention, Code of Practice and supporting documentation on Occupational Radiological Protection. The Convention in particular is a powerful tool to enhance radiological protection, and has been ratified by 47 Member States. The ILO also co-operates closely with the International Atomic Energy Agency (IAEA) in developing supporting documentation and is, for example, one of the co-sponsors of the IAEA Basic Safety Standards.

The ILO is a tripartite organisation, representing Employees, Employers and Governments, and has a significant interest in the concepts being proposed by the International Commission on Radiological Protection (ICRP). This presentation represents preliminary views on the latest proposals.

STAKEHOLDERS' VIEWS ON THE IMPLICATIONS OF THE NEW ICRP RECOMMENDATIONS: AN ENVIRONMENTAL PERSPECTIVE

Simon Carroll
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Abstract

The development of the new ICRP Recommendations are of significant interest to environmental organisations. There are several issues of particular interest:

1. whether the "approach and the numbers are right"? in the general recommendations;

2. to what extent the understandings being developed for both human and non-human species will effectively address concerns regarding protecting the health of people and the environment; and

3. to what extent these new recommendations will inform the broader regulatory and policy debates, in particular those concerning the uses of nuclear power, fuel cycle developments and radioactive waste management practices.

This presentation will explore various aspects of these issues from the perspectives of environmental organisations.

KEY IMPLICATIONS OF THE NEW ICRP RECOMMENDATIONS: CONTRIBUTION OF THE CRPPH EXPERT GROUP ON THE IMPLICATIONS OF ICRP RECOMMENDATIONS (EGIR)

Ted Lazo
OECD Nuclear Energy Agency

The International Commission on Radiological Protection (ICRP) has embarked on a broad programme of consultation in order to collect concepts, ideas and views regarding how radiological protection should be managed at the start of the 21st century. The results of this consultation will be a new set of comprehensive ICRP recommendations, updating and consolidating ICRP Publication 60 and all subsequent ICRP recommendations. It is expected that the new ICRP general recommendations will be published in 2005, with additional, more detailed "building block" recommendations being published in subsequent years.

The Nuclear Energy Agency (NEA) has for some time been interested in this area, and has developed a series of documents and reports, through its Committee on Radiation Protection and Public Health (CRPPH), discussing its views. The objective of the CRPPH in this work has been to contribute actively to the development of new ideas and approaches that could help the internationally accepted system of radiological protection respond better to the needs of policy makers, regulators and practitioners. As such, its work has been offered to the international community, including the ICRP, as forward-looking "food for thought".

In this context, the NEA and the ICRP have established a collaborative effort, whereby the NEA has analysed draft ICRP materials specifically looking at the implications that might arise should the ideas and concepts in the draft material be implemented in the form of a recommendation. Two such high-level ICRP draft documents have been submitted for this process, which was carried out by the Expert Group on the Implications of Draft ICRP Recommendations (EGIR), and discussed and updated in plenary by the CRPPH itself. The two documents submitted by the ICRP were:

- The Evolution of the System of Radiological Protection: The Justification for New ICRP Recommendations, Roger Clarke, 22 November 2002.
- Protection of Non-human Species from Ionising Radiation: Proposal for a Framework for the Assessment and Management of the Impact of Ionising Radiation in the Environment.

The CRPPH appreciates the openness of and collaboration with the ICRP to advance radiation protection for the benefit of society. This report raises a number of issues and makes a number of suggestions to enhance the understanding and transparency of the ICRP recommendations that will result from the framework documents that have been reviewed. The CRPPH looks forward to continuing its relationship with the ICRP to address and contribute to the resolution of issues. The Committee will also continue to contribute to the creation of a new set of ICRP recommendations,

having strong scientific foundations and broad stakeholder acceptance that will result in accelerated and efficient implementation of the final ICRP recommendations.

The key observations, issues and implications raised by the CRPPH as a result of its analysis of these documents are the following:

- There is broad agreement that the ICRP should clarify and consolidate its recommendations. However, the goal of the ICRP to publish new recommendations by 2005 is seen as being ambitious, and not absolutely necessary.
- Both of the documents from the ICRP are "framework" documents. While they provide discussions of the guiding principles and overall concepts that the ICRP is proposing to use as the bases for its recommendations, the details that would be necessary to fully understand the implications and ramifications of the new recommendations are not presented. It is assumed that the ICRP will modify, based on the views and opinions it is currently collecting, its framework appropriately and use this to develop detailed recommendations. In this context, it is also suggested that some of the details of the "building block" support recommendations should be developed and reviewed in parallel with the general recommendation document.
- The current efforts of the ICRP to clarify its framework and principles, and to consolidate the recommendations it has made since the issuance of Publication 60, are very much supported. Many aspects of the body of the ICRP's recommendations are difficult to interpret and implement, and simplification would be greatly appreciated. However, the framework documents suggest that some significant changes in its fundamental principles are being contemplated by the ICRP. In presenting its new framework, and subsequently its new recommendations, the ICRP will need to provide a clear and compelling argument as to why any significant changes are needed at this time. In view of the potentially large direct and indirect costs of translating ICRP recom-mendations into national legislation and international agreements and standards, it is suggested that the demonstration of the value of the new recommendations, through the use of road tests and/or case studies, should be considered before the recommendations are finalised and issued.
- Given that these documents present simply the framework for future recommendations, it is understandable that they do not present their ideas and concepts with a great amount of detail. However, some of the key ideas and concepts seem to be either completely new, or to have significantly evolved from their previous manifestations (in ICRP Publication and its subsequent supporting documents). Thus, in order to fully understand the Commission's proposed direction, there is a need for presenting much more detail regarding various key issues, such as:
  - Three basic principles, presented in the draft texts as Justification, Constraints to Optimisation and Authorised Levels.
  - The concept of exclusion, that is, how and why natural and artificial sources and exposures are included in the system, or considered as not entering within the system of radiological protection.
  - The reference flora and fauna approach to establishing radiological protection criteria.

Further, more specific questions and possible implication regarding these important aspects of the draft framework are provided in the body of this report.

- The ICRP has suggested in its draft framework that radiological considerations will form only one element, and often not the deciding element, in decisions regarding radiological protection options and optimisation. This implies that the final recommendations will be written in a way to allow national authorities the flexibility to appropriately address local issues. The balance that the ICRP strikes between international harmonisation of numerical criteria and the flexibility necessary for local approaches is very important, and will be a key consideration in the review of final ICRP recommendations.
- In discussing the role of radiological protection aspects in decision making, the ICRP has hinted at the distinction between the scientific aspects of risk assessment, the social aspects of risk evaluation and management, and the regulatory aspects of risk management. This distinction is seen as important to understanding the context of ICRP recommendations in the broader process of risk governance.
- Addressing the question of risk transfers, particularly within the optimisation process, has been one of the more difficult aspects of the current system of radiological protection. The additional emphasis being placed on the radiological protection of the environment will complicate this even further. It will be essential for the Commission, in its new recommendations, to discuss the aspects that it would see as useful for the balancing of protection of humans and non-human species at the policy, regulatory and operational levels.
- ICRP publications 77 and 81 provided some guidance from the Commission on radiological protection issues in the context of radioactive waste management options. The draft material that was reviewed provided no discussion of waste management issues at all. Potential exposures, which had been used with regard to waste management issues, was also not mentioned. The Commission will need to provide guidance for the long-term management of radioactive waste, particularly with regard to the protection of non-human species.
- Since the 1990 issuing of ICRP Publication 60, radiation protection policy makers, regulators and practitioners have become familiar with the meaning and use of several fundamental tools, including the concepts of dose limits, ALARA and collective dose. These three concepts, as well as such other ideas as the use of risk as a basis for numerical protection criteria, and potential exposures, are not discussed at all in the draft texts from the ICRP. There is broad agreement, but not full consensus, that these concepts should be kept as parts of the system of radiological protection because of their usefulness and their widespread use in regulatory and guidance texts at the national and international levels. At the very least, the ICRP should explain how these concepts, if by another name, are included in their new proposals.
- A key aspect of risk assessment and management is the addressing of uncertainties. Both assessment and management require the use of assumptions, biological models, environmental transport models, dose-effect models, etc. All of these assumptions and models include uncertainties, implying that the end result of such models also has a given level of uncertainty. At this point there is still very little knowledge, relatively speaking, of various ecosystems, implying that some margins of conservatism will be used. Although the ICRP has, in the past, provided some guidance as to how uncertainties should be addressed in regulation and practice, further guidance is

certainly necessary. This should begin with general guidance with respect to the overall approach to uncertainty, and continue with more specific guidance as to how such uncertainties should be understood in practice (policy, regulation and application). The need for and use of margins of safety, in regulation and practice, should be part of this discussion for the protection of both humans and non-human species.

SYNTHESIS OF THE FORUM

Chairs: Roger H. Clarke and C. Rick Jones

IMPLICATIONS ON ICRP DEVELOPMENTS

Roger H. Clarke
Chairman ICRP

This has been a valuable and constructive meeting. The four members of the ICRP Main Commission and the several members of its Committee 4 have learned about worries, discovered problems in communication and identified needs for further explanations. The ICRP Task Group Chairmen or members have presented their summaries of how their work will progress and they are now set to write draft sections for the 2005 Recommendations.

For the Main Commission Members, there has been major progress in that the definition of a constraint has been agreed, and also that ICRP is to promulgate international values. Also it has been accepted that the concept of intervention can be brought into the system of constrained optimization.

Some problems of language

Many people expressed concerns about "change". The word was used in a number of presentations and in summaries of breakout sessions. Perhaps the fault is mine since I published a paper, which posed the question, "Time for a change?" But the ICRP aim is **not** change; rather it is clarifying, consolidating, simplifying and elaborating! It is probably also wrong to talk about "new" recommendations.

It was also widely commented that ALARA was replaced by "best level of protection in the prevailing circumstances". Again, the Commission's intention was to emphasise that optimization is **not** a differential equation, but rather a frame of mind. We were concerned that ALARA was too associated with cost-benefit analysis, but perhaps we need to be clearer that if ALARA is to be retained it more resembles "safety culture" in nuclear safety. It means "protection culture", that unquantifiable attribute that professionals must exhibit.

Collective dose is another example of language problems. It was repeatedly said that Collective Dose was useful, especially in the workplace. Yet the formal definition of collective dose is a double integral overall space and all time, leading to a **single** numerical value. But this is not what participants want – everyone agreed that a matrix presentation was required and it was even proposed that ICRP develop a system of weighting factors for the matrix. ICRP either change the definition or find a new phrase to describe this disaggregated quality.

Some regulatory and operational concerns

It was a common feature of presentations that change to regulations is costly and can often be perceived to be disadvantageous. Most countries are only just implementing the 1990

Recommendations, some even still contemplating their introduction. The European Commission view is that the emphasis should now be on compliance with Basic Safety Standards, not their revision. However, it is identified that there are problems with the BSS in terms of the concepts of intervention and clearance, natural radiation sources and the use of collective dose.

There was a plea from everyone – all regulators, operators, EC, ILO, including those speaking for the NGOs – that "Limits" must be retained. They are enshrined in international law as well as national regulations. The Main Commissioned asked if individual-related criteria were still required and has suggested that their incorporation into source-related constraints would be sufficient. The answer from this Forum is an unequivocal and unanimous, **NO!**

The Main Commission members here have heard this message and will reflect the view in the draft recommendations now being prepared. It was also widely felt that the Commission should say that it not replacing Publication 60, but again rather it is building on those recommendations clarifying the confusions and finally, almost everyone agreed that simplification would be beneficial.

The way forward

It was said several times here, as it has been said before, "if it ain't broke, don't fix it". That first appeared in the Editorial of the Journal of Radiological Protection in June 2001 when the Commission published its proposals for revised recommendations.

However, what the Commission has seen is an ever-increasing burden of incremental change. Constant additions for which a more appropriate aphorism would be "the straw that broke the camel's back"! With the help of colleagues here, no backs will be broken, the load will be lightened and a new spring will be put into our steps.

What we can conclude is that:

- some things are different, because the science has evolved – an example would be radiation and tissue weighting factors;
- some things are added, because there has been a void – an example would be protection of non-human species;
- some things remain, because they work well and are understood – an example would be the system of protection and dose limits;
- some things are elaborated, because although they work, more guidance is needed – an example would be optimisation and the concept of constraints.

There appears no need to look for significant changes in the currently applied Basis Safety Standards and no need to change regulations in those countries that have adopted Publication 60.

This has been a pivotal meeting and ICRP is grateful to the NEA for convening the second Forum, wishes to thank the Spanish Council for Nuclear Safety for the splendid arrangements, but mostly wants to express its appreciation to the participants for so thoroughly contributing ideas and comments. The next step is forward.

SUMMARY COMMENTS

C. Rick Jones
Chair, CRPPH

In the closing session of the NEA/ICRP Forum, Mr. Jones, the Chair of the CRPPH, summarised the discussions during the conduct of the Forum from the perspective of the CRPPH. He noted that the 28 member countries of the CRPPH were once again pleased for the Committee to co-Chair a forum where broad representation of interested and effected stakeholders could come together to share their views with the ICRP on its latest efforts to enhance its recommendations, and to expand them to more explicitly address the radiological protection of the environment.

Mr. Jones expressed the appreciation of the CRPPH member countries to Professor Clarke, the ICRP Chair, for the open and inclusive fashion being implemented by the ICRP in the development of its latest recommendations. Mr. Jones committed the CRPPH to continue developing its constructive views of ICRP draft recommendations, and providing these to the ICRP in order to help evolve the ICRP recommendations in response to stakeholder input. The CRPPH will continue the work of its Expert Group on the Implications of ICRP Recommendations (EGIR), which monitors ICRP recommendation development and provides expert input to the ICRP on the possible impacts and implications of their recommendations. Mr. Jones thanked Professor Clarke for the changes that had been made to the previous draft of the ICRP recommendations and that were based upon comments and discussions held at the first NEA/ICRP Forum in Taormina, Sicily, in February 2002, and contributions by the NEA's CRPPH.

Mr. Jones indicated that several key points for the CRPPH have emerged from this meeting, as follows:

The ICRP recommendations should respect the roles and responsibilities of:

- the ICRP to make recommendations having a sound scientific basis to enhance radiological protection,
- policy makers to import societal and economic issues to establish public health policy, and
- the radiation protection community to implement that policy in an efficient and cost effective manner.

Effective communication of the ICRP recommendations and development process represents a challenge. A proactive communications strategy with policy makers, the radiation protection community, and the public will be critical to the acceptance and effective implementation of any new ICRP recommendations.

The ICRP should:

- continue a transparent and inclusive process in the development of their recommendations, and list any and all assumptions and uncertainties associated with their recommendations;
- minimize the change/evolution of terms;
- justify any changes to the current system of radiological protection and provide feedback to stakeholders that have provided comments to further build trust and understanding between parties; and
- perform a "road test" of new recommendations, prior to their publication, in order to make final adjustments and clarifications to facilitate application.

ICRP recommendations should result in enhanced radiological protection and strike a balance between the hazards and the expenditure of resources consistent with other public health and safety issues policy-makers have to deal with, such as prevention of AIDS, terrorism, fresh water and the security of the food supply.

Mr. Jones indicated that a third NEA/ICRP Forum is envisioned once the ICRP publishes new recommendations and after a period of time to allow for implementation. The purpose of this third forum would be to bring the implementers and the ICRP together to discuss best practices in implementation, and potential barriers to implementation.

Mr. Jones challenged Forum participants to be "ambassadors" to further promote the openness of the ICRP in the development of its new recommendations, and to support the continued high technical content of the recommendations to improve and expand understanding and communications.

Mr. Jones then thanked the Spanish delegation for its warm hospitality, the Nuclear Energy Agency Secretariat for its exceptional planning, and Professor Clarke and the ICRP for openness and cooperation in making the next set of ICRP recommendations a meaningful contribution to advance radiological protection.

CONCLUDING REMARKS

Jose A. Azuara
Vice Chairman, CSN, Spain

Now, ladies and gentlemen, it's time to close this forum.

But before doing it, let me a few minutes, to stress on the satisfaction of the Nuclear Safety Council, hosting in our country, and specifically in the Canary Islands, this event, impelled by the Nuclear Energy Agency in collaboration with the International Commission on Radiological Protection.

Not so long ago, the CSN had also the opportunity to host an important meeting at Seville, promoted by the IAEA, to improve the scientific knowledge of the biological effects of low doses of ionising radiation, and it's expected to develop in Madrid a meeting of the International Radiation Protection Association, on April 2005.

These events show that our country and, in particular, the CSN considers an important issue, the collaboration with the international organizations, to clarify all the aspects and questions involved (or underlying) in the system of radiological protection, so that its evolution give to national regulatory authorities and practitioners, a more clear, precise, and directly useful frame work.

All of us are aware of the ambition of the task, taking into account the different scientific, social, and economical aspects directly implicated on it, and the fact that it's no easy to find a balance between the international trends to harmonize the practices with the need of flexibility of the different countries, when implementing the new criteria.

And, it's clear that the extension of the principles of the radiological protection upon the environment and non human species, brings up additional issues that add new elements of complexity

Nevertheless, no matter its complexity the final goal is not only positive but also a necessity for our community and for the societies whose interests we have the responsibility to save, in the beginning of the twenty first century.

Because of that, we must support very much the evolution of the system of radiological protection, assuring that it is conducted through a process that allows the participation of all stakeholders concerned, by means of forums of argument and reflection like this, that I have no doubt will be developed within the coming years.

Finally, I want to thank very much to NEA and ICRP for the organisation of this Forum.

Special thanks to Commissioner Paloma Sendin and her supportive team for their excellent work and of course, to all of you for your active participation.

As well, thanks to local authorities of Lanzarote Island for their hospitality.

I am sure you have enjoyed your stay in Lanzarote these days and for those of you who are going to spend the weekend in this island, take pleasure in its wonderful weather and landscapes.

The second NEA-ICRP forum on the future for radiological protection is closed.

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