Radiation Protection

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Evolution of the System of Radiological Protection

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NUCLEAR ENERGY AGENCY
ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT

ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT

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NUCLEAR ENERGY AGENCY

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

The mission of the NEA is:

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

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

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

FOREWORD

The most significant challenge currently facing radiological protection experts is how to better integrate radiological protection within modern concepts of and approaches to risk governance. In response to this issue, the International Commission on Radiological Protection (ICRP) decided to develop new general recommendations to replace its Publication 60 of 1990, upon which virtually all current national legislation is based. The process of developing these new recommendations began in 1999 with the publication of an article by Professor Roger Clarke, ICRP Chair, on what was referred to at that time as "controllable dose". Since then, ICRP views have evolved significantly, largely due to stakeholder involvement that has been actively solicited by the ICRP, as well as internal discussions within the ICRP Main Commission and its four committees.

The NEA Committee on Radiation Protection and Public Health (CRPPH) has been an active partner in this process since its beginning. The CRPPH is made up of regulators and radiological protection experts, with the broad mission to provide timely identification of new and emerging issues, to analyse their possible implications and to recommend or take action to address these issues to further enhance radiological protection regulation and implementation. The regulatory and operational consensus developed by the CRPPH on these emerging issues supports policy and regulation development in member countries, and disseminates good practice. Given this mission, the CRPPH is very interested in helping the ICRP recommended system of radiological protection to evolve to better address national policy, regulatory and practical radiological protection needs.

Within this context, the CRPPH agreed that the views of Asian countries on this subject should be discussed in a dedicated forum in the framework of a topical conference. The first Asian regional conference entitled "Asian Regional Conference on the Evolution of the System of Radiological Protection" was held in Tokyo, Japan on 24-25 October 2002. The conference was supported by the Japanese Ministry of Education, Culture, Sports, Science and Technology (MEXT).

The objectives of the conference were to discuss in the Asian context:

1. how to implement an evolved system of radiological protection, and the need for flexible solutions;

2. the proposals of the Expert Group on the Evolution of the System of Radiation Protection (EGRP) to explore several specific concepts and their implementation, notably the characterisation of sources and exposures, and the regulatory process of authorisation;

3. how to address stakeholders with different societal and cultural backgrounds in the system of radiological protection;

4. the ICRP's current proposals and possible implications regarding the new general recommendations, with ICRP Chair, Professor Roger Clarke; and

5. a critical review of the ICRP's specific proposals on how a new system for the radiological protection of the public, workers and the environment could best be developed, both to gain broad public acceptance to address the needs of users and regulators.

The conference was organised in three sessions, covering the system of radiological protection, stakeholder involvement in the radiological protection decision-making process, and implementation of radiological protection recommendations. A special session was also held on the most recent thinking on new ICRP recommendations. Exciting scientific debates took place during the panel discussions organised in conjunction with each session.

These proceedings provide the presentations of the invited speakers, a summary of the conference results and the list of conference participants. They will be presented to the ICRP for consideration within the process of developing new recommendations for the system of radiological protection.

Acknowledgements

The NEA wishes to express its gratitude to the Japanese Ministry of Education, Culture, Sports, Science and Technology (MEXT) and Akihiro Fujimori for helping in the management of this conference.

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OVERVIEW OF THE CONFERENCE

The Asian Regional Conference on the Evolution of the System of Radiological Protection was organised by the NEA, sponsored by the EGRP (Expert Group on the Evolution of the System of Radiation Protection) of CRPPH (Committee on Radiation Protection and Public Health) Tokyo, Japan, 24-25 October 2002. The conference was supported by the Japanese Ministry of Education, Culture, Sports, Science and Technology (MEXT). The meeting also dealt with the item of the stakeholder involvement process featuring the activities of EGPSI (Expert Group on the Process of Stakeholder Involvement) of CRPPH.

It enjoyed the participation of 120 attendees from Australia, Canada, People's Republic of China, France, Hungary, Ireland, Korea, United Kingdom, U.S.A. and Japan, including radiation protection professionals, scientists, regulators and representatives from the nuclear industry.

The objectives of the conference were to discuss in the Asian context:

1. how to implement an evolved system of radiological protection, and the need for flexible solutions;
2. the EGRP's proposals to explore the specific concept of characterisation of sources and exposures, and of authorisation, , and their implementation and application;
3. how to address stakeholders with different societal and cultural backgrounds in the system of radiation protection;
4. the ICRP's current proposals and possible implications regarding the new general recommendations, with ICRP Chair, Professor Roger Clarke; and
5. a critical review of ICRP's proposal with specific views on how a new system for the radiological protection of the public, the workers and the environment could best be developed to, both to gain broad public acceptance to address the needs of users and regulators.

Fifteen scientific papers were presented in three sessions, covering the system of radiation protection, stakeholder involvement in radiological decision-making processes, and implementation of radiological protection recommendations. In addition, exciting scientific debates were sparked in the panel discussions configured for each of the sessions.

The onference had a special session on "Radiological protection at the start of the 21st Century: Status of developments", and the ICRP Chair presented the "Justification of the new recommendations" relating to most recently thinking of the ICRP new recommendations. With respect to decision making in radiation protection, the ICRP Chair appealed to the conference participants to change from an attitude of "DAD" (decide behind closed doors, announce to an unsuspecting world, defend the decision) to "MUM" (meet, understand the view of others and modify). The objective is not to try to "educate" the public, but to engage the public and to learn from the public in order to gain mutual trust.

MAIN POINTS OF THE CONFERENCE

Session 1: The system of radiation protection – The activities of EGRP

EGRP's activities and its critical review toward the way forward in radiological protection were well accepted by the conference. The key proposals for a new system to introduce "characterisation of sources and exposures" and "comprehensive authorisation process" showed good performance and promise in their "Road Tests". The first step is always the hardest, but they started off on the right foot and held forth the future possibility to be a powerful instrument to demonstrate the feasibility of the ideas by providing tangible visions.

EGRP ideas on "authorisation" and "characterisation" were generally accepted in the conference, and it is desirable to continue interaction and engagement with ICRP to assist in modernising the system of radiation protection. However the empirical approach and rather arbitrary selection of numerical scores in their processes was not quite clear to the Asian participants. The learning process on regional and cultural needs, flexible local and regional solutions should be extended beyond the NEA membership by engaging regional panels and international organisations. These inputs will be essential and beneficial for the new NEA expert group on implications of ICRP recommendations (EGIR).

Session 2: Stakeholder involvement in radiological decision-making processes

This was probably the first in-depth discussion of "Stakeholder involvement processes" in the field of radiation protection in the Asian region, and there was some confusion over "What is a Stakeholder?", "When, where and how to engage Stakeholders?", and it was not exactly clear to the participants why they should involve the stakeholders. Differences in the definitions, interpretations of terminology and societal context emerged in relation to the "Stakeholder involvement processes". International diversity of social and cultural differences in decision making and public acceptance procedures must be considered, and the future recommendations should be flexible to accommodate these differences. Case studies on ETHOS (Belarus) and Rocky Flats gave excellent lessons and inputs to the Asian participants to understand what the stakeholder involvement process is, and the case study of public participant in the Japanese radiation protection regulations illustrated the difference between the Asian and European way of public participation in radiation protection issues.

Session 3: Implementation of radiological protection recommendations – what works well, what needs improvement, what is expected of new recommendations

Regulators from Australia, China, Korea, and Japan presented their views on the implementation of radiological protection recommendations. Practitioner views were expressed by the Japanese electric utility, and scientific comments on the implications of ICRP new recommendations were provided. It came into focus that because of its complexity, some key concepts and proposals in the new ICRP recommendations were interpreted differently in different regions and societies.

Streamlining, simplifying and modernising the system of radiation protection are the prospective way to resolve the current confusion, but a certain level of flexibility is essential to allow for social and cultural differences in decision-making processes.

Special Session: Radiological protection at the start of the 21st Century: Status of developments

Professor Roger Clarke, the ICRP Chair, presented the "Justification of the new Recommendations", and emphasised that the new ICRP recommendations will be more than a replacement for 1990 recommendations. He wanted to shift away from a risk-based philosophy to an approach to background radiation levels, as this will be better understood by society and the general public. He noted the challenge to reduce the complexity of the current system with more than 20 dose constraints and to realise a more simple system with only a few primary numerical values for radiation protection.

Professor Clarke also stressed that new recommendations will have stakeholder processes built-in, which switchover the current system of radiation protection from "educate the public" to the new system to "engage the public and to learn from the public". In his view, trust has been lost by hiding behind the complexity of risk-based approach, and we must change our attitude. He pronounced that "DAD" is dead, and must be replaced with "MUM". This means that current risk-based approach must be changed to a "natural background-based approach", and simplified to reduce the constraint values.

Relating to the debates on the stakeholder involvement process, the conference generally accepted the need to involve learning process from the public. It was also agreed generally that the risk-based approach has prevented the easy understanding of the general public, and some challenges must be addressed to evolve the risk-based approach from "complex" to "simple, plain" to gain the trust of general public. There were many debates in the panel discussion, and eventually, the background-based approach would not be regarded as a universal tool to solve the difficulties in the communication with the public on the health, generational and environmental effects of radiation. It was discussed that alternating the risk-based approach to a background-based approach might just swap the difficulties in existing challenge of explaining the risk concept to the public with new challenge of explaining that there is "no distinction between natural and artificial radiations".

The conference recognised the needs of regulators and operators for clarification of some issues as "Justification", "Optimisation", "Dose-limits", "protection of patient exposure", "Control of Natural Radiation exposure (NORM)", "protection of the environment (species other than humans)" and "stakeholder involvement". The meeting suggested that these issues should be covered by the future activities of NEA and NEA/ICRP joint programs.

The way forward to the future

The need for evolution of the radiation protection system was widely accepted in the conference, while it was noted that the implementation of the new system must allow for the regional societal and cultural differences. From this point, the first Asian regional conference was successful to exhibit the "differences" among Asian (Korea, China and Japan), Oceanian (Australia), and western ways of thinking on how to improve the current system of radiation protection to be fit the needs for 21st century. In order to develop consensus on directions to the new ICRP recommendations, NEA and ICRP will further collaborate. To ensure appropriate consideration of specific cultural and socio-political contexts, a second Asian Regional conference is being planned by the NEA.

Welcome Addresses

J. Matsubara
Commissioner, Nuclear Safety Commission, Japan

I am delighted to deliver a welcome address to all of you as deputy-chairperson of the Japanese Nuclear Safety Commission, and at the same time, as an expert of radiation protection, at the occasion of the opening of the "Asian Regional Conference on the Evolution of the System of Radiological Protection" organised by OECD/NEA today.

As mentioned by Mr. Hirose, the NEA Committee on Radiation Protection and Public Health (CRPPH) and its EGRP has taken an increasing role in the process of the development of the new recommendation in ICRP.

This workshop held in Tokyo will serve as an important step for the further development of the new recommendation.

One of the goals of this workshop is to focus and to discuss how the current system of radiation protection is implemented in the Asian countries. The views from Asian and Pacific regulators will be provided for discussions. Basically the principles of radiation protection were established and mainly discussed in Western context. If we think about global fast penetration of peaceful applications of nuclear energy in the current world, I think it is proper time for Asians to discuss about essentials of radiation protection with our own words according to our situations, although the English language is a powerful communication medium during this conference.

Firstly, views from CRPPH and its Expert Group will be presented this morning. Discussions on how the system of radiological protection could be implemented by regulatory bodies in different countries are interesting and should be examined by a broader audience. Then the review on the implementation of current recommendations of radiological protection and demands from various sectors for the new recommendations will be raised and to be compiled for further consideration in international bodies.

I think that the establishment and manifestation of a clear policy of radiation protection by regulatory bodies is very essential for the public. At the same time the regulators and experts of radiation protection are responsible to explain or provide information on the health effects of radiation even at very low doses to the common people as their accountability.

Nowadays it is important that the concept of radiation protection should be developed taking account of the attitude of the public toward the risk of radiation. From this point of view, the differences of social context among different countries should be considered. We have initiated a discussion in a subcommittee of Nuclear Safety Commission in order to create and deepen the concepts of radiation protection to accommodate to Japanese contexts.

Proposals by Professor Roger Clarke, the Chairman of ICRP, are of course highlighted. Professor Clarke gave a presentation with respect to the latest perspectives of the ICRP commission towards a new recommendation. His presentation could be of primary concern for most participants here. The most remarkable key points in his presentation would be: the extension in the concept of dose limits providing protective action levels to protect individuals, simplification in dose description, philosophy for natural radiation exposures, and introduction of a policy for radiological protection of the environment.

Issues on the stakeholder involvement in radiological decision making are to be discussed in the present workshop. It is obvious that the risk communication to the public is of growing importance in the present world. Reports on the current aspects of risk communications in Japan will be given by staff-members of the Nuclear Safety Commission and Radiation Council, MEXT.

It is our great pleasure to have this opportunity to exchange opinions with each other, especially among participants of various countries, and promote international collaborations aiming at the evolution of the system of radiological protection.

I expect active and fruitful discussions among all participants.

Thank you very much for your attention.

Dr. K. Hirose
Executive Director for Nuclear Safety, MEXT, Japan

It is my great honor and pleasure to give opening statement to all of you participating in "Asian Regional Conference on the Evolution of the System of Radiological Protection" on behalf of the Ministry of Education, Culture, Sports, Science, and Technology (MEXT). This conference is a workshop organised by the Expert Group on the Evolution System of Radiation Protection (EGRP) of OECD NEA with support by MEXT.

ICRP is now in the important stage to develop a draft for new general recommendations to replace Publication 60, on which current national legislation systems in most countries are based. The NEA Committee on Radiation Protection and Public Health (CRPPH) has been played an increasingly constitutive role in the process of the development of the new recommendation in ICRP. The committee created EGRP to suggest specific directions to improve the system of radiological protection. We recognised that the task of the expert group would be very important and we have been supporting the activities of the group. It is meaningful that the achievements of the activity of the group would be reported and discussed in the workshop. The report involving a proposal for new recommendation of ICRP will be presented tomorrow by Professor Roger Clarke, the chairman of ICRP. Discussion on the views given by regulatory authorities of Asian countries including Australia, expert in radiation protection and representative of the user would be done with him.

The issue of stakeholder involvement in radiological decision making become more significant in the process of improving the legislation system for radiation protection. The CRPPH has addressed the issue in the Expert Group on the Process of Stakeholder Involvement (EGPSI). The achievements of the group will be summarised and discussed in this workshop as well as those of EGRP.

Various significant accidents and incidents related to radiological protection have occurred in these several years. In Japan, the Criticality Accident in Tokai-mura occurred three years ago. There is fear that these events would depress public reliability on radiation safety regulation policy. Under these circumstances, we feel that more reliable policy for radiation protection is necessary. From this point of view, we really appreciate that OECD NEA has planned to organise such a timely workshop held here in Japan.

I wish intense and fruitful discussions among the participants in this workshop to develop landmark achievement.

Thank you for your kind attention.

K. Shimomura
Deputy Director, Safety and Regulation, OECD Nuclear Energy Agency

Good morning Ladies and Gentlemen,

On behalf of the OECD Nuclear Energy Agency (NEA), I would like to welcome you to this Asian Regional Conference on the Evolution of the System of Radiological Protection. The NEA is very appreciative of the efforts made by the Japanese Ministry of Education, Culture, Sports, Science and Technology (MEXT) to host this regional conference. I also would like to thank all of you for the interest you have shown in this important subject and the efforts you have made to attend the meeting. The programme promises an interesting meeting, and your support will, I am sure, lead to useful results.

To give you some background information, let me briefly introduce the OECD Nuclear Energy Agency and its Committee on Radiation Protection and Public Health.

The Nuclear Energy Agency was established in 1958 as a semi-autonomous body of the Organisation for Economic Co-operation and Development, and includes currently 28 member countries from Europe, North America and the Pacific area. 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 the safe, environmentally friendly and economical use of nuclear energy for peaceful purposes, and so on.

The NEA is organised through a Steering Committee for Nuclear Energy under the OECD Council and performs its technical programme through seven standing technical committees and a Data Bank. The Committee on Radiation Protection and Public Health (CRPPH) organises information exchange amongst senior policy makers, regulators, and senior representatives of research and development institutions from 28 NEA member countries, in order to harmonise views on important radiation protection issues. The cross-party representation of industry, safety authorities, and governmental policy bodies make the CRPPH an uniquely placed international forum.

The current programme of the CRPPH comprises four major topics: The evolution of the system of radiological protection, the issue of stakeholder involvement, international nuclear emergency preparedness and management, and occupational exposure management including the ISOE Asian Technical Centre in Tokyo. All four topics enjoy the strong involvement of Asian specialists.

Regarding the evolution of the system of radiological protection, the CRPPH will try to assist in building a common understanding. The objective is to assure that new recommendations address the needs of policy makers, regulators and implementers. There is no doubt that the International Commission on Radiological Protection (ICRP) is the independent scientific body to issue radiological protection recommendations which are, after their publication, implemented in most countries' national regulation. In order to allow interested communities to build confidence based on common ownership, the CRPPH will bring together a broad set of stakeholders, providing input from regional, national, socio-political and cultural considerations. This broad input will be provided to the ICRP for their considerations.

With a view to the development of the future system of radiological protection, the CRPPH engaged in parallel in the discussion of new concepts, in the governance and process evolution, and in tuning the existing system of radiological protection. In order to test whether the developed evolved concepts do more good than harm, various case studies are currently being carried out, some of them will be presented at this workshop.

This Asian Regional Conference on the Evolution of the System of Radiological Protection will have four sessions introducing in detail the CRPPH activities in the system of radiological protection, stakeholder involvement in radiological decision making processes, the ICRP view on radiological protection at the start of the 21^{st} century, and the implementation of radiological protection recommendations. The conference enjoys the participation of implementers, regulators, scientists, and radiation protection professionals from Australia, China, Japan, the Republic of Korea, Europe and North America.

The main objectives of this regional conference are to discuss the implementation of an evolved system of radiological protection in the Asian context, to consider the need for regional solutions and to address stakeholders with other socio-political background and cultural context. The NEA believes that the CRPPH can provide active partnership with a broad stakeholder community in order to support ICRP in its considerations.

Let me finally express my hope, that this initiative will assist both the NEA Member countries to develop common views among governmental policy advisors, regulators and implementers, and the ICRP in broadening the information basis and discussion input needed for its process of the development of new recommendations.

Again, I would like to thank you, in advance, for what I am sure will be very fruitful discussions. I look forward to participating in these discussions, and to listening and contributing during this Conference.

THE WAY FORWARD IN MODERNISING THE SYSTEM OF RADIOLOGICAL PROTECTION: ACHIEVEMENTS AND OUTCOMES OF THE CRPPH EXPERT GROUP (EGRP)

J. McHugh
Environment Agency, United Kingdom

The considerations and proposals from the CRPPH Expert group, for refining and improving the present system of radiation protection are described. The EGRP considered and built on the foundation provided in the NEA/CRPPH publication "*A Critical Review of the System of Radiation Protection*". In particular it elaborated on the following priority areas: numerical guidance; concepts of regulatory control, exemption and triviality; justification and optimisation; and decision-making and decision aiding. The EGRP report "*The Way Forward in Radiological Protection*" was published in 2002 and has been offered to the wider radiation protection community and to ICRP as input to future recommendations.

EGRP suggested that aspects of exclusion, exemption and clearance and triviality could better be addressed through a simplified , but comprehensive process of "authorisation" by regulatory bodies. Recognising that successful modern decision making on radiation risks increasingly involves stakeholder participation, it would help to identify the circumstances where involvement of "stakeholders" in decisions would assist, and to characterise the sources and doses where decisions would benefit from stakeholder involvement. These two new ideas should be subjected to "Road tests" as a trial to see if they would improve the present system of protection.

THE EVOLUTION OF THE SYSTEM OF RADIOLOGICAL PROTECTION: THE PROGRAMME OF THE NEA COMMITTEE ON RADIATION PROTECTION AND PUBLIC HEALTH

S. Mundigl
OECD Nuclear Energy Agency

The primary aim of radiological protection has always been to provide an appropriate standard of protection for the public and workers without unduly limiting the beneficial practices giving rise to radiation exposure. Over the past few decades, many studies concerning the effects of ionising radiation have been conducted, ranging from those that examine the effects of radiation on individual cells, to epidemiological studies that examine the effects on large populations exposed to different radiation sources. Using information gained from these studies to estimate the consequences of radiation exposure, together with the necessary social and economic judgements, the International Commission on Radiological Protection (ICRP) has put forward a series of recommendations to structure an appropriate system for radiological protection, and to ensure a high standard of protection for the public and for occupational exposed workers.

The ICRP system of radiological protection that has evolved over the years now covers many diverse radiological protection issues. Emerging issues have been dealt with more or less on an individual basis resulting in an overall system, which while very comprehensive, is also complex. With such a complex system it is not surprising that some perceived inconsistencies or incoherence may lead to concerns that radiation protection issues are not being adequately addressed. Different stakeholders in decisions involving radiological protection aspects tend to focus on different elements of this perceived incoherence.

To advance solutions to these issues, the OECD Nuclear Energy Agency (NEA) has been working for some time to contribute to the evolution of a new radiological protection system, through its Committee on Radiation Protection and Public Health (CRPPH). This group of senior regulators and expert practitioners has, throughout its existence, been interested in the development of recommendations by the ICRP. Recently, this interest has included a very active CRPPH programme to develop ideas and suggestions that the ICRP can take into account in its 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 current programme of the CRPPH comprises four major topics: The evolution of the system of radiological protection, the issue of stakeholder involvement, international nuclear emergency preparedness and management, and occupational exposure management including the ISOE Asian Technical Centre in Tokyo. All four topics enjoy the strong involvement of Asian specialists.

Evolution of the system of radiological protection

Already at an early stage, the CRPPH focused on 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 (OECD/NEA, 2000), and was provided directly 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 proceed by suggesting specific modifications to the current system which would result in improvement and simplification. The results of this work have been synthesised and published (*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 Implications of ICRP Recommendations for a System for Radiological Protection (EGIR) to identify the possible implications of the ICRP's new draft recommendations concerning the overall framework of the system of radiological protection, and 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 final report of EGIR was presented to the CRPPH and endorsed for publication: Possible Implications of Draft ICRP Recommendations, OECD/NEA, 2003.

Radiological protection of the environment

In support of this work, the NEA proposed to contribute to the debate on radiological protection of non-human species, by promoting and establishing 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: *Radiological Protection of the Environment, The Path Forward to a New Policy?*, was held 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 in 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 results of the Forum have been synthesised and published for consideration by the ICRP and the international community, and have contributed to the ICRP's development of draft recommendations. (*Radiological Protection of the Environment, Summary Report of the issues, OECD/NEA, 2003; Radiological Protection of the Environment, The Path Forward to a New Policy?, Workshop proceedings, Taormina, Sicily, Italy, 12-14 Februuary 2003, OECD/NEA, 2003).*

Stakeholder involvement processes

Contemporary society has become increasingly interested in participating in public decision making on health, safety and environmental protection issues. As governments have tried to better understand society's interests, and to better integrate societal needs in the decision-making process, it has become possible to begin identifying common policy issues and lessons.

For many years, the OECD NEA and especially the CRPPH has an active work programme on details and implications of stakeholder involvement in radiological protection decision-making processes. The series of workshops in Villigen, Switzerland (1998 and 2001), and related follow-up work offers assistance to the international radiological protection community on how to better integrate radiological protection into modern society. The lessons that have been learned in this area carry implications on national policy and on the governmental infrastructures necessary to carry it out.

The second Villigen workshop discussed policy-level aspects of how stakeholder involvement can affect decision making in situations involving radiation exposure to the public or to workers. A summary report, *Policy Issues in Radiological Protection Decision Making: Summary of the 2nd Villigen (Switzerland) Workshop*, January 2001, OECD/NEA, 2001, was published in 2001.

Testing new concepts: Case studies

With a view to the development of the future system of radiological protection, the CRPPH engaged in parallel in the discussion of new concepts, in the governance and process evolution, and in tuning the existing system of radiological protection. In order to test whether the developed evolved concepts do more good than harm, various case studies are currently being carried out; some of them will be presented at this workshop.

The way forward in radiological protection proposed a characterisation of sources and exposures and a new concept of authorisation, which could replace the currently used concepts of exemption, exclusion and clearance. These new ideas were thoroughly road-tested and the results were published by the NEA in the report *A New Approach to Authorisation: A Road Test of the Ideas of the CRPPH Expert Group on the Evolution of the System of Radiological Protection,* prepared by R.V. Osborne and F.J. Turvey, OECD/NEA, 2003.

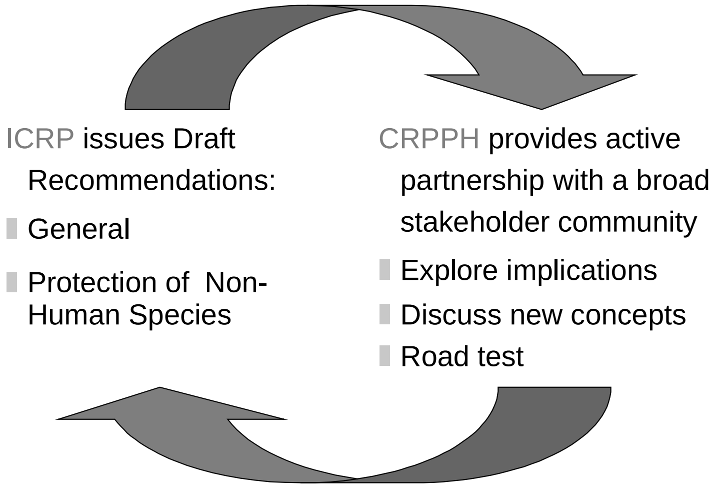
Regarding the governance and process evolution, the NEA embarked on various case studies, one in the Asian region, one in the European region, the ETHOS project in Belarus, and one in the North American region, Rocky flats in the United States. The results of these case studies were also presented at this workshop and will be published by the NEA.

Asian regional conference

This first Asian regional conference is an important step in the evolution of the system of radiological protection, as it addresses, for the first time, stakeholders with other socio-political background and cultural context. The main objective is to facilitate the implementation of an evolved system of radiological protection in the Asian context, providing enough flexibility to allow for regional solutions.

Building common understanding

Regarding the evolution of the system of radiological protection, the CRPPH will try to assist in building a common understanding. The objective is to assure that new recommendations address the needs of policy makers, regulators and implementers. There is no doubt that the International Commission on Radiological Protection (ICRP) is the independent scientific body to issue radiological protection recommendations which are, after their publication, implemented in most countries' national regulation. In order to allow interested communities to build confidence based on common ownership, the CRPPH will bring together a broad set of stakeholders, providing input from regional, national, socio-political and cultural considerations. This broad input will be provided to the ICRP for their considerations.



The next steps

The NEA and the CRPPH will continue to explore the implications of new ICRP Recommendations including input from a broad stakeholder community with different socio-political background and cultural context.

The 2nd NEA/ICRP Forum *The Future of Radiological Protection*, which was held in Lanzarote, Canary Islands, Spain, April 2003, focused on the implications of these recommendations. This second forum was seen as a major step forward in the development of new ICRP Recommendations. Proceedings and a summary document will soon be published by the NEA.

The 3rd Villigen Workshop Stakeholder Participation in Decision Making Involving Radiation will be held in Villigen, Switzerland, 21-23 October 2003 and will focus on exploring processes and their implications.

To broaden the input from the Asian radiological protection community, the NEA is currently planning to hold a Second Asian Regional Conference in June/July 2004, supported by regional Asian expert group meetings.

REVIEW OF THE IDEAS OF THE EGRP ON CHARACTERISATION AND AUTHORISATION: CHARACTERISATION OF SOURCES AND EXPOSURES

R.V. Osborne and F.J. Turvey

The aim of the work described is to devise and test a system of characterisation of sources of, and exposures to, ionising radiation that would provide guidance, preferably in numerical form, to regulators.

In devising the system some 50 to 60 apposite characteristics were identified. These were divided into two lots; one for sources and the other for exposures. The sources were divided into 9 groups and the exposures into 8 groups. There is an average of three related characteristics in each group, e.g., in the source group called *physical state* these are *gas*, *liquid* and *solid*. Usually, but not always, the characteristics in a group are mutually exclusive. Each is given a value on the scale of 0 to 5 so that the sum of all in a group is 5. Again, taking the above example, gas is given a value of 3, liquid 2 and solid zero.

The character of a source and an exposure to it is assumed to be the sum of the selected characteristics.

When characterising a source and exposure, one fitting characteristic is chosen from each of the 17 groups and their values contribute to a total score for the source and again for the exposure. These are expressed as a percentage of the maximum possible scores in each case: thus the exposure and source characteristics are expressed in percentage terms. The character of the combined source and exposure can now be expressed by calculating the mean value of the two percentages.

In some instances there may be no characteristic in the group that fits, or describes well, the source or exposure under consideration. In such instances the group is ignored and the maximum score used in the percentage calculation is reduced by the highest valued characteristic in that group. For example, radiotoxicity is not a relevant characteristic of a cosmic radiation source and exposure.

A character score above 65% indicates the need for the regulator to consult with stakeholders. A score of less than 35% indicates to the regulator that no protective measures are needed but stakeholders may need to be consulted. An intermediate score usually means that the regulator must evaluate the situation in the traditional manner and that stakeholders need not be consulted. However, if the character score is close to the 65% or the 35% borders then the source and exposure may be re-evaluated using the double counting system which is aimed to give a refined result that anticipates the difference between the regulators judgement, based on technical, social and economic considerations, and those of the stakeholders. Regulators may find this refined result useful in making judgements in borderline cases.

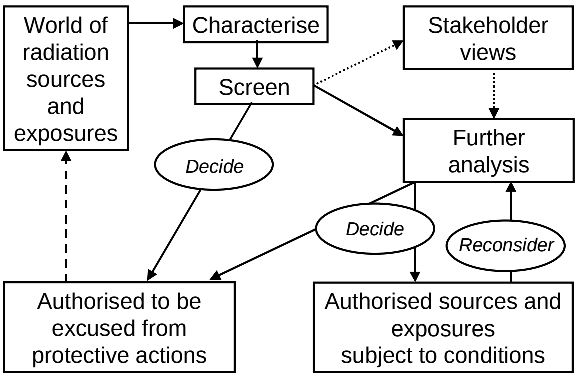
REVIEW OF THE IDEAS OF THE EGRP: COMPREHENSIVE AUTHORISATION

R.V. Osborne and F.J. Turvey

One of the questions addressed in the review of the ideas of the EGRP was whether the process of comprehensive authorisation as described in "The Way Forward: a Contribution to the Evolution of the System of Radiological Protection" would lead to a better system of protection.

The process can be seen as a particular application of the general approach taken in assessing and managing health risks of all kinds. Such an approach is to define the problem and put it in context; to analyse the risks; to examine the options for addressing the risk; to decide which option to implement – i.e., the optimum solution; to implement the decision; and to evaluate the results. The EGRP ideas cover the first four steps.

The first step (described in of the previous part this presentation) is realised by characterising and screening any selection from the world of sources and exposures, as illustrated in the diagram. The decision made as a result of the screening may be that the source and exposure being considered can be excused from protective actions. In effect, the source and exposure are returned to the "world of radiation sources and exposures". Alternatively, the screening may lead to the realisation that further analysis is needed, as shown in diagram, possibly with input being sought from stakeholders. The "further analysis" corresponds to the next three steps of the general approach and can here be called an optimisation of protection under dose constraints. The initial question asked at this stage is whether the exposures are justified. If so, then the optimisation would entail considering, *inter alia*, the characteristics of the source and exposures in more detail, any relevant dose constraints or quantitative guidelines, the feasibility and cost of protective actions, any other related impacts on health and the environment, stakeholder views and the societal context of the exposures. For all but the last two considerations, specific recommendations from international agencies would be helpful, particularly in encouraging the application of a common set of quantitative criteria. For the last two considerations, given differing national practices, only general recommendations from international agencies might be expected.



The decision from the further analysis by the regulatory authority may be that optimum outcome is that the sources and exposures should be excused from protective actions or it may be that they can be authorised subject to some conditions. The process so far has, in effect, covered the mechanisms in the current system of exclusion, exemption and regulatory control. Reconsideration of a source and exposure that is currently under regulatory control may lead to a change in the level of control and, in particular, may prompt the regulator to decide that that particular source and exposure no longer warrant control; they can be excused. The latter decision is equivalent to implementing the process for clearance in the current system.

In the review we have tested the process of characterisation, screening, and optimisation – called here "comprehensive authorisation" – on a variety of sources and exposures, ranging from cosmic ray exposures of the public to radioactive releases from nuclear facilities. Our finding has been that the scores obtained in the characterisation range from less than 35% to more then 65%, the values suggested (see Part 1 of this presentation) as the criteria for excusing from regulatory action and for indicating the need for stakeholder involvement.

The comprehensive authorisation process would appear to lead to the same general outcomes as does the present system but in a more unified way without some of the confusing terminology. Characterisation looks to be a helpful way of triggering stakeholder involvement, though there may be some difficulty in arriving at a common set of attributes – some "tuning" is needed. There is still a need for international recommendations on dose constraints and other quantitative guidelines for consideration in the optimisation process. The process of comprehensive authorisation appears to be an evolution of the present system, able to take advantage of those parts of the current system that work well. With the comprehensive authorisation process, an improved coherence with the approaches in health risk assessment in general and in environmental risk assessment would appear to be achievable.

EUROPEAN REGION CASE STUDY
THE ETHOS PROJECT FOR POST-ACCIDENT REHABILITATION IN THE AREA OF BELARUS CONTAMINATED BY THE CHERNOBYL DISASTER

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Abstract

As the worst civilian nuclear accident, the Chernobyl disaster presented the authorities first in the Soviet Union and then in the independent republics with an unprecedented problem. Strenuous and costly efforts were made to limit the effects of the accident and then to cope with the evacuation or rehabilitation as appropriate of the contaminated areas. By the mid-1990s, however, there was increasing evidence that the problems were over-taxing traditional responses. Into this context, a French team of specialists from a range of disciplines entered with a view to attempting improvements, but without preconceived ideas of what they would do or how they would do it. Beginning by listening to the people of the area of Belarus selected for the so-called ETHOS project, they discovered a profound distrust of the authorities and experts born of the perceived shortcomings of the official responses to the problems to date. They thus worked in close co-operation with the people both to identify the problems that concerned them and to develop solutions that took account of local opportunities and constraints. This interim report on a case study examining the ETHOS project is based on interviews with a wide range of people in the area of the project. It presents the problems identified by interviewees with the initial responses of the authorities and then their assessment of the ETHOS approach. The overall finding is that where public confidence has been lost in the context of an event such as the Chernobyl disaster, the authorities need to make a special effort to establish trust to a point where confidence returns. Traditional top-down responses appear to have exacerbated and reinforced the loss of confidence in this case whereas the approach of the ETHOS team appears to have succeeded in building trust to a significant degree – perhaps even to a point where there may be evidence that confidence is returning.

Introduction

The context for this case study surely needs little introduction. On 25 April 1986 an explosion and fire in the number 4 reactor at the Chernobyl nuclear power plant in what is now Ukraine released a significant amount of radiation to the atmosphere. The bulk of the material expelled during the accident fell out in the immediate vicinity of the plant, but lighter material was carried by the wind causing significant contamination across a wider area of Ukraine, Belarus and Russia. Contamination was also evident to a lesser extent in other parts of Europe and the effects of the accident could be measured throughout the entire Northern Hemisphere.

The causes of the accident are now accepted to be a combination of flaws in the reactor design and a poor safety culture within the plant that led operators to take risks that a better degree of co-ordination would have revealed and prevented. As the worst civilian nuclear accident in history, the

Chernobyl disaster presented the authorities with an unprecedented problem. The immediate containment and more prolonged clean-up operations eventually involved as many as 600 000 people (known as liquidators) and some hundreds of thousands of residents were evacuated from their homes and relocated to uncontaminated areas.

While the acute health effects of the accident are perhaps not as serious as had been feared, uncertainties must remain as to the consequences of prolonged exposure to low doses of radiation. Beyond that, the psychological impact of the accident has been significant if less easy to measure for those still living in areas officially designated as contaminated. And of course the broad socio-economic consequences for those areas should not be underestimated.

The impact of the accident was also felt throughout world in the form of a diminution, even a breakdown, of public confidence in the nuclear industry and the authorities charged with regulating it and responding to any problems. But nowhere was this more acute than in the regions of Ukraine, Belarus and Russia most directly affected by the contamination.

In the context of such a breakdown in confidence the Soviet, and later the post-independence, authorities in these countries needed to make a significant effort to build public trust to a point where confidence returned. This case study examines the reactions of people in a number of villages in the contaminated area of Belarus to the efforts of those authorities and contrasts them with their reactions to an innovative approach to post-accident rehabilitation implemented by a French team working in the region from 1996 onwards. The study is based on a series of interviews conducted in July of this year with people from all sectors of society, from the senior levels of the local administration to the ordinary people in the villages. It should be stressed, however, that this presentation offers only initial results, as the full study is not yet complete.

Defects in the approach of the Soviet and post-independence authorities

To criticise the behaviour of the authorities faced with the worst civilian nuclear disaster ever with the benefit of some 16 years of hindsight is of course relatively easy. But it risks being a pointless exercise unless the aim is to attempt to draw broader lessons for the future. To criticise them on the basis of prevailing *expert* models, however, also risks missing an extremely important lesson that surely needs to be drawn from this event – what was the perception of the *ordinary people* of what the authorities were doing? It is surely clear that a nuclear accident may result in such a catastrophic breakdown in public confidence that the assistance and co-operation that authorities will need from ordinary people as they move to respond will simply not be there. Unless the response is such that it actively seeks to build trust and thus restore confidence, it may actually be counterproductive. As we shall see, this is precisely the finding of the Belarus case study.

The interviews revealed that the approach of the authorities (both Soviet era and post-independence) to the contaminated areas in Belarus is criticised at all levels. The strongest criticism comes from the ordinary people, but even the local authorities themselves concede that things could have been done better. The problems identified can be grouped under these inter-related headings:

- a top-down approach without proper monitoring or feedback;
- consultation and measurement processes that were more formal than real;
- an approach that produced unintended side effects.

A top-down approach without proper monitoring or feedback

The overall approach of the authorities could best be characterised as top-down. Money was allocated at the highest level where it was then in essence assumed that the problems had been solved. This attitude arose from the fact that the process of identifying the problems was itself top-down. This could accordingly give rise to the construction of a picture of the situation on the ground quite different from that perceived by the people actually requiring help, and also to a poor understanding of the range of potential solutions actually available.

Sometimes this meant that radical solutions were implemented instead of more measured efforts to meet basic needs of clean food and clean fuel. Such policies frequently ended up being more costly, not least because they produced unintended side effects. A typical example cited by interviewees was a preference on the part of the authorities for the abandonment of contaminated areas without a proper appraisal of whether rehabilitation was in fact possible and without their being able to afford and thus complete the new settlements intended for the people relocated – to say nothing of the psychological problems associated with forcible and even voluntary relocation.

Once at the local level, decision making with regard to the expenditure of funds was often poor due to the fact that there was inadequate risk- and cost-benefit analysis. This led to expenditure on relatively large-scale infrastructure projects that required ongoing investment and which could not therefore be sustained. Examples included the construction of new outpatient clinics in small villages that have never been much more than empty shells because of a lack of funds to equip them, instead of developing existing healthcare infrastructure in slightly larger centres.

Consultation and measurement processes were more formal than real

It would of course be entirely wrong to suggest that the Soviet and post-independence authorities did not engage in any local level consultation as a means of achieving a better characterisation of problems or did not take decisions based on radiological measurement. The evidence of the study suggests, however, that these processes were often carried out in a way that suited bureaucratic forms rather than the needs of the people they were supposed to help.

People in the contaminated areas readily admit that the authorities and experts did come to ask them questions about local conditions and problems but they complain that little real effort was made to understand their position, to find out what really concerned those living there. A similar criticism is made of foreign and international organisations that are perceived to have treated the contaminated areas and their inhabitants in an unduly disengaged manner. No doubt science requires this dispassionate approach but the perception of those living in the contaminated areas was that they were being treated as guinea pigs.

Criticism of radiological measurement in general was a recurring theme in the interviews conducted. While a good deal of measurement was clearly carried out, people complained that it was not always systematic or well related to local needs, essentially only allowing identification of the most contaminated areas. They also complained that data collected by different agencies was contradictory and that poor communication between the agencies meant that no effort was made to remove or explain inconsistencies. As a consequence it was difficult to relate the data to the identification of problems or the development of solutions. There was also a feeling that measurement of people was often "for the sake of measurement" rather than with any clear healthcare objective in sight whether at an individual or collective level.

The scientific community beyond its role in radiological measurement comes in for similar criticism – a failure to engage properly in the understanding of real problems as opposed to working to its own unexplained agenda. When information was shared it was either not properly explained or too basic to be of any real use.

Overall, then, the bureaucratic structure is seen as having favoured formal as opposed to real outcomes. Reports were required which confirmed the allocation of funds, the expenditure of funds, the numbers of people re-housed, and so on, but none of this ensured that what was being done was actually of any use to the people it was all designed to help. The net effect of this formal and top-down approach is widely perceived to have been the hugely inefficient expenditure of vast sums of money by the authorities in the years following the accident without a proper understanding of the problems. And beyond that, the lack of proper planning and monitoring is seen to have produced unintended side effects.

An approach that produced unintended side effects

At its most basic, the overall approach of the Soviet and post-independence authorities is frequently criticised by interviewees for its incoherence and inconsistency such that near neighbours could be in receipt of quite different levels of benefit for no readily understandable, or at least no clearly explained, reason. Beyond that, the fact that benefits were linked to levels of exposure seems in some cases to have led to irresponsible behaviour, with reports of people deliberately increasing their exposure to radiation with a view to receiving higher-level benefits. It was also suggested that even if the system was widely perceived to be incoherent or ill adapted to the problems at hand, the fact that people were actually receiving money or other benefits from it meant that there was actually little incentive to reform it.

Perhaps the most frequently cited unintended side effect relates to the policy of offering children in the contaminated areas trips to sanatoriums as a means of reducing the total radiation dose they receive in the course of a year. A typical child might go on two such trips a year, each lasting 21 days. This certainly looks like a good idea but its implementation may indeed be making matters worse. First of all, the trips are organised during the academic term when the children are in any case most of the time in relatively clean schools. This leaves them at home during the summer holidays when they often spend time in the forests or swimming in the many ponds, both of which may well be heavily contaminated. And beyond this failure to address adequately the dose issue it is explicitly designed to respond to, the policy is also perceived to be having an adverse effect on the children’s education, thus affecting life chances in an area where prospects are already diminished. Again, however, it was suggested that the unhelpful facts relating to dose are being ignored because too many people feel they are benefiting from it as it stands: for example, bureaucrats who can point to the number of children sent on trips – again a symptom of a formal and top-down approach.

The ETHOS approach

It was into this context that a team of French radiologists and other experts arrived in 1996. Listening to local people and observing the problems with the existing post-accident strategies, they implemented an innovative approach characterised by:

- the involvement of the local population;
- an inter-disciplinary approach aimed at coping with the complexity that previous methods had masked; and

- an aim to promote and develop radiological safety as an integral part of the overall improvement of the quality of life.

Based on interactions with the local people, the team helped to establish six Working Groups that sought to develop solutions to problems that they themselves had identified. These were:

- radiological protection of children;
- production of clean milk;
- marketing of privately-produced food;
- radiological culture through education in school;
- involvement of young people in rehabilitation; and
- management of domestic radioactive waste.

Each group embarked on a process of collective learning where local problems were characterised and assessed before moving forward to develop solutions aimed at reconstruction and improvement within the constraints of available resources.

It is now possible to read a great deal about the success of the ETHOS project from the reports and presentations of the French team, but of greater value would be an assessment of the project by the people it was designed to benefit, the people who were so disillusioned by the top-down approach of the Soviet and post-independence authorities. That is what this case study aims to do and we can go on now to look at some of the broad findings to date.

In contrast to the prior approach adopted by the Soviet and post-independence authorities, that introduced by the ETHOS project is much more favourably regarded at all levels, from the ordinary people in the villages involved right up to the head of the local administration. In particular, the ETHOS approach is praised because it *involved* local people right from the identification of problems, through the collection of data to the taking of decisions. Thus, whereas the approach adopted by the authorities previously failed to build trust so as to get to a point where confidence was restored, the building of such trust was explicitly referred to throughout the interviews as a key achievement of the ETHOS project. It is important, therefore, to examine the mechanisms by which this trust was built. These can be considered under the following headings:

- active involvement or inclusion of stakeholders;
- personal engagement and perseverance of foreign experts;
- tangible objectives identified and aimed for;
- a real effort to help people understand the position they were in;
- improved contacts with the outside world; and
- a contextual approach.

Active involvement or inclusion

Throughout the interviews conducted in the contaminated area a recurring theme was profound appreciation for the fact that the ETHOS project actively *involved* the people it was designed to help. *This indeed was frequently identified as the main reason for the success of the project*. People welcomed the fact that the project allowed them to contribute to the identification and characterisation of problems. They also appreciated the fact that the project demonstrated to them that they had real choices and were allowed to exercise them – an approach that produced a significant shift in attitude from the fatalism that previously characterised the contaminated area. Importantly, they felt that they had a meaningful involvement in the project, that they were being helped to help themselves, and not that they were being used as guinea pigs. This was also expressed as a need to feel that they were being invested in rather than being the passive recipients of humanitarian aid – important as this undoubtedly was in some phases of the crisis. This sort of involvement was frequently described as having inspired people, as having tapped the potential that was always there but which the previous approach had failed to utilise. People readily admitted that they had taken too many things for granted, had believed they simply could not be changed, until the ETHOS project had allowed them to think about their situation more positively. It is worth noting in conclusion that many were keen to emphasise that there was no financial incentive to be involved in ETHOS – people gave of their time and energy because they believed in it. One doctor's assessment was simply that the best results were achieved when people were engaged through the issues that concerned them most, and that was why ETHOS had succeeded.

Personal involvement and perseverance of foreign experts

In contrast to the perception that authorities and experts had previously been remote and uncaring, the foreign experts in the ETHOS team were seen to have shown personal commitment and perseverance, indeed enthusiasm. This was not only evident in their frequent visits and obvious concern for the people they were working with, but also in the fact that they were prepared to take a stand for them vis-à-vis the authorities, for example in winning the release of clean lands for cultivation. That was just one example of the way in which the French team was seen to have cut through the pre-existing indifference of the authorities – whereas the latter were seen to have no stake in the area and thus not to care, the French team lived and worked with the people. This personal involvement was also seen as very important in helping to calm people's fears during the economic crisis in Belarus in the mid-1990s – an example of the way in which the approach developed by ETHOS was flexible enough to cope with emergent problems that added to the complexity of the situation.

Tangible objectives identified and aimed for

In contrast to the lack of information people previously had about what was being done for them and the frequent feeling that the authorities and experts actually had no clear aim in sight, the ETHOS project's preoccupation with meaningful tangible results was identified by many interviewees as a reason for its success and a key building block in the attainment of trust by the foreign team. Significantly, this view was also held by some in the local administration who admitted previous mistrust and identified the focus on the achievement of real results as an important factor in the success of ETHOS in overcoming that problem. The use of demonstration projects was especially appreciated and was often identified as a particularly successful means of informing and engaging more people in the overall work. It is one thing to tell people that adopting a particular agricultural practice will minimise radiation and maximise yield and income, it was said, and quite another to show them that it actually works.

A real effort to help people understand the position they were in

Again in contrast to the previous lack of understanding and the consequent negative and fatalistic outlook, the ETHOS project's emphasis on ensuring that people understood what was going on was seen as vital in building trust. A frequently cited example was people's direct involvement in radiological measurement so that they could see, understand and, crucially, believe the information produced. Another example was the comparisons drawn with the situation in France with regard to background radiation which helped to put the situation in Belarus into perspective whereas previously the focus had simply been on the fact that Belarus was contaminated and therefore implicitly without a future.

Improved contacts with the outside world

For people who felt remote and isolated in the contaminated area, the mere presence of foreign experts who did more than simply pass through was already reassuring. More than that, however, the way in which the ETHOS team, whether actively or passively, helped to develop links especially with Western Europe was seen as very significant. Local people felt that they had something in common with people in other places who faced relatively high levels of background radiation. They also felt that others were now treating the aftermath of Chernobyl as a common trans-boundary problem in need of solutions rather than as something they had to suffer alone and essentially without hope.

A contextual approach

A very significant factor in the achievement of trust was seen to be the extent to which the ETHOS approach was contextual and thus allowed a meaningful response to specifically local needs, which in turn allowed local initiative to re-emerge. Examples of this aspect of the ETHOS approach emerging from the interviews include: the taking of systematic measurements and the setting of household level norms with regard to contaminated ashes; the development of practical exercises as an integral part of normal school lessons so that pupils could relate what they were learning to their local area and specifically could understand how they could continue to live in that area; the development of detailed maps which demonstrated that whole villages should not be regarded simply as contaminated but contained varying levels of contamination and clean areas which once identified could be used strategically to reduce dose; a similarly detailed and context-specific approach to the production of food; the production of individual dose charts for each child in a kindergarten class so that children and parents could see the effects of different strategies for dose reduction rather than simply being part of a nebulous average; the micro-analysis of land in order to identify precisely rather than roughly where it is safe to plant crops, etc.

Conclusion

In summary, then, there is a stark contrast between the attitudes of people towards the approaches to post-accident rehabilitation adopted on the one hand by the Soviet and post-independence authorities in Belarus and on the other by the ETHOS team. Whereas the former did nothing to build trust between authorities, experts and the local population – and indeed even exacerbated the problem – the latter saw the building of trust as fundamental to making progress with rehabilitation. All the indications emerging from this case study so far are that they have succeeded to a very considerable extent.

Of course, the post-accident situation in the contaminated areas of Belarus has its own particularities, but that does not I think diminish the value of a study of the approach adopted by the ETHOS team as a source of general lessons for the nuclear industry and its regulators: as sure as we may be of what the right answers are to the problems we face, insofar as they directly involve a non-expert population it is vital that our approach sees the maintenance of confidence – or the building of trust to restore lost confidence – as fundamental. Formal, top-down, bureaucratic structures may seem to provide us with security and certainty and also to offer efficiencies, but as the experience in Belarus shows this can all be more illusory than real.

THE ROCKY FLATS CONTROVERSY ON RADIONUCLIDE SOIL ACTION LEVELS

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Abstract

An account of the Rocky Flats radionuclide soil action level controversy is presented as a case study for the purpose of understanding the nature and value of stakeholder involvement in the management of radiological hazards. The report consists of three main sections. The first section outlines the Rocky Flats story, including the Cold War era, which was characterised by secrecy and distrust, the post-Cold War era, in which trust and co-operation between risk managers and the public began to develop. This contrast between these two historical periods provides the context necessary to understand the radionuclide soil action level controversy, the main events of which are described in the second section. In the final section, the Rocky Flats case is briefly discussed within the framework of a general model of stakeholder involvement and the lessons learned from the case are identified: (1) without a basis in shared values, collaborative public involvement in the management of radiological hazards is not possible; (2) given a basis in shared values, collaborative public involvement can lead to improved solutions to the management of radiological hazards; and (3) risk managers should therefore seek to understand the values of public stakeholders and to identify ways, through stakeholder involvement, that those values can be incorporated in management practice.

Introduction

This report describes the Rocky Flats radionuclide soil action level controversy as a case study for the purpose of understanding the nature and value of stakeholder involvement in the management of radiological hazards. The report consists of three main sections. The first section outlines the Rocky Flats story, including the Cold War era, the post-Cold War era, and the transition between the two. This provides the context necessary to understand the radionuclide soil action level controversy, the main events of which are described in the second section. In the final section, the Rocky Flats case is briefly discussed within the framework of a general model of stakeholder involvement and the lessons learned from the case are identified.

The Rocky FlatssStory

Cold War era

The 2 600-hectare Rocky Flats site is located 26 kilometres from Denver, Colorado. During its operational period, from 1952 to 1989, the Rocky Flats Plant was a part of a huge, decentralised "national factory" established by the United States government for the production of nuclear weapons.

Other elements in the system included the Hanford and Savannah River sites, which produced the plutonium that workers at Rocky Flats fabricated into hollow spheres, the "pits" that served as triggers for nuclear weapons. Approximately 700 000 plutonium pits were produced at the Rocky Flats Plant. These pits were shipped, along with components produced at other sites, to the Pantex facility in Texas for final weapons assembly. Rocky Flats operations were first managed by Dow Chemical and then, from 1975 to 1989, by Rockwell International.

From the beginning, the relationship between Rocky Flats and the civilian population that surrounded it was characterised by secrecy, a secrecy that was generally accepted as a Cold War necessity by the local population, which benefited greatly from the thousands of jobs that were created and the millions of dollars that were pumped into the local economy. Behind the wall of secrecy, managers of the plant focused primarily on efficient production. Although concerned with worker safety, managers knew the tradeoffs they were making: efficiency would be gained at the cost of worker safety. And the focus of safety concerns was almost exclusively on radiation exposure, with relatively little attention paid to fire hazards.

Plutonium processing and fabrication at Rocky Flats resulted in frequent small fires that were usually easily extinguished. In 1957, however, a blaze heavily damaged a plutonium-processing building before being controlled. The operators and the government interpreted these fires, large or small, as posing no threat to the public, and they managed to block any public release of information about them.

The end of the period of secrecy began, in 1969, with a large fire in the plutonium fabrication building. The total cost of the fire ($70.7 million) was the highest on record for an industrial accident in the U.S. Local newspaper accounts reported that the fire caused no injuries and that radioactive contamination was confined to the building. Later studies confirmed that little or no contamination was dispersed. The source of the fire, oily rags laced with plutonium, was not revealed at the time or in later reports. Although civilian managers of the facility maintained that the fire demonstrated that significant off-site release of plutonium was not possible, government officials concluded that the Denver area had barely escaped a catastrophic release of burned plutonium in the form of powdery ash.

In response to the 1969 fire, government managers paid greater attention to fire safety, requiring stricter fire regulations and the installation of sprinkler systems. No significant fires were reported during the remaining 20 years of plutonium processing at Rocky Flats. But these measures did not satisfy the concerns that had been provoked in various segments of the public by the fire. For example, an environmentalist group called the Colorado Committee for Environmental Information did not accept the conclusion of government managers (at the time, the Atomic Energy Commission) that no plutonium escaped the plant boundaries as a result of the fire. The group, which included qualified scientists, carried out their own measurements on land surrounding the site and found plutonium oxide dust particles. Although plant managers maintained their position of denial, the environmentalists blamed the release of the plutonium particles on the 1969 fire. Faced with undeniable evidence, plant managers finally admitted that the plutonium particles came from the plant, but not as a result of the 1969 fire. The contamination was the result, they said, of the 1957 fire and of leaking drums of nuclear waste. In short, authorities, by their own admission, had been lying to the public for years in an attempt to cover up their failures to safeguard the public from radioactive releases resulting from plant operations and accidents.

Public distrust of Rocky Flats management was further fuelled by media coverage in 1973 of an accidental release of tritium into the reservoir supplying water to a town close to the plant. Plant managers assured local health officials that the site contained no tritium and therefore could not be the source of the contamination. Ultimately, the AEC identified the source as plutonium scrap metal that had been contaminated with tritium and then shipped to Rocky Flats from the Lawrence Livermore laboratory. Once again, Rocky Flats management was presented to the public as being incompetent and uncaring. Within a year, Dow Chemical was replaced by Rockwell International. In 1975 the AEC was split into the Nuclear Regulatory Commission, with control over nuclear power, and the Energy Research and Development Administration (renamed, two years later, the Department of Energy – DOE), with control over nuclear weapons production, including Rocky Flats.

Whatever the benefits brought about by the changes in management at Rocky Flats, public concern and controversy over the very existence of the plant only grew in the following years. Opposition to the plant was organised not only by environmentalists and health professionals, but now also by peace activists. In 1979, 9 000 protestors demonstrated at the gates of the plant, and 300 were arrested. Later that year, 16 000 persons, workers and their pro-nuclear allies, counter-demonstrated their support for the plant. Rocky Flats had become a focal point for a public struggle, a stage from which opposing sides could present their cases to the public.

During the early 1980s, a struggle developed between DOE and the Environmental Protection Agency over management of radioactive contamination on the Rocky Flats site. DOE claimed that Rocky Flats and other weapons sites were exempt from the environmental regulations enforced by EPA. The Chernobyl accident in 1986 stimulated an agreement between DOE, EPA, and the State of Colorado to resolve issues of regulatory compliance and hazardous waste management at Rocky Flats. Although kept secret from the public, officials at DOE knew at the time that environmental compliance at Rocky Flats was poor. Contrasting with the health and safety risks of Rocky Flats during the mid-eighties were the economic benefits: 6 000 jobs, with a yearly payroll of $280 million, coupled with $140 million spent for material and service support.

Toward the end of the 1980s, Rocky Flats became the focus of investigations by the FBI, EPA, and DOE. All found serious violations of environmental and waste management regulations. In 1989, these investigations culminated in a “raid” on the plant by FBI and EPA investigators. By the end of the year, Rockwell had been replaced by EG&G, and DOE had announced that plutonium operations at Rocky Flats would be “temporarily” suspended. The end of the Cold War in the early 1990s transformed the temporary stoppage to a permanent one. In 1992, DOE announced that the plutonium production mission at Rocky Flats had ended, replaced by a mandate to decommission and decontaminate the site.

Summary of the Cold War era

During the Cold War era, the relations between Rocky Flats management and the general public were characterised by secrecy and distrust. The distrust was based on conflicting values. From the public’s point of view, Rocky Flats management valued production over safety and preparations for war over the pursuit of peace. The end of the Cold War signalled a dramatic change in value orientations. Rocky Flats management realised that, in order to carry out its new mission of decommissioning and decontamination, it had to become open to the public and adopt the public’s concerns for health and safety as its primary guiding values.

Post-Cold War era

The transformation from plutonium production to cleanup, from secrecy to openness was symbolised, in 1994, by an official change of name from the Rocky Flats Plant to the Rocky Flats

Environmental Technology Site. And in 1995 Kaiser-Hill, an environmental engineering joint venture, took over management of the site from EG&G.

The change of mission at Rocky Flats coincided with similarly significant changes in attitude and operations at DOE. In 1993, the Clinton administration replaced the Bush administration, and a new, reform-minded leadership, stressing the public's right to know rather than the government's right to secrecy, took over at DOE. One major reform, carried out between 1993 and 1996, was the establishment and funding of local Site-Specific Advisory Boards at 12 DOE sites. With the co-operation of the state and local governments, a Rocky Flats advisory board, known as the Rocky Flats Citizens Advisory Board (RFCAB), was formed in 1993. To insure broad representation, initial (and subsequent) RFCAB members were selected from eight categories: academic institutions, administrative/business, community/neighbours, local government, health care providers, public interest groups/environmental organisations, Rocky Flats employees, and technical disciplines. Membership has ranged from 15 to 25, and the work of the group has been supported by a four-person staff.

The goals of the RFCAB, outlined in its mission statement, were:

1. to provide "informed recommendations and advice to the agencies (Department of Energy, Colorado Department of Public Health and Environment, and the Environmental Protection Agency), government entities and other interested parties on policy and technical issues and decisions related to cleanup, waste management and associated activities";
2. to promote "public involvement, awareness and education on Rocky Flats issues." Over the years, the RFCAB has developed more that 100 consensus recommendations.

In 1999, the RFCAB formulated a *Vision for the Cleanup of Rocky Flats*, a document that stated the Board's positions on environmental restoration, building remediation, special nuclear materials shipment, waste management, and site reuse. The *Vision* made clear recommendations on issues for which the Board had reached consensus; on issues lacking consensus, no recommendations were made. For example, the Board opposes any radioactive waste disposal onsite, but there is no consensus on whether it should support the disposal of transuranic waste at the Waste Isolation Pilot Plant in New Mexico. Regarding the critical issue of future use of the site, the Board recommended that the entire site become open space after completion of the interim cleanup. Selection of the specific type of open space, the Board said, should be a process that includes comprehensive public involvement.

Summary of the post-Cold War era

In contrast to the secrecy and distrust of the Cold War, the years that followed it produced a growing openness on the part of DOE, resulting in the development of a degree of trust and co-operation between government managers, the RFCAB, and the general public.

The radionuclide soil action level controversy

The trusting relations that had been developed between DOE, the RFCAB, and the general public were tested in the mid-nineties when the public concern was expressed over the degree of cleanliness for the Rocky Flats site that DOE was committed to.

The triggering event

The controversy started in 1996 when DOE announced interim radionuclide soil action levels (RSALs). For plutonium, the RSAL was about 4,300 Bq kg^{-1} assuming a dose limit of 0.15 mSv y^{-1}. The RSALs, which determine post-cleanup limits for radionuclides in Rocky Flats soil, were incorporated into the Rocky Flats Cleanup Agreement (RFCA). The RFCA is the legally binding agreement between DOE the regulatory agencies (EPA and the Colorado Department of Public Health and Environment). When members of the public had a chance to examine the RSALs, concerned developed over the fact that the RSALs for Rocky Flats seemed to be higher than at other remediation sites. This public concern led to calls from the RFCAB, local government officials, and public interest groups for an independent assessment of the RSALs and the process used to establish them. A series of discussions between these groups and DOE led to an agreement by DOE to fund an independent scientific assessment of the RSALs for Rocky Flats.

From controversy to collaboration: The radionuclide soil action levels oversight panel and risk assessment corporation

A panel of community representatives, known as the Radionuclide Soil Action Levels Oversight Panel (RSALOP), was formed to monitor the new study. This panel was similar in some ways to the RFCAB, and some individuals were members of both groups. The RSALOP was unique among public advisory groups, however, in the high level of technical training and experience of most of its members: out of 13, 5 had Ph.D.s, 2 MSs, and 5 BSs (DOE, EPA, and CDPHE were each represented by an ex-officio member). The technical expertise of the RSALOP meant not only that they were extraordinarily well equipped to understanding the highly technical arguments associated with RSAL assessment, but, even more important, that they were likely to believe that such arguments carried weight. That is, the members of the RSALOP believed in the legitimacy of scientific arguments and evidence, and would base their recommendations on an assessment of those arguments and that evidence.

The general orientation of the RSALOP was immediately evident when they followed the standard procedure of soliciting proposals for the RSAL assessment from technically qualified consultants. Risk Assessment Corporation (RAC), a team headed by John Till, and with previous experience at Rocky Flats, was selected for the job. Till has described the structure of the interaction between his team and the RSALOP as follows:

> The Panel met for work sessions with RAC monthly between October 1998 and March 2000, with all meetings open to the public. An additional three informational meetings were held specifically to update the community on progress and results. The regular monthly Panel meetings lasted about three hours. Before each meeting a two-hour technical discussion session allowed Panel members, DOE, and others to have a more in-depth dialogue with RAC scientists. This format proved to be very successful because of the intense interest in carefully following the assumptions being made and in understanding the technical methods applied. If the soil action level selected appeared to be too high, the public would be concerned about its implications on health of future populations. If the level selected was too low, the cost of cleaning up the facility could be come prohibitive. (Till & Meyer, 2001, p. 371)

Thus, Till and his team saw the focus of their job to be on explaining to the RSALOP both the technical aspects of their work and the tradeoffs involved in recommending RSALs for Rocky Flats. The Panel, in turn, concentrated on understanding the technical arguments, interpreting them for the RFCAB and the broader community, and, finally, advising DOE.

The RSALOP organised the project into eight tasks:

1. Cleanup levels at other sites

As noted above, the widespread public belief that DOE's initial RSALs for Rocky Flats were higher than those at other sites led to a call for an independent assessment. The RSALOP and its consultants released a report in April 1999 that confirmed public concerns: RSALs for Rocky Flats were higher than at other sites. But the report went beyond simple comparisons. It identified the key parameters in the calculation of RSALs and showed that the differences in RSALs among sites could be explained by differences in the assumptions made for the key parameters. This basic technical understanding of RSAL calculation provided a foundation for the remaining tasks in the project.

2. Computer models

The RAC consultants produced a report in July 1999 that surveyed available computer programs for use in calculating RSALs. Among these was the RESRAD programme, which had been used by DOE. Discussions between RAC and the RSALOP led to the selection of the RESRAD program. In addition to familiarising the RSALOP with the ways RSALs are calculated, this task was important in enabling the Panel to understand why DOE had used the RESRAD programme in the first place.

3. Inputs and assumptions

Both John Till and the RSALOP have described the difficulties involved in this critical task. According to Till, the initial goal of Panel members was the recommendation of a single specific soil action level for each radionuclide. The sole criterion, according to some Panel members, should be health risk. Till and his team, in contrast, stressed that economic and socio-political factors should also be taken into account and that their work should lead to a methodology rather than a specific RSAL. And the methodology must be based on stochastic procedures, incorporating probability distributions as input and output. Even with the relatively high level of technical expertise represented on the RSALOP, Till and colleagues experienced difficulties in communicating the meaning of the probabilistic concepts that were central to their methodology. According to Till, the process was "painstakingly tedious and time consuming, but in the end it proved to be a vital element of the project's success."

In addition to the difficulties of dealing with probabilistic concepts and models, the Panel and the RAC consultants also had to tackle the more concrete and politically sensitive problem of defining exposure scenarios for possible future site uses. This part of the task was perfectly suited to Panel members, of course, and, through them, members of the RFCAB, and, ultimately, the general public. According to Till, there were significant differences among Panel members regarding beliefs about possible future events. A good deal of time was devoted, by both Panel members and the RAC team, to discussions of exposure scenarios, particularly to breathing rates and soil ingestion rates. Outside experts were also consulted. Till called these discussions the most difficult of the entire project. In the end, three scenarios were selected to form the basis of RSAL calculations: (1) a rancher who lived onsite and downwind from the most highly contaminated area; (2) a child of the rancher who lived at the same location as the rancher; and (3) an infant of the rancher.

4. Methodology

This task encompasses the project as a whole, reflecting the position advocated by the RAC team that the overall goal of the project should be the selection of a methodology for calculating RSALs, as opposed to recommending specific RSALs. Since methodological issues are discussed in the reports produced for the other specific tasks, no separate report was published for this general task.

5. Independent calculation of RSALs

The report for this task presents the results of RAC's independent assessment of RSALs for the selected exposure scenarios.

6. Soil sampling protocols

In December 1999, RAC released a report that reviewed the current site sampling program and procedures and provided recommendations for the development of a sampling protocol for future use at the site.

7. Interaction with the Actinide Migration Panel

Toward the goal of developing the best possible approach to the closure of the Rocky Flats site, the Actinide Migration Panel (AMP) gathered state-of-the-art knowledge on the behaviour and mobility of actinides in the environment. To take advantage of this effort in their own work, both RSALOP members and RAC consultants regularly attended AMP meetings.

8. Public involvement

The public was invited to attend the monthly meetings between the RSALOP and the RAC team. In addition, three public meetings were held at key points to obtain reactions from the community on all phases of the technical review.

The eight project tasks and the constructive interaction between the RSALOP and the RAC team reflected the general scientific/academic orientation of the Panel. Another indication of the Panel's overall approach was its formation of a Peer Review Team made up of five nationally recognised experts in relevant fields. This Team provided ongoing review and comments on all documents produced by RAC. According to John Till, these peers review process contributed to the quality of the consultants' work. Till cites the specific instance of peer reviewers calling *RAC*'s attention to the neglected impacts of fire on their calculations. *RAC* responded in writing to every comment provided by the peer reviewers, and the responses were in turn reviewed by the RSALOP. This continuing interaction throughout the project contributed significantly to the Panel's growing confidence in RAC's technical approach.

Assessment of the RSALOP/RAC collaboration

In a summary statement on the project, John Till highlights both success and failure:

The primary objective of this project was to calculate a radionuclide soil action level for cleanup at the Rocky Flats Environmental Technology Site. The project was performed with oversight and input from a Panel made up of community and government representatives to improve the acceptability of the results as a decision-making tool for establishing a cleanup level of the site. The results were presented as probability curves of possible values for several of the most restrictive exposure scenarios. Assuming a dose limit of 0.15 mSv y^{-1} and taking uncertainties into account, the results indicated a range of radionuclide soil action levels between about 700 and 2,000 Bq kg^{-1} assuming a 10% probability level results in a nominal value for a radionuclide soil action level of about 1,300 Bq kg^{-1}. Although this result formed the technical foundation for a soil action level for cleanup based strictly on meeting a specified level for permissible exposure to radiation, it most likely will be given further consideration by accounting for economic and socio-political factors that were not addressed in this study. (Till & Meyer, 2001, pp. 377, 378)

The project was very successful within its restricted mandate: RSALs were calculated and recommended to Rocky Flats management. This was a significant achievement that the development of trust and confidence between the RSALOP and the RAC team made possible. The trust between the two groups was based primarily on shared respect for scientific/academic values. Both groups believed that the best approach to Rocky Flats cleanup was one based on the best available scientific and technical information. And both groups also believed that the best approach to obtaining the best scientific and technical information was one that was open to criticism and correction from independent, qualified individuals. So long as outside critics shared their scientific/academic values, the RSALOP and RAC would listen to what they had to say and take account of it. That is, broader participation in the process – by *qualified* individuals/groups – can lead to better, more technically defensible results. Although the specific results of the project were not universally accepted either by DOE or by public critics – the open process followed by the RSALOP and RAC certainly contributed to acceptance of the general approach by the wider public.

Within the context of scientific and technical discussion/debate, this project was very successful in demonstrating the power of graphic presentations. Here is John Till describing one such presentation:

"The technical approach provided a series of probability curves based on the different scenarios developed with the assistance of the Panel. One key feature considered was the occurrence of a prairie grass fire. A fire could significantly affect the amount of vegetation present and, thus, increase subsequent resuspension. The fire was accounted for in the different scenarios using a probabilistic approach. [The figure] is a composite graphic illustrating the most restrictive scenarios and the importance of considering the prairie fire. A probability level of 1 implies that the dose limit will be exceeded. Although a 10% probability level was used in our calculations because this level represents generally acceptable scientific levels of uncertainty, it was stressed to the Panel that it could change the probability level to whatever value best reflected the concerns of the community.

To better visualise this range of radionuclide soil action levels, [the figure] is underlain with a spectrum that expands in both directions around 1200 Bq kg^{-1}, which is about where the rancher curve intersects the 10% probability level. The spectrum is darker near the centre and lighter farther out. The graphic suggests a range of possible radionuclide soil action levels between about

700 and 2000 Bq kg^{-1}. Although there is no quantitative basis for this range, it is apparent that going too far in either direction from the centre of the spectrum can potentially be problematic for a variety of reasons. Radionuclide soil action levels that are significantly lower may correspond to overly conservative scenario descriptions and may incur significantly greater costs than can be justified. On the other hand, radionuclide soil action levels that are significantly larger lead to a high probability of exceeding the prescribed dose limit and could impact human health. This representation of probability curves greatly enhanced the Panel's understanding of our results and aided in their selection of a soil action level for cleanup at Rocky Flats. (Till & Sharp, n.d., p. 5)."

The colourful graphics employed by the RAC team were very effective in helping to communicate complex, probabilistic technical information. But it must be kept in mind that the audience for these presentations was generally technically sophisticated, if not in the specific topic being explained. Also, the RSALOP was eager to learn; they saw that becoming familiar with and learning to understand relevant technical issues was central to their mandate as representatives of the RFCAB and the wider public.

The successes of this project – the establishment of trust, the open discussion of highly technical issues, the development of a methodology to calculate RSALs – all depended significantly on the narrowness of the context in which the project took place. That narrow context is also the source of the project's failures. One specific shortcoming, identified by John Till, was the failure (because excluded from the mandate) to consider RSALs in conjunction with economic and socio-political factors. Another failure mentioned by Till was a failure to plan and provide for the implementation of the results of the project. Not only was there no budget to support possible implementation efforts, there was no provision for implementation in the agreement with DOE and the state and federal regulators. Instead of accepting the work of the RSALOP and RAC, DOE and the regulators performed their own reassessment of the RSALs. Although no yet officially announced (as of December 2002), DOE officials have indicated that the final RSALs will be close to those recommended by the RSALOP and RAC.

A general failure of the project, again stemming from the narrowness of its mandate, was its inability to generate much interest or involvement in the wider public. In an important sense, this lack of public involvement is not a failure at all. It can be seen as a triumph of efficient representation, of those who are qualified and motivated representing those who are affected but either not qualified or not motivated. Still, it is a stated goal of both the RFCAB and the RSALOP to involve the wider public. The RFCAB undertakes many routine activities aimed at increasing public involvement, such as placing advertisements for meetings on a monthly basis, sending monthly meeting notices to a mailing list, publishing a newsletter, maintaining an Internet web page, etc. Among the 30 attendees at a recent meeting, however, there was only one independent member of the general public. Given the realities of daily life, most people, except in times of crisis, seem to be willing to rely on trusted representatives to do most of their public participating for them.

In sum, the project was a significant success within the boundaries of its mandate. And without those clearly defined boundaries, success may not have been possible.

Conclusions and lessons learned

As with every case study, the specific historical and cultural context of the Rocky Flats radionuclide soil action level controversy made possible – and set limits on – successful stakeholder involvement. Nonetheless, the Rocky Flats case suggests several lessons that may prove valuable in other risk management contexts.

The context of Rocky Flats

The most significant event in the history of Rocky Flats was the end of the Cold War, which led to the transformation of mission from plutonium production to cleanup. During the production period, the concerns of public critics of Rocky Flats and those of DOE were diametrically opposed. DOE was in the business of producing dangerous weapons, with the collateral production of dangerous wastes. Public opposition was based not only on environmental concerns but also – particularly for the broader public outside the vicinity of the plant – on nuclear weapons and war concerns. When DOE stopped making weapons and waste and started planning for cleanup and closing, it, in effect, ceded victory to its former opponents and joined them in working toward goals that everyone (at Rocky Flats, if not at the places to which Rocky Flats wastes were to be shipped) endorsed. There was broad consensus on a shared set of values; confrontation had been replaced by co-operation.

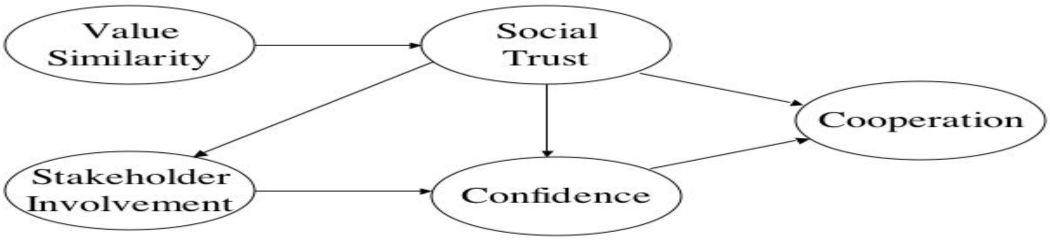
When the environment of its operations changed, DOE adapted appropriately for the most part, as did their former opponents. Of course, the consensus that evolved was not all encompassing. Public concerns, as represented by the RFCAB and local governments, centred on public health, in the present and far into the future. The public wanted the site to be as clean as practically possible. DOE, on the other hand, had to be concerned with the costs of the cleanup, and the workers on the site (still 5 000 during the cleanup phase) were concerned about keeping their jobs. The disputes during cleanup, then, were totally different from those during production. They were not about basic values; they were about tradeoffs between values – costs and cleanliness – that everyone agreed were important. This is the context within which the dispute over RSALs took place.

Understanding stakeholder involvement at Rocky Flats

Stakeholder involvement in the radionuclide soil action level controversy at Rocky Flats was successful because it was based in, and legitimised by, a relationship of mutual trust that had been established, first, between the RFCAB and DOE, and, second, between the RSALOP and RAC. The RFCAB and DOE were able to work co-operatively because they were working toward the same goal, the cleanup of Rocky Flats. The scope of their trust was limited, of course, and those limits were tested in the radionuclide soil action level controversy. Still, in that controversy, the RFCAB and DOE were able to agree on constituting the RSALOP, trusting it to manage a process acceptable to both groups. In addition to sharing the goal of a clean Rocky Flats, the Advisory Board and the Panel also shared with DOE a broad acceptance of the efficacy and legitimacy of scientific procedures. This was demonstrated throughout the collaborative process carried out by the RSALOP and RAC.

The successful stakeholder involvement process at Rocky Flats can be understood within the general model of stakeholder involvement shown below:

A General model of stakeholder involvement



This model, derived from a general theory of social trust (Earle & Cvetkovich, 1995; Earle, Siegrist, & Gutscher, 2002), shows that successful stakeholder involvement is dependent on the prior establishment of social trust. In other words, there is nothing in stakeholder involvement procedures, *themselves*, that will lead to confidence in the good behaviour of the other and co-operation between groups. The value of stakeholder procedures, such as public involvement in advisory groups, is interpreted within the context of existing social relations. If those relations are distrustful, as was the case in Cold War Rocky Flats, no amount of involvement or advice-giving will lead to confidence and co-operation. Once trust is established, however, stakeholder involvement can be very effective in building confidence in the other, leading to co-operation. How is trust established? As the model shows, social trust is based on shared values. Thus, a clear demonstration that two groups are pursuing the same goal, as was the case in post-Cold War Rocky Flats, can lead to trusting relations, which in turn can provide the context for productive stakeholder involvement and mutually beneficial co-operation.

The Rocky Flats radionuclide soil action level controversy is a prime example of what Charnley (2000) has called *Democratic Science* and Beierle and Cayford (2002) have called *Democracy in Practice.* As outlined by Charnley, the process involves the following steps:

1. Stakeholder values help clarify concerns about potential risks and risk management goals.
2. Questions that must be answered to address stakeholder concerns are articulated and the factual information needed to answer those questions is identified.
3. Stakeholders then identify and agree on whom should be responsible for obtaining the needed factual information.
4. After the needed scientific information is obtained, it is combined with other information and used either to re-frame the problem and risk management goals or to guide decision making.

The democratic ideals articulated by Charnley and by Beierle and Cayford are values shared by many stakeholders and by many risk managers. The activation of these ideals, however, requires – as our model of stakeholder involvement shows – that specific stakeholders and specific risk managers share certain specific values. Trust and successful stakeholder involvement depend less on agreement on general, abstract formalities than they do on agreement on local, concrete concerns.

The lessons of Rocky Flats

In this report, eight key events in the history of the Rocky Flats radionuclide soil action level controversy were highlighted:

1. The nation-wide transition from Cold War secrecy (based on opposing values) to post-Cold War openness (based similar values, at least in part).
2. The establishment by DOE of site-specific advisory boards, including the RFCAB, to provide advice to DOE and other agencies and to promote public involvement.
3. The announcement by DOE of interim RSALs for Rocky Flats.
4. The expression, through the RFCAB and other organisations, of public concern over the interim RSALs.
5. The formation of the RSALOP.
6. The hiring of RAC.
7. The collaborative interaction between the RSALOP and RAC, resulting in a recommended methodology for calculating RSALs for Rocky Flats.
8. The implementation of the project results (or lack thereof).

This series of events reveals the three general lessons of Rocky Flats:

1. Absent a basis in shared values, collaborative public involvement in the management of radiological hazards is not possible.
2. Given a basis in shared values, collaborative public involvement can lead to improved solutions to the management of radiological hazards.
3. Risk managers should therefore seek to understand the values of public stakeholders and to identify ways, through stakeholder involvement, that those values can be incorporated in management practice.

References

1. Ackland, L. (1999). *Making a real killing: Rocky Flats and the nuclear west.* Albuquerque, New Mexico: University of New Mexico Press.

2. Beierle, T.C. & Cayford, J. (2002). *Democracy in practice: Public participation in environmental decisions.* Washington, DC: Resources for the Future.

3. Charnley, G. (2000). Democratic science: Enhancing the role of science in stakeholder-based risk management decision-making. Washington, DC: HealthRisk Strategies.

4. Earle, T.C. & Cvetkovich, G. (1995). *Social trust: Toward a cosmopolitan society.* Westport, Connecticut: Praeger.

5. Earle, T.C., Siegrist, M., & Gutscher, H. (2002). Trust and confidence: A dual-mode model of co-operation. Unpublished manuscript. Western Washington University, Bellingham, WA.

6. Till, J.E. & Meyer, K. R. (2001). Public involvement in science and decision making. *Health Physics*, *80*, 370-378.

7. Till, J.E. & Sharp, S.L. (n.d.). Public participation in decision-making for contaminated sites. Retrieved from: http://www.google.com/search?q=cache:2tAnkqrirOwC:www.oita-nhs.ac.jp/~irpa10/CD-ROM/Full/01312_10_latesr13h00585.pdf+public+participation+decision-making+contaminated+sites&hl=en&ie=UTF-8

EXPERIENCES IN THE LAST AMENDMENT OF RADIATION REGULATION LAWS IN JAPAN

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Abstract

In the deliberation on the introduction of the ICRP recommendation to the radiation regulation laws in Japan, the Radiation Council opened the meetings and the draft report to the public, and requested comments. Submitted comments were reflected in the deliberation. As for the following three subjects, that is, dose limit of occupational exposure for women, classification of workplaces and limitations of the occupational exposure in the emergency, a lot of opinions were expressed in the process of the deliberation on the council, and there were a lot of various opinions of the general public to the draft.

These opinions were the opinions from each standpoint where benefit conflicted with damage, opinions based on different ideas, and opinions from a socially different standpoints.

The Council drew the conclusion after having examined that the grounds of argument had been well verified in a scientific manner and the conclusion of each subject maintained the correspondence in the whole system of law.

In order to improve the current comment requesting system, it was pointed out that further discussions by open system among authors, experts and submitted general publics who had the responsible opinion is desirable.

Introduction

The technical criteria for radiation protection in Japan have been deliberated in the Radiation Council respecting for the ICRP Recommendations, and the deliberation on the introduction of the ICRP Recommendation (Publication 60) to the Radiation Regulation Laws were started in 1991. During this deliberation, Freedom of Information Act was enforced in 1997, and since then, the Council held meetings with participation of the public, opened the draft report, and requested comments from the general public. Comments submitted by the public consisted of about 1 400 letters, largely exceeding our expectation. The Council considered the comments and finally revised the draft reflecting them.

The outline of the deliberation process in the Council and the review for the current comment requesting system are introduced below, especially on subjects where opinions varied in the Council and incorporating the comments submitted by the public.

Deliberation in the Council

As a result of deliberations, the quantities used for radiological protection, the dose limits for occupational and public exposures, the system of protection in medical exposure, etc. in the ICRP Publication 60, it was recognised that the grounds of arguments for these subjects are well verified physically and biologically, and their introduction to the Radiation Regulation Laws was adopted.

Contrary to above subjects, there were various opinions in the Council and the comments submitted from the public on the following subjects: the dose limit of occupational exposure of women, classification of workplaces and limitation of occupational exposure in an emergency.

The dose limit of occupational exposure for women

In the deliberation of the Council, the following problems were indicated. The first is difficulty to ensure safety by a conceptual regulation system. In Publication 60, paragraph 177, it is stipulated that the Commission considers that its policy will be adequately applied if the mother is exposed, prior to a declaration of pregnancy, under the system of protection recommended by the Commission, including the recommended dose limits for occupational exposure. On this basis the Commission recommends no special occupational dose limit for women in general. The system described above is a philosophical one; however, in our country, there is no law system of ensuring safety by setting up a concept, and traditionally safety is ensured using numerical standards, such as microgram per cubic centimeter for noxious substances.

Second, if the dose limits for occupational exposure, 100 mSv per 5 years and 50 mSv in any single year, are applied for women, there is the possibility that the exposure becomes 50 mSv within a short term period before the pregnancy is declared. The protection standards for any conceptus should provide a standard broadly comparable with that provided for members of the general public. If so, the dose limit of 50 mSv for conceptus contradicts to the dose limit for the public, and exposure of 50 mSv is unacceptable level of risk.

Third is the protection of maternity. In the Treaty of United Nations, it is clearly described that taking any special measures aimed at protecting maternity should not be interpreted as discrimination against women.

As a result of deliberations, the Council determined the dose limit of occupational exposure for women to be 5 mSv per 3 months, because of the possibility they could be or become pregnant. Only as an exceptional case, the special dose limit does not apply to declared women .

Minority opinions in the Council were that the equal opportunity of employment for men and women is described in the International Treaty, so that it is not necessary to introduce the special dose limit of occupational exposure for women.

Submitted comments were as follows.

The majority of submitted comments did not admit the need of special dose limit, because the ICRP did not recommended on a scientific basis, and women performing work in radiological areas would be difficult owing to work control dose level set at a level that is lower than the dose limits, such as 4 mSv per 3 months.

A minority of comments, submitted from labour unions, said that the special dose limit for female workers is needed for the protection of maternity and conceptus. Another comment, submitted from The Ministry of Labour, was that the exceptional clause is a retreat of maternity protection.

Classification of workplaces

The Council considered following three necessary conditions for radiation controlled area:

- designation of controlled areas is an important factor in radiation control and needed to be prescribed by regulation laws;
- doses received outside the designated area should be lower than the dose limits for the general public; and
- dose level at the boundary of a controlled area is in need of practical guidelines for radiation control and for protection of anyone staying at outside the area.

From these considerations, the Council determined that the laws should prescribe the dose level at the boundary. The following investigations were considered:

- As the dose limit for public in special circumstances, the ICRP recommends 5 mSv.
- The dose rate decreases with distance from the boundary of controlled area.
- The doses to be practically received at the outside of the area will be less than the established dose level considering a position outside the area in which it stays and the length of time it has remained.

Considering the above conditions and investigations, the Council has reached the judgement that the dose level at the boundary should be selected, as the actual dose received at outside area is less than 1 mSv per year without any special control.

The Council determined the following dose levels at the boundary of controlled areas:

- dose level for external exposure; 1.3 mSv per 3 months in effective dose;
- radioactive air concentration for internal exposure; the mean concentration in 3 months is corresponding to 1.3 mSv per 3 months in effective dose; and
- for co-existing case of external and internal exposure; sum of both exposures correspond to 1.3 mSv per 3 months in effective dose.

Minority opinions in the Council were that the designation of controlled area and consideration for workers staying outside the controlled area should be entrusted to the discretion of registrants and licensees; this was stated in the guidelines.

Submitted comments were as follows:

Majority comments pointed out no need to change existing level (300 micro Sv per 3 months). Reasons for these comments were as follows: (1) there is no over-exposure under existing laws; (2) additional shielding for buildings and facilities constructed under existing laws will increase cost; and (3) restrictions of the usable amount of RIs and nuclides and operating time of devices such as accelerators and generators will limit research works. Research groups, radiological technician groups, research institutes and scientific societies submitted these opinions.

Limitation of occupational exposure in an emergency

The ICRP recommended that the effective dose should not be allowed to exceed 0.5 Sv in the control of the accident and immediate and urgent remedial work except for life saving. However, 0.5 Sv is a half of total effective dose received in a full working life, and this brings anxiety of affection to later radiation work.

On the other hand, IAEA, in its Basic Safety Standard, recommended that exposure for emergency workers should be kept below twice of annual dose limit in intervention.

The Council determined the dose limit for occupational exposure in an emergency as 100 mSv, and add it is inadequate to apply for preventing action of large amount discharge of RIs and for life-saving action, and even if in an emergency, it is necessary to decrease workers exposure to as low a level as possible.

Minority opinions in the Council were as follows: Since the establishment of the dose limits for occupational exposure in emergency by laws led the restriction of emergency action, dose level should be indicated in guidelines, and judgement of dose limitation entrusted to registrants and licensees.

Majority of submitted comments were as follows: If the exposure of workers is over the dose limit, the government will inflict a punishment on registrants and licensees, and these systems will restrict judgement and action in emergency; therefore the exposure of workers should be limited by guideline in emergency action plan.

Minority comments were varied:

1. Protection of health and property of the public take priority over the safety of workers. If dose limit of workers prescribed by laws, emergency action will be restricted and expand damage of the public, so limitation of exposure by laws is not needed.
2. Occurrences of emergency are the responsibility of registrants and licensees, so, they should perform emergency work irrespective of the dose limit.
3. Limitation of workers' exposure by laws is needed to ensure the safety of workers such as fireman, policeman and supporting groups. The binding force of a guideline is weak compared with laws; it is imaginable that workers be commanded to work exceeding the guideline, and so, limitation by laws is needed.

Determination of safety criteria and standards

On the occasion of determination for safety criteria and standards, correspondence and judgement are different depending upon the bases of opinions and comments, such as philosophy, grounds, situation and viewpoint. If the opinions and comments for safety criteria are different and conflicting, decision makers should judge considering the following points: that is, bases of opinions and comments, principle of radiation protection, and philosophical and numerical consistency in the systems.

Case 1. Confrontation between merits and demerits

This case corresponds to workplace classification. Opinions of public and regulatory authority are to ensure the public safety; that is benefits, so they assert that the dose level at the boundary of the controlled area is to be decreased. Opinions of registrants, licensees and researcher were not change existing dose level owing to the increase of cost due to additional shielding and limitation of research works; these are loss. Simple judgement is to apply 1 mSv per year as the dose level at the boundary of controlled area. For this case, the Council considered the consistency of the protection system and principle of radiation protection. Judgement of the Council was to give priority to ensure safety of persons remaining outside the area, considering optimisation of radiation protection.

Case 2. Need of consideration on plural factors

This case corresponds to dose limit for female workers. Several factors complicate this matter.

First, conflicting opinions were based on philosophy. The opinions of some groups were that conceptus should be considered as a member of general public, and special dose limit for female workers is needed for the purpose of protection of maternity. The opinions of the other group are that the special dose limit is not needed, for reasons of equal opportunity of employment of for men and women.

Second, conflicting opinions were based on conflicting viewpoints.

The opinions of some groups were that application of 5 mSv per 3 months is beneficial to the safety of female workers. The opinions of the other groups were that performance of work would be limited owing to low dose limit.

Third, conflicting opinions were based on varied situations. The opinions of some groups were that application of special dose limit for females ensures the safety of radiation work, so that radiation work can be given to females without anxiety. The opinions of the other groups are that employment of female radiation workers will be difficult owing to the low occupational dose limit for female.

Judgement of the Council was based on the logical and numerical self-consistency in laws.

Case 3. Numerical limits by law or discretion of registrants and licensees

This case corresponds to establishment of dose level at a controlled area, and limitation of occupational exposure in emergency.

For the establishment of dose level at a controlled area boundary, the opinions of some groups were that the establishment of dose level should be entrusted to the discretion of registrants and licensees. This is same as the ICRP recommendation. The opinions of the other group were that these are an important factor in radiation protection control and need dose level needs to be regulated by laws.

For the protection of workers and the public remaining outside of the controlled area but inside of the supervised area, the opinions of some groups were that this correspondence should be done as the operating management of registrants and licensees. Opinions of the other groups were that laws including numerical standards should ensure the protection of workers and the public.

For limitation of occupational exposure in an emergency, opinions of some groups were that the establishment of dose limit by laws will restrict emergency action due to penal regulation; therefore, limitation of workers exposure should be entrusted to registrants and licensees. Opinions of the other groups were that the protection of workers is one of the most important matters in an emergency and should be protected by laws.

The judgement of the Council was that the protection of the public and workers is the obligation of regulatory authorities, so laws should regulate these dose levels and dose limits.

The merits of a more open information system and current comment requesting system are to enhance the transparency of the decision-making process, in order to reflect comments of multilateral viewpoints, especially that of the concerned public. Radiation safety standards are usually based on scientific and technological grounds, and hitherto determined by experts of each field in the Radiation Council. However, in case the standards relate directly to public safety, it is important to investigate the public's viewpoints, and the current comment requesting system is one of the methods according to accomplish this. Therefore, hereafter, comments from interested parties and individuals should be actively included in the decision-making process using this system.

Defects and limitation of current system are as follows:

- Supporting groups are usually in silent agreement in Japan.
- Opposing groups are very active.
- There are no further discussions after submission of comments; this is a limitation of the current comment requesting system.
- Situations of persons who submitted comments are unknown. These are important to understand the bases of opinions.
- No one takes responsibility for their comments; this is important for further discussions.

In order to improve the current comment requesting system, it is desirable to promote further discussions by open system with writers, experts and persons who submitted comments as responsible presenters of opinion, that is, stakeholders.

Conclusion

Recently, demands of the public are increasing strongly for the establishment of highly reliable safety standards and rigorous regulation. In these circumstances, responsibilities of decision-makers on safety standards are also increasing.

The radiation safety criteria should satisfy the following essential conditions:

1. the system of radiation protection is logical and coherent;
2. the grounds of argument are well verified scientifically; and
3. the numerical values of standards are self-consistent in the system.

Justifiability and suitability of safety standards will be investigated in various situations. Interventions by economic, social and political groups are anticipated in the decision-making process, and in some situations political judgement may take priority.

It is very important to firmly bear in mind that ultimately, decision makers are to be judged by the court for the logical justifiability and suitability of safety standards.

THE DIRECTION OF ICRP – NEW RECOMMENDATIONS

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Abstract

ICRP has been stimulating discussion, during the past three years, on the best way of expressing protection philosophy for the next publication of its Recommendations, which it hopes will be by 2005. The present recommendations were initiated by Publication 60 in 1990 and have subsequently been complemented by additional publications over the last twelve years. In this paper the totality of those recommendations is summarised and used to indicate a way forward to produce a simplified and more coherent statement of protection philosophy for the start of the 21st century.

Introduction

In the last three years ICRP has been stimulating discussion on the best way of expressing protection philosophy for the next publication of its Recommendations, which it hopes will be by 2005. The Commission has been encouraged by the support it has received from around the world for the strategies it is pursuing, both on the scientific front and for its openness in engaging in the debate. It is therefore beginning to prepare the first draft of these recommendations with a view to distributing an early version for comment, even though the background work is incomplete.

These recommendations should be seen as a consolidation of recommendations from Publication 60 and those published subsequently, to give a single unified set that can be simply and coherently expressed.

Major changes from the 1990 recommendations

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

The existing concept of dose limits has been extended to embrace a range of protective actions and the level above which each action should be taken, called Protective Action Levels. Protective actions can be applied to the source and to the pathways leading from the source to the doses in individuals. They replace a range of terms that include intervention levels, action levels, constraints and exemption levels as well as the dose limits for workers and the public.

The opportunity is also being taken to give a clarification of dosimetric quantities needed for protection purposes, to include a coherent philosophy for natural radiation exposures and to introduce a clear policy for radiological protection of the environment.

Exclusion of sources and associated exposures

The Commission continues to use the term “Practice” to mean the deliberate introduction of a new controllable source or the continued operation of a controllable source that has deliberately been introduced. Its Recommendations can then be applied 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 a controllable source are 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 is seen as a regulatory term applied to non-excluded sources, but which the regulatory body decides can be released from its control.

Natural sources

The Commission intends to include recommendations for protection from natural radiation sources. It is clear that it is the controllability of the exposures, which determines whether the exposures are excluded from, or included in, the system of protection. In particular, the control of radon-222 is a special case because of its ubiquitous nature.

The Commission’s Recommendations for radon-222 in Publication 65 have been widely accepted and the Commission proposes they should continue. These suggested ranges of activity concentration within which an optimised action level would be found. For the future, single levels for members of the public and workers might be recommended, for example, 500 Bq m^{-3} for homes and 1 000 Bq m^{-3} for workplaces. As now, the recommendation would be that for exposures above the action level, the system of protection is applied. Exposures below the designated action level are then excluded from the system.

The Commission now intends to include a policy for protection from the other natural sources and is considering an approach analogous to that for radon-222. The Commission is likely to recommend an exclusion level for natural sources, on the grounds that it is impractical to control all natural sources. The criterion, as with radon, should not be expressed in dosimetric quantities, but rather it is activity concentration that is probably the most appropriate quantity and a value at the upper end of the existing natural range.

Scope of the recommendations

Apart from these exclusions, the Commission has aimed to make its recommendations applicable as widely and as consistently as is possible. Irrespective of the origins of the sources, the Commission’s recommendations cover exposures to both natural and artificial sources, so far as they are controllable.

Justification of a practice

"Justification" was treated as the first principle of radiological protection for the Recommendations in Publication 60. The Commission now recognises that there is a distribution of responsibilities for judging justification, which lies primarily with the appropriate authorities. They make decisions for reasons that include economic, strategic or defence considerations and in which the radiological considerations, while present, are not always the determining feature of the decision. The Commission now deals with this requirement and the system of protection is applied to practices only when they have been declared justified.

The justification of patient exposures is included in the Recommendations but has to be treated separately, 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.

Health effects of radiation

The Commission will present its views on the quantitative estimates of health risks following exposure. There is a need to be clear about the range of dose over which information needed for stochastic effects. People are exposed, inevitably, to natural background radiation and this is from a few to a few tens of millisieverts in a year. It is at this range of dose that risk factors are required and the effects of added increments of dose above that background.

For deterministic effects, the major factor is the degree of loss of function in a tissue. The distributions of the dose both within the tissue, and in time, are usually of considerable importance. These will be covered in the Recommendations.

Dosimetric quantities

There have been some persistent difficulties with, and misunderstandings of, the definitions of the Commission's dosimetric quantities. The Commission will remove these by clarifying its definitions and specifying their application.

The Commission uses the averaged absorbed dose in an organ or tissue. The implicit averaging is valid only if the range of doses is such that the proportional dose-effect relationship applies. There is no proposal to move away from the use of effective dose as currently defined:

$$E = \sum_{T} w_T \sum_{R} w_R \, D_{T,R}$$

There is however a need to reconsider the definition of detriment used to derive the tissue weighting factors and the numerical values of both w_T and w_R. Publication 60 had nine groups for w_R, while the w_T values for ten tissues and the "remainder" lie generally within a factor of two from 0.1. Only bone surfaces and skin lie outside this range. The Commission considers that some simplification is warranted.

For deterministic effects it is now thought that no weighting factors are necessary, because the RBE rarely exceeds a value of 2. Absorbed dose in Gy is considered to be an adequate quantity for assessing deterministic effects.

General basis of a system of protection

This system of protecting individuals and groups is intended to provide a higher standard than the previous one. A necessary basic standard of protection from each relevant source is achieved for individuals by setting Protective Action Levels which are values of quantities, usually dose, but may be activity concentrations, and are usually annual values, but may be a single value depending on the circumstances.

Factors in the choice of protective action levels

The starting point for selecting levels for action is the concern that can reasonably be felt about the annual dose from natural sources. The existence of natural background radiation provides no justification for additional exposures, but it can be a basis of judgement about importance.

Suggested levels of concern are illustrated in Table 1 expressed as fractions or multiples of the natural background. Having dealt with radon separately under the Exclusion section of this paper, the natural background exposures now exclude the contribution from radon. The remaining effective dose from natural sources varies by at least an order of magnitude around the world and demonstrably leads to no major hazard to human health.

Table 1. **Levels of concern and individual effective dose as a function of the natural background, excluding radon exposures**

Level of concern	Effective dose
High	> 100x
Raised	> 10x
Normal	Average natural background
Low	< 0.1x
None	< 0.01x

Additional doses far below the natural annual dose should not be of concern to the individual and should also be of no concern to society. An illustrative set of Protective Action Levels and the associated actions are set out in Table 2. All the numerical values and actions are taken from the Commission’s recommendations in Publications 60, 63, 64, 65, 77 and 82.

Optimisation of protection

The Commission wishes to retain the words "Optimisation of protection" and applies it both to single individuals and to groups. However, it is applied only after the meeting of the restrictions on individual dose defined by the Protective Action Levels. 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 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, are a legitimate arithmetic quantity, but is of limited utility. It aggregates information excessively and for making decisions, a large dose to a few people is not equivalent to a small dose to many people. The highest individual dose is useful to check that the Protective Action Levels have been successfully applied, but contributes little to optimisation of protection. The necessary information should be presented in the form of a matrix.

The process of optimisation in future may 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 not obvious how the Commission's recommendations will deal with this degree of societal process.

Table 2. **Illustrative Protective Action Levels and the associated actions for normal operation of justified practices and prolonged exposures (effective dose in a year or as indicated) and single events (effective dose or as indicated)**

Exposed group	Recommended protection action level	Associated action
Normal operation of practices		
All groups	**0.01 mSv**	Include source and exposure in the system of protection
Members of the public and general workers	**0.3 mSv**	Reduce doses by direct and environmental action
Specially trained radiation workers	**20 mSv** **1000 Bq m^{-3}**	Reduce doses by direction action and by modifying working procedures Reduce Radon exposure by pathway action
Prolonged exposure*		
Members of the public including general workers	**10 mSv** **100 mSv** **400 Bq m^{-3}** **0.5 Bq g^{-1} (natural activity)**	Must consider reducing doses by direct or environmental action Immediate action is required to reduce doses by direct action, environmental action or relocation Reduce Radon exposure by pathway action Reduce exposure by pathway action
Single events and accidents		
Members of the public including general workers	**5 mSv** **50 mSv** **50 mGy (in thyroid)** **1,000 mSv (long-term)**	Advise sheltering in buildings Arrange short-term evacuation Issue stable iodine Arrange long-term relocation
Specially trained radiation workers	**1,000 mSv**	Upper level for planned emergency work

* This is the sum of all doses from all sources of prolonged exposure (i.e., exposure rate reasonably constant over a human lifespan) at a given location.

Radiological protection of the living environment

In ICRP 60 it was stated that “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”. The human habitat has probably been afforded protection through the application of the current system of protection. However, there are circumstances where the ICRP statement is insufficient or wrong. These include environments where humans are absent or have been removed and situations where the distribution of radionuclides in the environment is such that exposure to humans would be minimal, but other organisms could be exposed.

The need and goals for protection of the environment have been defined by society. The role of ICRP should be to define how radiological protection can contribute to achieve these goals. This would help regulators demonstrate compliance with existing international and national environmental requirements and demonstrate that radiological protection is consistent with international principles. It would provide advice with respect to intervention situations and help to inform stakeholders. ICRP should develop a system of radiological protection for humans and the environment and reflect its commitment for the environment in its organisation of work and composition of experts. A Task Group of the Main Commission is drafting a report for consultation, the principles of which will be incorporated into the recommendations. Table 3 gives an indication of the criteria under consideration for setting radiological protection guidance. They parallel the policy being developed for protection of humans.

Table 3. **Proposed “derived levels of concern” for non-human sectors of the living environment**

Relative dose (Rate)	Likely effect on individuals	Aspects of concern
> 1 000x normal	Early mortality	Remedial action needed?
> 100x normal	Reduced reproductive success	Dependent on what flora and fauna, and numbers likely to be affected
> 10x normal	Scorable DNA damage	Dependent upon size and nature of area affected
Normal background	Low	No action
< background	Low	No action

Proposed timescales

The Main Commission invited its four Committees to discuss its draft recommendations at their meetings in mid-2002. The Commission then expects to take account of the views expressed at its meeting in October 2002, after which a version should be made widely available for comment in 2003. The intention is to have a well-developed draft in 2004.

VIEWS FROM THE JAPANESE REGULATORY AUTHORITY

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Abstract

The legislation system for regulation of radioisotope in Japan was established in 1957. The system has been revised gradually since its establishment. Major amendments of the law were made in 1988 on the basis of ICRP Publication 26 and in 2000 on the basis of Publication 60. Main principles provided in the publication have been already introduced into the law. However, some concepts proposed in the recommendations are still under discussion. The current status of implementation of the ICRP recommendations in the Japanese regulatory system is summarised. Views from the regulatory authority of Japan on the points to be improved in the current system of radiological protection are presented.

Outline of legislation system for radiation protection in Japan

In order to prevent radiation hazards and to secure public safety, manufacturing, sale, use and measurement of radioactive materials and use of radiation generating equipment are regulated by the Ministry of Education, Culture, Sports, Science and Technology (MEXT) on the basis of the Law concerning Prevention of Radiation Hazards due to Radioisotopes, etc. Reactors and nuclear fuels are regulated by MEXT and the Ministry of Trade, Economy and Industry (METI) based on the Law concerning Control on Nuclear Material, Nuclear Fuel and Reactors. Medical use of radioisotopes and radiation generators are under regulation by the Ministry of Health, Labour and Welfare (MHLW) based on the Pharmaceutical Affair Law and the Medical Service Law. Exposure of general workers to ionising radiation is regulated by MHLW based on the Occupational Safety and Health Law. Exposure of mariners is regulated by the Ministry of Land, Infrastructure and Transport, and that of government officials by the National Personnel Authority on basis on the Government Officials Act, respectively.

The legislation system for regulation of radioisotopes was established in 1957. "The Law concerning Technical Standards for Prevention of Radiation Hazards" was enacted in 1958. The law requires the uniformity of the technical standards for prevention of radiation hazards. Its basic principle is that the dose to radiation worker or member of general public should be kept under the level below which there would not be radiation hazards. According to the law, the Radiation Council was constituted in MEXT to unify the standards of different laws related to radiation protection. When the regulatory authorities concerned enact some technical standards for prevention of radiation hazards, they must consult the Radiation Council.

Figure 1. **Structure of Laws Related to Prevention of Radiation Hazards**

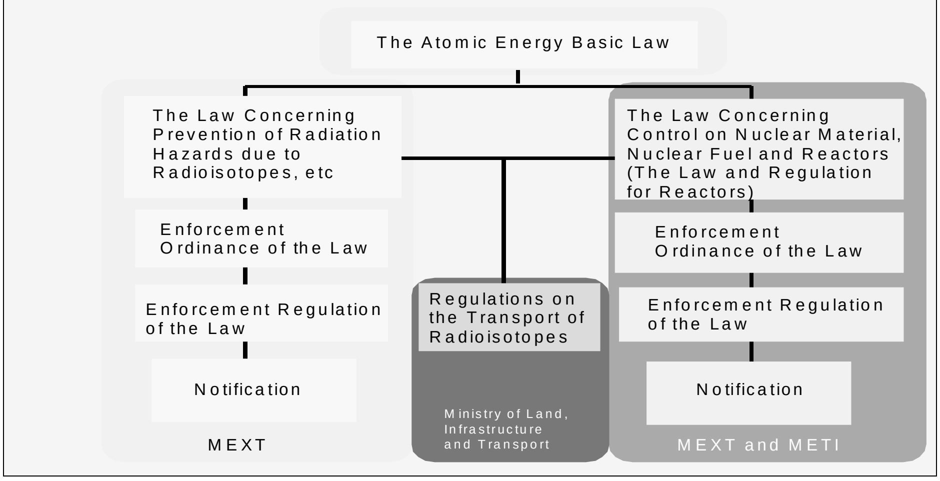
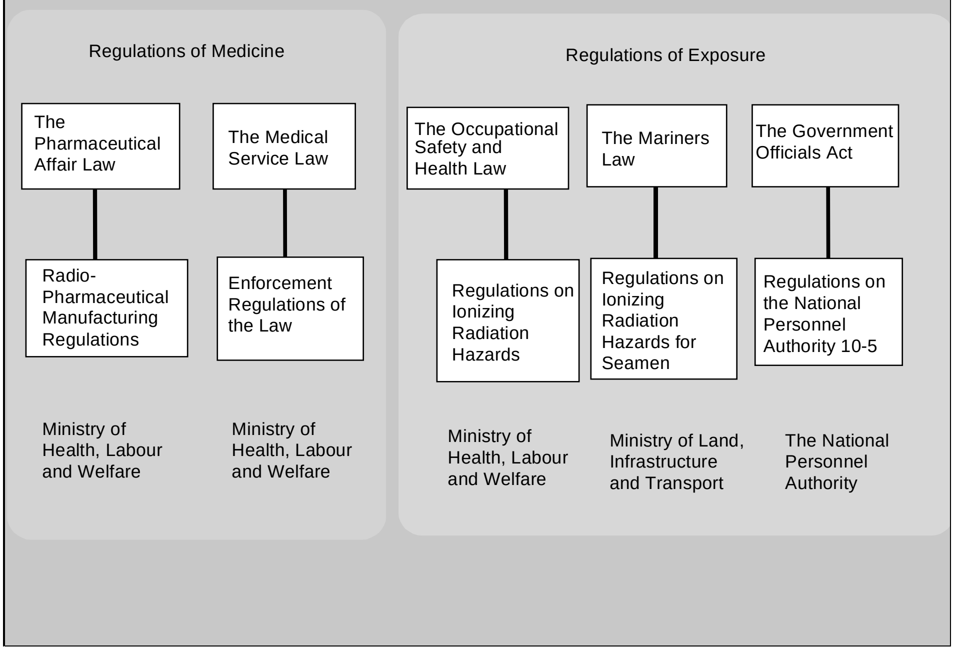


Figure 2. **Other Ministries on Radiation Protection**



The system of radiological protection with general principles of justification, optimisation and dose limitation was established in the ICRP Publication 26 published in 1977. The major amendment of the law was made in 1988 according to Publication 26. A new system of dose limitation and definition of effective dose proposed in ICRP Publication 60 were introduced into the law system in 2000. The introduction of concepts of “exclusion and exemption”, “potential exposure” and “dose constraint” into the legislation system is now under discussion in the Radiation Council.

Justification of practice

With respect to the status of introducing the concept of "Justification of practices " into the legislation system, the concept is not clearly stipulated in the current laws. It is provided, however, in the Law concerning Prevention of Radiation Hazards that "A person who has caused danger to human lives, bodies or properties by operating equipment installed with radioisotopes or radiation generator without permission, or by emitting radiation in other improper way shall be imprisoned up to 10 years". In addition, even if his/her activity is only an attempt to cause that danger, the person shall be penalised. These penalties limit the radiation practices to certain extent.

There are various problems in the introduction of "Justification". The benefits of radiation utilisation differ case by case, and their values, too. We do not have a universal ruler to measure them. A regulatory authority should not make any judgement of justification without a commonly accepted ruler. The individual user shall retain his/her right to make benefits from radiation under certain conditions that would prevent radiation hazards of the workers and the public.

In order to adopt "Justification" into the legislation system, a guideline for the judgement of risk/benefits should be developed with a commonly accepted ruler and shown in the system of radiological protection. The case where a "practice" cannot be justified should be discussed. For example, the following cases should be described in the system:

- exposure due to irradiation targeting the human body except for medical use; and
- use of radioactive material in foods, cosmetics, and toys.

Optimisation of protection

Concerning the status in the implementation of "optimisation of protection", the principle of optimisation is described in some laws. They oblige users to minimise radiation exposure, but no concrete requirements are provided. Actually "optimisation" is in the hand of individual users.

The problem is that methodology in evaluation of benefits and risk is not elaborated in a practical manner.

Concrete procedure for the "optimisation" in various cases of "practice" should be provided in the system of radiological protection. Multiple sets of level for dose constraint, which are suitable for various cases of "practice" should be prepared.

Dose limitation

The system for dose limitation and definition of effective dose revised in ICRP Publication 60 were introduced into the legislation system in 2000. Although dose limitation is well managed according to the revised regulation system, there is a problem that a risks concept based on probability of hazards would not be sufficiently accepted by the general public. They feel that the radiation exposure at dose below dose limit would be absolutely safe, however exposure at dose that exceeds the dose limit would be extremely dangerous even if it exceeds at small amount.

It is necessary to develop ways of explaining that dose limit is based on the risk concept. Introduction of simplified action levels proposed by Professor R.H. Clarke in this conference might preclude misunderstandings of dose limit by general public. The feasibility of dose control by action levels should be confirmed before its introduction into regulation system. The radiation dose to an individual of a critical group should be less than 1 mSv/year in the current legislation system. It is considered to be difficult to achieve consensus on the adoption of the dose constraint that restricts the level of one user less than 0.3 mSv/year, because 1 mSv/year is sufficiently low and the cost due to the adoption a lower figure would be considerably high.

Effective dose

The concept of effective dose is too complicated for the general public to understand its meaning and usefulness. The effective dose is quite difficult to measure practically and not easy to calculate. Change of definition for the purpose of only simplification is not preferable because frequent changes cause a problem in consistency and reduction of reliability on regulation system. Unit of effective dose, sievert (Sv), is confusing because Sv is also used for the equivalent dose. A new unit for equivalent dose might be a solution to the problem.

Exemption

The concept of “exemption” was clearly defined in ICRP Publication 60. The introduction of the concept has been discussed in the Radiation Council. Exemption levels provided in IAEA Basic Safety Standards are going to be adopted into the regulation system. A system for regulation of natural radioactive materials above the exemption level is now being discussed in the Council. The issue of exemption of the radiation source involving “practice” which is deemed not to be justified is also still under discussion.

Natural radiation exposure

Exposure to natural radiation, in principle, would be excluded from the regulation. In the case where exposure dose would be enhanced by a certain “practice”, the source whose activity and concentration are higher than exemption level should be subject to the regulation. In the case that exposure dose would be enhanced by an accident or a practice performed in the past, the exposure due to the source would be reduced by “intervention”. Introduction of “intervention” into the legislation system will be discussed in the future. Classification between objects of “practice” and those of “intervention” is not always easy. It would be difficult for the general public to understand the reason for the difference between level for dose limit in “practice” and action level in “intervention”. Clear explanation for the difference is necessary.

Japanese context

Japanese people have a specific concern about the exposure to radiation due to Atomic bombs which are source of artificial radiation. On the other hand, they have a custom of bathing in a natural-radioactive hot spring. The water containing radon is said to be effective for treating diseases such as rheumatism and other disorders. It is desirable to regulate natural radioactive materials considering the characteristic specific to the Japanese, i.e. they are more concerned about the risk from artificial sources than from natural sources.

Conclusion

The system of radiological protection proposed by ICRP was adopted into Japanese regulation system. Procedure in implementation of “Justification” and “Optimisation” should be improved. Although dose limitation is well managed according to the revised regulation system, the public would not have sufficient understanding of implication of dose limit. Introduction of action levels may give solutions of some problems in the concept of dose limitation but consistency of dose limitation should be considered.

VIEWS FROM THE JAPAN HEALTH PHYSICS SOCIETY

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Abstract

The Japan Health Physics Society set an ad hoc working group (hereinafter "the Working Group") to investigate the proposals presented by Professor Roger Clarke, chairman of the ICRP, in 1999 towards new ICRP recommendations, and to make suggestions from the standpoint as an academic society for radiological protection in Japan. The Working Group discussed the present situation of the system of radiation protection and the ICRP Proposals with regard to the items of definition of dose, health effect of radiation, dose and dose level, category of exposure, optimisation and role of stakeholder, collective dose, exclusion and exemption, and medical exposure. The basic policy of the Working Group is that the philosophy and criteria of the system of radiation protection, which are now effectively used for relevant regulations or some other purposes and are functioning well, should be basically retained unless there are positive reasons for revising them on specific grounds. The ICRP Proposals, an individual-oriented radiation protection concept, should basically be coherent with present protection system, a societal-oriented radiation protection concept, and should have enough rational scientific grounds.

The Working Group: (1) suggests there is a need for scientific rationality in any newly introduced criteria or standards for the system of radiation protection; (2) understands, for the present, that there is no other option but to adopt the linear no-threshold (LNT) hypothesis relating dose and risk of health effects at low level radiation exposures. This is the precautionary principle as applied to radiological protection; (3) recommends the role of stakeholders be explained as an example of one of the steps in the optimisation process; (4) suggests protective action level or dose limits should be related to radiation risk, even though these levels indicate only when to begin considering protective actions; and (5) believes that establishing a system of radiation protection for medical exposure is important.

Introduction

ICRP has the role to establish the basic concepts for radiological protection standard and issue the relevant recommendations for preventing radiation injury for the use of nuclear power or radiations, and radioactive materials. It is highly appreciated and also expected that ICRP establish the rational and understandable standards for radiological protection. The Japan Health Physics Society set an ad hoc working group (hereinafter "the Working Group") to investigate the proposals presented by Professor Roger Clarke, chairman of the ICRP, in 1999 towards new ICRP recommendations, and to make suggestions from the standpoint as an academic society for radiological protection in Japan.

The Working Group discussed the present situation of the system of radiation protection and the ICRP Proposals with regard to the items of definition of dose, health effect of radiation, dose and dose level, category of exposure, optimisation and role of stakeholder, collective dose, exclusion and exemption, and medical exposure, taking into account the comments from the different national or international societies. The ICRP Proposals, an individual-oriented radiation protection concept, should basically be coherent with present protection system, a societal-oriented radiation protection concept, and should have enough rational scientific grounds. The Working Group thought that well functioned philosophy and criteria of the system of radiation protection should basically be taken over. In the following paragraphs the investigation results and suggestions of the Working Group are summarised.

Basic policy of the Working Group

The philosophy and criteria of the system of radiation protection, which are now effectively used for relevant regulations or some other purposes and are functioning well, should be basically retained unless there are positive reasons for revising them on specific grounds. Meanwhile, those systems of radiation protection, which are thought improper or inadequate, might be considered to be revised. In proposing any revision of these systems, efforts should be made clearly to indicate sufficient rational scientific grounds together with careful consideration of the results (i.e., merits and demerits) of the proposed revision.

The results of investigation and suggestions of the Working Group

Definition of dose

The simplification of radiation and tissue weighting factors has been proposed. Any change in the definition of dose should be made with careful consideration from the viewpoint of the consistency and continuity of radiation protection. Concerning the introduction of simplified weighting factors, it is necessary to clarify the problems of existing weighting factors and to discuss from a scientific point of view.

Health effects of radiation

The health effect of low-dose radiation is considered to be in combination with other environmental factors. The lower the dose or the dose rate is, the less significant radiation is as a risk factor in inducing carcinogenic or genetic effects. The epidemiological study for humans deals with combined effect of radiation and other factors on the selected group. However, it seems that such epidemiological study should not be expected to obtain valid information on the health effect of low-dose radiation. Meanwhile, biological experiments including animal study involve uncertainties in deducing their results on the health effect of low-dose radiation for human because combined effect of radiation and other factors are not taken into account in these experiments. Data obtained for the victims of Hiroshima and Nagasaki shows a linear relationship between the dose and the effect while data obtained in animal study shows a curvilinear relationship between them. As the effect of radiation at low dose is not clearly known yet, the relationship between dose and effect has to be on the basis of assumption. It is inferred that the relationship between the dose of low-dose radiation and its carcinogenic effect on human living in a complex environment is not linear.

The existence of threshold values should be discussed based on the results of epidemiological study on the health effect of low-dose exposure and on the elucidation of the mechanism of carcinogenesis. However, at present, we have to understand that sufficient knowledge has not yet been obtained to deny the "hypothesis of linearity with no threshold (LNT)." Therefore, the Working Group understands that there are no other options possible for the moment but to adopt LNT hypothesis in the dose-response relationship of radiation-induced carcinogenesis as a precaution in radiation protection.

Dose and dose level

The standards for dose level should be based on common standards applicable to other sources of environmental risks as well. At present, there is no definite logic as to and whether the standards for doses, including exposure to harmful substances, should be distinguished from (or combined with) public and occupational exposures. These decisions could not be made by dealing with radiation alone, but would be made by society as a whole. In the discussion on dose levels for workers and the general public, it is not proper to adopt the natural background radiation dose level as a basis from the very start, and then to discuss action levels at 10 times, 100 times, one tenth, or one hundredth the base level. This way of discussion deviates from the main purpose of radiation protection that calls for discussing protection standards based on the radiation risk. Instead, arrangements should be made to discuss protection standard levels based on the health risks of radiation, evaluate the general public's exposure to the background radiation, and then present the background as a convenient indicator in explaining these standard levels.

The new proposal suggests 20 mSv and some other dose levels as protective action level, but their grounds are not clarified. If the dose levels are based on acceptability as "a social scientific factor", their rational grounds should be explained.

The trivial radiation doses should be dealt with as doses on a personal basis. There are no definite grounds for setting a dose limitation of 1mSv/y for the general public. The new dose levels should be harmonised with the permissible levels specified in the present system of radiation protection.

System of radiation protection

The present system of radiation protection is well designed and well implemented for the protection of workers involved. Therefore, in respect of the present system which is based on ICRP 1990 recommendations, it does not seem that the system for the protection of workers includes some inconveniences and has to be significantly revised.

Categories of exposure

In addition, there is no positive reason for changing the existing three categories of radiation exposure – occupational, public and medical exposures, because such occupational, public and medical exposures cannot be dealt on the same ground. It is difficult to apply the same level of radiation protection for personnel to the public "as a group" because of the wide spread of age distribution of the public and the difference of sources for the individuals concerned, etc. Besides, measures for the general public affected by radiological accidents are not fully prescribed. Sufficient discussion is needed on a permissible level of public exposure to make this determination.

Optimisation

The new proposal calls for providing a protection system with priority shifted from utilitarianism to the protection of individuals and for implementing the system in the order of justification, applying of protective action level and optimisation. Optimisation of protective measures focused on individuals is ideal but implementation of such optimisation remains unclarified.

The optimisation process involves an allocation of risks. New recommendations should provide rational grounds on the risk allocation among beneficiaries and non-beneficiaries, the present and the future, workers and the general public, and potential and realistic exposures.

Role of stakeholders

Such a decisive statement as the agreement with stakeholders being the only solution to the optimisation should not be included in ICRP recommendations. The role of stakeholders should be shown only as one of the measures taken in an optimisation process as an example. In order to prevent social confusion, it is essential for ICRP recommendations to provide such levels that optimisation is not required.

Collective dose

The principle of protection (justification, optimisation and dose limitation) functions effectively in radiological work, by achieving the protection of individuals by optimising the protection of the group as a whole. In this context, collective dose is considered to be an effective tool in selecting effective protective measures for occupational exposure.

Exclusion and exemption

So far, uncontrollable radiation sources (exposures) have been excluded from regulatory control, while for those, which are controllable, exemption and dose levels have been given for practice and also for intervention. ICRP Publication 82 recommends annual exemption levels of 10μSv for the practice and 1 mSv for commodities as the generic intervention exemption levels but it does not clearly prescribe concerning NORM. The relationship between exemption for practice and one for intervention and the consistency of such levels are left unclarified.

Sources involving only very small individual exposure – “trivial exposure” – and also such sources for which regulation on any reasonable scale will produce little or no improvement could be exempted from regulatory concern. Careful consideration should be made to derive rational grounds for the exemption and the actual numerical values.

Medical exposure

In the medical diagnosis and treatment, determination of the medical indication, corresponding to the medical level, for individual condition of a patient’s disease is made according to the judgement (justification) for selection or implementation of practices that also include radiological diagnosis or treatment. Medical diagnosis and treatment should be clearly distinguished from other practices because they are the subjects of contract between patient and a medical institution and they requires patient's acceptance as a precondition. In a group medical examination such as mammography, collective dose is evaluated which is based on the assumption of linear relationship between the dose and the effect. The risk from medical diagnosis should not be discussed solely by collective dose, but should be discussed in comparison with risks from other medical examinations. The radiation dose to individuals who voluntarily help in the care or support of patients is generally low and, therefore, a cut-off dose will be useful. The requirement of radiation dose to individual who undertakes medical examinations will differ depending on the categories of examinations from the point of radiation protection.

Medical exposure is dealt with in a separate system of protection and, accordingly, it is necessary to establish a protection system for this category. In addition, it is important to establish the standard of judgement, based on scientific grounds, for medical exposure, which conform with condition of an individual patient as a means of medical treatment.

Summary

The Working Group thought that well-functioning philosophy and criteria of the current system of radiation protection should basically be continued. In summary, the Working Group: (1) suggests there is a need for scientific rationality in any newly introduced criteria or standards for the system of radiation protection; (2) understands, for the present, that there is no other option but to adopt the linear no-threshold (LNT) hypothesis relating dose and risk of health effects at low level radiation exposures. This is the precautionary principle as applied to radiological protection; (3) recommends the role of stakeholders be explained as an example of one of the steps in the optimisation process; (4) suggests protective action level or dose limits should be related to radiation risk, even though these levels indicate only when to begin considering protective actions; and (5) believes that establishing a system of radiation protection for medical exposure is important.

References

1. Clarke, R.H. Control of Low-level Radiation Exposure: Time for a Change?, J. Radiol. Prot. 19 (2) 1999.

2. ICRP, A Report on Progress towards New Recommendations (Memorandum), J. Radiol. Prot. 21 (6) 2001.

3. Clarke, R.H. Radiological Protection at the Start of the 21st Century, NRPB Radiol. Prot. Bull. No.231 Sept. 2001.

WHAT WE EXPECT OF ICRP NEW RECOMMENDATIONS

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Abstract

We believe that it is essential for Japan to continue to maintain and promote nuclear power generation.

To promote nuclear power generation, we believe it is important that the effect of low-level radiation on humans and the exposure dose limits have to be widely and properly understood by the general public and radiation workers. From such a point of view, we express our agreement with ICRP's latest attempt that is aimed at preparing a simple and easy-to understanding radiological protection system. We would like to express some of our opinions about ICRP's new recommendations.

- The relation between PAL and the conventional dose limit should be shown clearly.
- Optimisation on low-enough level (natural background level) should be omitted.
- The process of optimisation must take the state of affairs in each country into consideration.
- The dose limits (100mSv/5yrs and 50mSv/yr) for workers should not be changed. (Single-year dose limit of 20mSv/yr has no flexibility and has serious impact on nuclear power operators.)
- Full discussion is necessary to establish the radiological protection criteria for environment.

We appreciate ICRP's releases and calls for opinions regarding the new recommendations.

We hope ICRP continues to disclose the status of discussion in a timely manner, and invite opinions.

Introduction

Nuclear power generation is positioned as a major power source in Japan. At present, about 35% of electricity generated in Japan comes from 52 light-water reactors. We believe that it is essential for Japan to continue to maintain and promote nuclear power generation.

To promote nuclear power generation, we believe it is important that the effect of low-level radiation on humans and the exposure dose limits have to be widely and properly understood by the general public and radiation workers. From such a point of view, we express our agreement with ICRP's latest attempt that is aimed at preparing a simple and easy-to-understand radiological protection system. We would like to express some of our opinions about ICRP's new recommendations from a viewpoint of a Japanese electric utility.

Protective Action Levels (PAL) for the public

The draft of Protective Action Levels (PAL) for the public can be highly appreciated because the recommendations made by ICRP since 1990 and the world's practices are systematically arranged in respect of the normal operation of practices, prolonged exposures, and single events and accidents. But, we would like to ask ICRP to take the following two points into consideration.

- As for the normal operation of practices, the concept of dose limits have widely taken root in society in the form of the dose limits for the public. Therefore, we would like to ask ICRP to give consideration to provide clear explanations about the relationship between the proposed PAL=0.3 mSv per year and the present dose limit of 1 mSv per year to avoid misleading the people into believing that the risk of radiation has become higher.
- In the new recommendations, different values of PAL are proposed for the normal operation of practices, prolonged exposures, and single events and accidents, respectively. From viewpoints of risk for individuals and radiological protection, we would like to ask ICRP to give easy-to-understand commentary on why the values are allowed to differ.

Optimisation of protection

The level from which to exempt the optimisation from application has to be established by a common-sense judgement. Otherwise, such a theory that doses must be reduced infinitely may be tenable from a viewpoint of those who receive no merit from the practices. In Japan, for example, there is a regional difference of 0.4 mSv per year of the natural background radiation level. In some other countries, such differences are larger. In consideration of these differences, we believe that the concept of optimisation is unnecessary for the doses that are below the level of fluctuations in natural background radiation (for example, 0.1 mSv per year).

As I mentioned above, we believe that the establishment of the level from which to exempt the optimisation from application contributes to prevention of unnecessary confusion in society and unnecessary social costs.

We would like to express one more opinion about optimisation. In the draft of the new recommendations, it is suggested that the involvement of stakeholders in the process of optimisation may become most important. We also recognise it is important. But we think the following two points should be carefully discussed:

- The process of optimisation must take the state of affairs in each country into consideration.
- Decisive statements such as the agreement with stakeholders being only solution to optimisation should not be included in ICRP recommendations.

Instead, we believe it is important for ICRP to provide the information required for optimisation such as the data about risk of radiation, in an easy-to-understand form.

Protective Action Levels (PAL) for radiation workers

Table1. shows the changes in the number of nuclear power plant workers whose exposure doses exceed 20 mSv per year in recent years. There are about several tens to two hundreds of workers whose exposure doses exceed 20 mSv per year. There are also many workers whose exposure doses are 15-20 mSv per year. These highly exposed radiation workers are specially trained technicians and skilled workers, working at nuclear power plant during the outage for inspection. It is difficult to reduce the number of workers whose exposure doses exceed 20 mSv per year to zero on a single year basis.

Table 1. **Number of workers whose exposure doses* exceed 20 mSv/y, and 15-20mSv/y (*total annual exposure from plural nuclear facilities)**

Fiscal year	89	90	91	92	93	94	95	96	97	98	99	00	01
> 20mSv	416	504	91	63	169	63	30	62	154	29	36	62	32
15-20mSv	812	773	229	293	662	297	351	408	620	612	773	707	627

In the draft of new recommendations, a value of “20 mSv per year” is shown as a protective action levels for workers. We basically agree with the direction toward a simple and easy-to-understand protection system. But, as I mentioned before, merely changing the dose limit of “5-year average of 20 mSv per year and 50 mSv per year” as stated in the 1990 recommendations to PAL’s single-year dose limit of “20 mSv per year” has a serious impact on nuclear power operators. This change may have impact on periodical inspection and maintenance such as securing enough technicians or work quality, etc. We would like ICRP to understand this point. Another problem is that the single-year basis PAL means substantial reduction of dose limits. We are concerned that such reduction of dose limits may accelerate fears of workers concerning radiation. If there are not any change of scientific grounds, we request the following:

> The dose limits for workers (100 mSv/5 years and 50 mSv/year) should not be changed. (The dose limits should not be single-year values, and should be provided with periodical flexibility.)

It is our understanding that the dose limit of a 5-year total of 100 mSv with periodical flexibility is a simple enough and easy-to-understand limit.

Radiological protection of environment

We recognise that the radiological protection of environment is an important theme, now and in the future. But, it seems that the radiological protection systems for humans have no impact on the environment. It should be discussed from scientific, philosophical, social and economic points of view in a well-balanced manner. Let me give an example that we are concerned about. In case of geological disposal of high-level radioactive waste, surrounding microbes might be highly exposed. We would like to ask ICRP to give consideration not to allow such geologic areas to be defined as part of the environment. We also believe that it is important not to lose ways to cope with major issues such as global warming because of concerns about a trivial effect of radiation on the environment. The following are thus suggested:

- Full discussion is necessary to establish the radiological protection criteria for the environment.
- It is too early to include radiological protection of the environment in the new recommendations at this stage.

Conclusion

It took more than a decade to eventually introduce the 1990 recommendations into laws and regulations. Revision of ICRP's recommendations and consequent changes due to amendments of laws and regulations have a great impact on society, and bring about major changes in worksites of nuclear power stations as well. For the changes, electric utilities have to give adequate explanations to their employees and to the public. It takes a great deal of labour and money for us to get these changes firmly established at a nuclear power station. When publishing the new recommendations, we would like to ask ICRP to give clear and easy-to-understand explanations. We appreciate ICRP's releases and calls for opinions regarding the new recommendations. We hope ICRP continues to disclose the status of discussion in a timely manner, and continues to invite opinions.

THE SYSTEM OF RADIATION PROTECTION: VIEWS FROM THE AUSTRALIAN REGULATOR (ARPANSA)

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Abstract

Of those issues identified by the EGRP at previous meetings, there are a number of areas where, from the Australian perspective, the current system of radiological protection could benefit from change. These include stakeholder issues, the environment, inconsistencies in numerical values and risk comparison with more common hazards. Implementing any recommended changes would present some bureaucratic challenges but would also provide an opportunity for increasing national uniformity of regulation. However it is recognised that the current system does not provide an unacceptable level of protection and it is therefore important that any proposed changes are thoroughly tested in practice to ensure a real net benefit.

Regulation in Australia

The object of the legislation that establishes the Australian Radiation Protection and Nuclear Safety Organisation (ARPANSA) is *"to protect the health and safety of people and the environment from the harmful effects of radiation"*. The concepts of "undue risk" and "international best practice" are emphasised in all aspects of the regulatory functions of the organisation. A key role of ARPANSA as the peak national body in radiological protection is the promotion of national uniformity, particularly through the work of the Radiation Health Committee and their role in the production of national standards and codes of practice.

Recommendations of ICRP 60 are implemented in Australia through the Australian Standard, *National Standard for Limiting Occupational Exposure to ionizing Radiation (1995)* and associated recommendations. There are some differences of approach between the nine separate jurisdictions within Australia (six States, two Territories plus the Commonwealth or Federal jurisdiction) but all legislation relates to this Australian Standard. The Standard was declared in March 1995, therefore experience in applying the recommendations of ICRP 60 is limited to little more than seven years. Any comprehensive change would require amendment of the Australian Standard and of nine independent sets of legislation and could not therefore be undertaken lightly. It would however provide an opportunity to introduce further rationalisation and uniformity across jurisdictions.

What works well?

Dose limits

For regulatory purposes, numerical dose limits have the advantage of being both easily understood and enforceable. International best practice is readily established by reference to dose limits recommended by ICRP.

Dose constraint

The concept of dose constraint has been promoted through the Australian Standard and associated recommendations and is widely applied within Australia. It must be noted that there is some inconsistency in its application and sometimes a lack of understanding that values should be agreed with the regulator.

Collective dose

Collective dose is prone to misuse but is helpful in particular circumstances. Examples where collective dose is used to advantage include analysis of trends, measurement of the performance of radiation safety programmes and as an indicator of safety culture. In Australia, the use of collective dose is written into the standard procedures for establishing emergency planning zones for visiting nuclear powered warships.

Optimisation

The concept of optimisation is applied effectively and forms a central part of radiation protection planning for more potentially hazardous operations. For some routine operations, the process of optimisation may simply take the form of, for example, establishing empirically an acceptable dose. For operations with no risk of exposure above this level, no further optimisation is needed.

An important exception is medical exposures where there is opportunity for improvement in the optimisation of patient dose. One particular, very topical example in Australia is the aggressive promotion of CT scans of the “worried well”. Effective dose, to asymptotic patients, may be as high as 10 mSv per scan.

What could be improved?

Decision aiding, decision making and stakeholder issues

In relation to the decision making process, the expert group has identified the necessity of maintaining a clear distinction between scientific, regulatory and social considerations. Guidance on developing co-operative relations with all stakeholder groups is needed.

Recent decision making with regard to politically controversial nuclear issues, (licensing construction of a replacement research reactor close to Sydney for example) has broadly followed the approach discussed in the expert group report. However deliberate separation of risk assessment and of risk management considerations has still failed to engender public trust despite extensive consultation procedures. The decision of the CEO of ARPANSA to licence reactor construction has passed its first legal challenge and can therefore be considered robust but continued opposition is expected.

Risk to the environment

There is a high degree of concern within the Australian population with regard to adverse effects on the environment from all causes. It is evident that the previously accepted ICRP position with regard to radiation safety that “protecting man means that you are protecting the environment” is no longer socially or scientifically acceptable. However in the summary of his reasoning leading to the issue of a licence to construct a replacement reactor near Sydney, the CEO of ARPANSA states that because the rationale presented in ICRP 60 has not been revised, it still formally represents international best practice which must be taken into account in his decision making. The current review, by ICRP and IAEA, of the whole area of radiation protection of the environment should lead to a resolution of this legislative paradox.

NORM/TENORM

There are many examples of incoherence with regard to the treatment of NORM and TENORM in the current system of radiation protection. One specific recent example is given below.

Recent revision of the Australian code of practice for safe transport of radioactive materials required an amendment of the definition of radioactive material qualification from the IAEA *Regulations for the Safe Transport of Radioactive Material* 1996. An increase in the values of acceptable activity concentration was introduced for processed bulk materials such as alumina mining ores and washed sands containing low levels of NORM. Without this amendment, the code would have to have been applied to enormous amounts of material that present a very low hazard.

Intervention criteria

In the case of an intervention, ICRP 82 recommends countermeasures be introduced where individual doses can be reduced by more than 10 mSv per year. This guidance is not always followed – sometimes because of the widespread acceptance and understanding of the dose limit for a practice of 1 mSv per year for a non-radiation worker. In fact, 1 mSv per year has almost become the *de-facto* intervention level in many instances. Indiscriminate adoption of this criterion will result in impossibly stringent requirements for many interventions such as, for example, rehabilitation of uranium mines in areas of elevated background radiation.

Any efforts to remove the distinction between intervention and practice must not reduce the capacity to set realistic clearance criteria in this type of situation.

Comparison with other hazards

The EGRP has stated that that the system of radiological protection “should tie the rationale for numerical radiological protection criteria to international agreement and social judgement and consider tying this rationale to a broader public acceptance of other risks”. ICRP 26 did this in a fashion by relating permitted dose limits to the risk accepted in other industries. Such an approach is worth revisiting. This could potentially be extended to include circumstances where radiation workers are also exposed to hazardous materials of various kinds.

Conclusion

The EGRP has identified a number of instances where the current system of radiation protection could be improved. Many of these find support from specific examples in the Australian context. Experience with the current system based on ICRP 60 and subsequent recommendations is however limited to just seven years in Australia, less in many other countries. Hence there is some opinion that it is too soon for change of any kind. In addition, it is recognised that the current system does not provide an unacceptable level of protection. It is therefore important that any proposed changes are thoroughly tested in practice to ensure they will result in a detectable improvement in both safety and simplicity for the regulator, for those regulated and for other stakeholders.

DISCUSSION ON SEVERAL PROBLEMS IN EVOLUTION OF RADIATION PROTECTION SYSTEM

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Abstract

As viewed from the standpoint of radiation protection practice, it is necessary that the current system of radiological protection should be made more simple and coherent. The human-based protective measures alone are far from having met the requirements of environmental protection in many circumstances. Protecting the environment from ionising radiation would be implicated in radiation protection. Collective dose is an useful indicator, of which applicable extent should be defined. Using such an quantity could help improve radiation protection level, but applicable conditions should be indicated, temporal or spatial. Natural radiation is the largest contributor to the radiation exposure of human. Occupational exposure from natural radiation should be controlled, for occupations such as underground miners and air crew. Controlling both man-made and natural radiation exposure of pregnant women and children needs to be enhanced, especially radiological diagnosis and treatment.

China's radiation protection community, as a whole, is paying considerable attention to the ICRP's new Recommendations. Prof. Clarke's article "A Report on Progress towards New Recommendations, a communication from the International Commission on Radiological Protection, [1] has been translated into Chinese and published on Radiation Protection, the Official Journal of China Radiation Protection Society with a view of intensifying awareness of the new Recommendations within more radiation protection workers and people concerned. In addition, a special meeting was convened in early 2002 to address the comments on the new Recommendations.

On evolution

Simplification and coherence

A dozen years have elapsed since the publication of ICRP 60 Recommendations, and China's radiation protection community has experienced the same inconveniences as other countries. [2] Among the three principles of radiation protection, "justification" is often beyond the scope of radiation protection itself. As a basic principle, justification has to be taken into consideration in studying and decision making with respect to the problems associated with radiation protection. But in many circumstances, radiation protection is merely one of the factors affecting the justification of a practice. Too many terms and words have led to difficulty in understanding not only for the public and the non-professional radiation protection workers, but also even for professionals in the field of radiation protection. For example, the terms related to limits alone include dose limit, risk limit, dose constraint, directive limit for intervention level, authoritative limit, reference level, investigation level and action level among others. The terms in relation to risk include risk, hazard, tolerable, acceptable and unacceptable, and so on.

Improvement

In the ICRP Publication 60, there is an expression about environment protection, which is that: "*(16) The Commission believes that the standard of environmental control needed to protect man to the degree currently thought desirable will ensure that other species are not put at risk… 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*."

This presentation is not sufficient for environmental protection. This would apply to environments where man does not live, however for its own safety, mankind might move from one place to another. In some environments, the distribution of radioactive materials may give rise to small amounts radiation exposure to humans, but thereis significant exposure of other species. It follows that more definite and direct presentation concerning radiation environmental protection is needed. In the recent past years, the research efforts devoted toward radiation environmental protection has already been intensified. In 1996, UNSCEAR published a special report entitled "Effect of Radiation on the Environment". [3] IAEA, in collaboration with other international bodies, issues a number of special paper collections on radiation environmental effects. These efforts have laid down the favourable basis for developing radiation environmental protection requirements. The impact of radiation on the environment and biosphere is a very complicated problem, of which man's awareness has been very limited. Therefore, it should be noted that this problem is very import in considering the development of the principles and requirements in relation to radiation environmental protection.

Keeping as relatively stable as possible

ICRP Publication 60, entitled "1990 Recommendations of the International Commission Radiological Protection", was published in 1991. Six years later, six international organisations, including IAEA, endorsed the International Basic Safety Standards for Protection against Ionising Radiation and for the Safety of Radiation Sources (IAEA, Safety Series, No. 115). [4] A number of nations, or national organisations, issued their own respective revised radiation protection standards around the year 2000, each with reference made to, or account taken of, the ICRP 1990 Publication. The revision and development of Chinese radiation protection standards was initiated in 1995. The Chinese Basic Safety Standards for Protection against Ionising Radiation and for Radiation Sources (draft for approval) was completed by the end of 2000 and later finalised and published in October 2002. The Standards mirror the experiences of China's radiation protection community, with reference made to both ICRP Publication 60 and IAEA Safety Series No. 115. As in most countries world-wide, the main task in China in the forthcoming years is to disseminate and implement new Standards. For this application, it is very important to keep the Standards relatively stable. Any drastic change in Standards would be unfavourable for the upgrading of the level of radiation protection.

Collective dose

Conditional retaining of collective dose concept from the perspective of biology

Conditional retaining of the concept of collective dose is necessary on the grounds of biology underlying radiation protection. The UNSCEAR 2000 Report, on the basis of comprehensive analysis of available data, concluded that, as far as is known, even at low doses radiation may act as mutational initiator of tumorigenesis and that anti-tumorigenic defences are unlikely to show low-dose dependency. In general, tumorigenic responsedoes not therefore appear to be a complex function of increasing dose. The simplest representation is a linear relationship, which is consistent with most of the available mechanistic and quantitative data. NCRP has independently made a full-range review of the relevant the theroretics, experiments and epidemic data, with exclusion of any affection from the existing policies. A similar idea appears in the NCRP Publication 136, Evaluation of Linear Non-threshold Dose-Response Model of Radiation Protection. From the findings of the radiation effect study, the current radiation protection necessarily has to be based on linear non-threshold. Therefore, the aim of radiation protection is to protect not only individual but also population. This means it is necessary control both individual dose and population dose. The current radiological effect study findings cannot lead to creation of a more reasonable dose-response model than linear non-threshold model, but meanwhile cannot disaffirm the others. This is indicative that, at low dose, the linear non-threshold model may have significant uncertainty and the actual thresholds have been observed in many circumstances. Thus, the use of collective dose has to be based on controlling of time and space.

Conditional retaining of collective dose concept from the perspective of actual use

Retaining the concept of collective dose is also necessary from the perspective of actual application. In ICRP Publication 1, the Commission pointed out the need not only to protect individuals, but also to protect populations. Subsequently, the concept of collective dose was formulated. With formulation and subsequent implementation of the principle of radiation protection optimisation, a widespread use of collective dose was witnessed. Collective dose is adopted by many international organisations, national agencies and operating units as an important indicator for measuring radiation protection. In assessing occupational exposure and public exposure, for example, UNSCEAR used collective dose as a major indicator. Moreover, collective dose is among the ten indicators used by World Association of Nuclear Operator for assessing nuclear power plant performance. As a concept widely accepted by society as a whole, it would be undesirable to change collective dose.

Controlling collective dose for higher level of radiation protection

To control only individual doses rather than collective doses will be disadvantageous to raising the level of radiation protection. We have an example of occupational exposure in this case. For the purpose of fulfilling a practice under poor conditions, for example, simply paying attention to individual dose could lead to the excessive use of workers, over more technically-driven approaches, thus keeping individual doses low, but significantly increasing collective doses. This is especially a risk in developing countries where human resources are ample and inexpensive. Similar situations also can be found in the case of public exposure. If only individual dose control is required, the concentration control alone is sufficient in controlling the release of air-borne effluent, thus leading to a conclusion that the inventory control associated with collective dose will not be of importance. Even when air-borne effluent release leads to an over-high dose to the critical population group, the requirements could be met through increasing ventilation and raising stack height. A similar situation would also exist for liquid effluent. Clearly, this is neither beneficial to environmental protection nor to radiation protection and technical progress.

Need for well defining the condition of collective dose application

There exist cases where collective dose is inappropriately used, such as collective dose calculation for radiotherapy through integration without time limitation. So, the conditions under which collective dose can be used have to be clearly defined.

1. **Dose and dose rate limitation:** Collective dose can only apply to a range of small doses, generally below 0.2 Gy, or 0.1 Gyh^{-1}.
2. **Time limitation:** Calculation of collective dose should be limited with time. The relationship between dose and hazard, based on the current adjustment, would be not applicable to the future population. Limiting of time length should be situation-specific. On the policy of radioactive waste disposal, ICRP 81 recommends that doses should not be taken to represent detriment beyond about 300 years.
3. **Well defining minimise:** Form the view point of practice, it is necessary to well define the minimal. In most cases, on the one hand, it is very difficult to reduce collective dose concerned using reasonable resource. When the dose is very low, we should not use resources to reduce a risk that is very small to individual and society as a whole. When the dose is very low, on the other hand, there is significant uncertainty as to risk. In the case that risk has already been very small with significant uncertainties, it is unnecessary, and difficult, to conduct analysis on an item-by-item basis.
4. Extrapolation from collective dose to health hazard should be conducted carried out with caution.

Incorporation of controllable natural radiation into scope of radiation protection

Need for effective control of controllable natural radiation

In the recent past decades, man-made radiation exposure has been under effective control. As noted in the NUSCEAR 2000 Report, the annual average dose to the occupational workers world-wide has dropped from 1.9 mSv a^{-1} during 1975-1979 to 0.6 mSv a^{-1} during 1990-1994. Meanwhile, there has been a great expansion in nuclear power development and in application of radioisotope and radiation across the world. Subsequent collective dose decreased from 5 490 man-Sv during 1975-1979 to 2 700 man-Sv during 1990-1994, by a factor of about 2. In contrast, little data with respect to controllable natural radiation exposure can be found in this Report. As such, the discussion of dose trends is difficult. But, data that have been already been published shows that the occupation exposure and population exposure arising from artificial activity enhanced natural radiation are much larger than man-made radiation source exposures.

Table 1. **Occupational exposure to natural radiation, mSva^{-1}** [7]

Type of work	Individual dose		Collective dose
	Typical	Range	
Underground mine	4.8	0.36-18	2.88×10^4
Underground non-ferrous metal	16	1-120	$>9.6\times10^2$
Underground iron mine	12.8	2.3-36	
Underground mines of other type		0.18-160	
Underground workplace	4	0.2-31	
Cavern	8	0.14-40	
Tunnel construction	30		
Gas lamp mantle	32		
Hotspring	2.4	0.1-8	
Mineral processing	>1.7		
Air crew	4	1-10	
Nuclear power plant	1		
Nuclear and radiation technology	2		2
Underground uranium mine	10		2.2×10^2
Nuclear industry	3		3×10

Exposure from controllable natural radiation

Table 1 shows the level of occupational natural radiation exposure across the country, together with those from nuclear power plant, nuclear industry, radiation technology, radioisotope application and to uranium miner for the purpose of comparison. As shown in the table, the dose received by gas lamp mantle workers is the highest, followed by those in underground mines and underground workplaces. The individual dose arising from non-ferrous metal mine is the highest among the underground activities, with typical value of 16 mSv a^{-1} and with high proportions significantly in excess of annual dose limit, 20 mSv a^{-1}. This value is one order of magnitude higher than those from nuclear power plant and application of nuclear and/or radiation technology. There is little data made available in relation to mineral processing. However, the individual doses to the workers, as at Baiyunebo Iron Mine near Baotou City in Inner Mongolia, indicate a significantly less low level. Air crew receive relatively stable dose, unlikely to be in excess of 20 mSv a^{-1}, but higher than those from nuclear power plant and nuclear industry. It should be noted here that a considerable fraction of reproductive-age females working in airline crews are highly likely to receive a dose higher than the dose limit, 1 mSv. Table 1 only gives the data for a few occupations because of lack of statistics with respect to a wide variety and range of occupational workers. As indicated in the Chinese Yearbook of Coal Industry, the nation-owned key mines countrywide have 888 214 underground workers, who contribute 40.9% of the national total output. Out of the rest, 17.3% is from locally-administrated nation-owned coal mines and 44% from private-owned mines. The all-personnel labour productivity of the nation-owned key coal mines is reported to be 2.18 t a worker, [7] and those for the locally-administrated national and private-owned coal mines may be presumed to be 0.8 and 0.5 t a worker respectively, leading to the estimated respective numbers of coal workers of 1 020 000 and 3 966 000. Accordingly, the total number of coal workers countrywide amounts to 6 million. The number of underground miners in non-ferrous metal mines countrywide can be estimated at 60 000, based on the output and productivity presented in Chinese Yearbook of Non-ferrous Metal Industry. [9] Clearly, it follows from the above that occupational natural radiation exposure is higher than man-made radiation source exposure from perspective of both individual dose and collective dose. The above-mentioned findings are derived on the basis of the situation in the country, but similar ones can be also found in other some developing countries.

Incorporation of controllable natural radiation into scope of radiation protection

As mentioned above, artificial activity-enhanced occupational natural radiation exposure, such as exposure of the workers in underground mines and workplace, is much higher than occupational exposure from man-made source. But radiation exposures of workers of these types are not listed in the scope of occupational exposure in many countries. It is evident that controllable natural radiation should be incorporated into the scope of radiation protection on scientific ground and, thereby, the exposure of workers arising from controllable natural radiation be among occupational exposure. This is because that both natural radiation and man-made source radiation all belong to ionising radiation in nature, with the entirely identical biological effect. From the scientific viewpoint, the same protection level should be taken for both. Of course, in developing the relevant standards, social and economic considerations should be taken into account.

Attention to protection of pregnant women and children

Minors are more sensitive to radiation-induced thyroid tumorigenesis. As observed in many studies, there has been a clear trend towards decreasing turmorigenesis risk with increased age when being exposed to radiation. For 14 years after the Chernobyl accident, 1 800 patients with thyroid cancer, who were exposed to the accident when they were children, were diagnosed within the affected territories of Russia, Ukraine and Byelorussia. This number is far higher than the estimates made according to previous knowledge, with extraordinarily high incidence and short induction term. [6] It has been proven that, within 5-28 weeks after impregnation, the nerve centre system is very sensitive to radiation. There are about 600 cancer patients per 10 000 exposed persons when the dose to the foetus exceeds 100 mGy, about 0.06% per 10 mG.

With widespread use of radiation and radioisotope in diagnosis and radiotherapy, protection of pregnant women and children has attracted growing attention. In recent years, ICRP published many recommendations of relevance, especially ICRP Publication 84 Pregnancy and Medical Exposure dealing with the concerned protection issues in particular. Another issue worth additional attention is the protection of young women of air crews, especially in the Asian area, because considerable portion of female crews are of the age of pregnancy. In new Recommendations, protection of pregnant women and children should be appropriately added.

References

1. Roger H. Clarke, A Report on Progress Towards New Recommendations, 2001.

2. CRPPH, A Critical Review of the System of Radiation Protection OECD, 2001.

3. UNSCEAR, Sources and Effects of Ionising Radiation, UNSCEAR 1996 Report to the General Assembly with Scientific Annex, ISBN 7-5022-2135-2.

4. IAEA, Safety Series No.115 International Basic Safety Stand- ads for Protection against Ionising Radiation and for the Safety of Radiation Sources, IAEA, Vienna, 1996.

5. ICRP, ICRP-77 Radiological Protection Policy for the disposal of Radioactive waste, ISBN7-5022-2072-0.

6. UNSCEAR, Sources and Effects of Ionising Radiation UNSCEAR 2000 Report to the General Assembly with Scientific Annex, ISBN 92-1-142238-8.

7. Pan Ziqiang, Controlling Occupational Exposure due to Artificial Activity Enhanced Natural Radiation, Chinese Journal of Radiation Health 11(3), 129, 2002/12/25.

8. Sun Xudon, Yi Li, Chinese Yearbook of Coal Industry, Beijing, Coal Industry Publishing, 2001.

9. Editorial Board of Chinese Yearbook of Non-ferrous Metal Industry, Chinese Yearbook of Non-ferrous Metal Industry, 2001.

10. ICRP, ICRP-84 Pregnancy and Medical Radiation, 2000, Pergamon.

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