

Third Workshop on Science and Values in Radiological Protection Decision Making

Summary Report of the Workshop
and of the 6th Asian Regional
Conference on the Evolution of the
System on Radiological Protection

Tokyo, Japan
6-8 November 2012

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Committee on Radiation Protection and Public Health

3RD WORKSHOP ON SCIENCE AND VALUES IN RADIOLOGICAL PROTECTION DECISION MAKING and 6TH ASIAN REGIONAL CONFERENCE ON THE EVOLUTION OF THE SYSTEM OF RADIOLOGICAL PROTECTION

WORKSHOP 2012 SUMMARY REPORT

Tokyo, Japan
6-8 November 2012

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Radiological Protection

**3RD WORKSHOP ON SCIENCE AND VALUES
IN RADIOLOGICAL PROTECTION DECISION MAKING**

and

**6TH ASIAN REGIONAL CONFERENCE ON THE EVOLUTION
OF THE SYSTEM OF RADIOLOGICAL PROTECTION**

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ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT

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FOREWORD

The workshop began with the sincere expression by all present that our deepest sympathies go out to the people of Japan and all those who suffered from the natural disaster and the subsequent nuclear accident at Fukushima.

The Committee on Radiation Protection and Public Health (CRPPH), a standing committee of the Nuclear Energy Agency (NEA), has an ongoing interest in actively enhancing stakeholder engagement in radiological protection. In 1993, the CRPPH workshop on *Radiation Protection on the Threshold of the 21st Century* launched the activities of the CRPPH to pursue this important issue (OECD/NEA, 1993).

Based upon discussions within the profession and with stakeholders, the CRPPH identified the need to better understand the relationship between the science and values that are inherent in, and a challenge to, the system of radiological protection (OECD/NEA, 2007a, 2007b). In addressing this need, the CRPPH began a long-term initiative to reflect through a series of workshops on the science and societal values impacting and implicit in the system of radiological protection. The first workshop was organised in collaboration with the Radiation and Nuclear Safety Authority of Finland (STUK), and entitled “Science and Values in Radiological Protection”. It took place on 15-17 January 2008 in Helsinki, Finland. The CRPPH went on to organise a second Science and Values workshop, in collaboration with France’s Institut de Radioprotection et de Sûreté Nucléaire (IRSN) and the French Ministry of Ecology, Energy, Sustainable Development and Land-use Planning (MEDDAT), which took place on 30 November-2 December 2009 in Vaux-de-Cernay, France. The report of these first two science and values workshops was very informative and concluded in part that:

The CRPPH has recognised that mutual understanding on the scientific evidence and on the radiological protection values and practice is important both for obtaining optimal protection and for identifying the gaps in knowledge that are most relevant for radiological protection. Most of the participants at both science and values workshops agreed that while there is no immediate need to change the current principles, extended dialogue among all concerned stakeholders is necessary in order to facilitate integration of challenging scientific phenomena into existing regulatory frameworks. This type of exchange forum between regulators and scientists was welcomed and could serve as a model way of moving forward. As such, the CRPPH has agreed to hold a third workshop on science and values, to take place in Japan. (OECD/NEA, 2011)

Beginning in 2002, the CRPPH also organised five Asian regional workshops, held in Japan and in collaboration with the International Commission on Radiological Protection (ICRP), to obtain Asian regional stakeholder input into the development of ICRP Publication 103, and after its issuance, to provide feedback on its implementation.

As a follow-up to the 2008 and 2009 Science and Values workshops, and as a continuation of the five Asian regional workshops, a joint event in the form of a third workshop and conference was organised to further these discussions. Consequently, the 3rd Workshop on Science and Values in Radiological Protection Decision Making and the 6th Asian Regional Conference on the Evolution of the System of Radiological Protection were held concurrently on 6-8 November 2012, in Tokyo, Japan. This joint event, referred to as Workshop 2012, is the subject of this report. Workshop 2012 was co-organised by the CRPPH, the Nuclear Regulation

Authority (NRA), the Ministry of Education, Culture, Sports, Science, and Technology (MEXT), and the National Institute of Radiological Sciences (NIRS) of Japan. In this workshop 134 participants from 16 countries came together to share their experiences, knowledge and issues and to provide recommendations to further enhance radiological protection. The workshop benefited from the active and devoted participation of a spectrum of stakeholders including local Fukushima Prefecture residents and local leaders, journalists, physicians, as well as radiological protection professionals. See Annex 1 for a list of Workshop 2012 participants.

The NEA and CRPPH would like to thank the three co-organising Japanese organisations for their support for the workshop and also thank the many Chairs, Co-Chairs, and Rapporteurs for their tireless contribution to the success of the workshop and to this report. A special note of appreciation is also extended to the Japanese participants at the workshop, both professionals and local stakeholders, who took time out of their already extended work schedules to make valuable contributions to the discussions and outcomes of the workshop.

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INTRODUCTION

Objective

The 3rd Workshop on Science and Values in Radiological Protection Decision Making and the 6th Asian Regional Conference on the Evolution of the System of Radiological Protection, together designated as Workshop 2012, focused on three relevant and timely topical areas and the science and values driving the evolution of the system of radiological protection. Workshop 2012 featured input from Asian regional experts, young scientists, professionals, and other stakeholders, including representatives of civil society.

Its objective was:

Workshop objective

To better understand how science and values aspects may influence the evolution of the system of radiological protection, and to better understand how science and values aspects should be included and transparently articulated in radiological protection decision making.

Taking into account the experience gained following the 2011 Fukushima accident, the discussions focused on developing a better understanding of the scientific and value-related elements that could assist radiological protection to move forward in an acceptable and sustainable direction. The three topical areas of focus determined by the co-organisers to be of most and timely interest to participants at the workshop dealing with post-Fukushima issues were:

- 1) Assessment and Management of Low Dose Exposures and Public Health;
- 2) Protection of Children and Self-Help Behaviour Approaches;
- 3) Non-Cancer Effects.

Workshop format

The morning and early afternoon sessions of the first day of Workshop 2012 consisted of Plenary Session 1, entitled “Managing the Consequences of the Fukushima Accident”. Invited plenary presentations addressed the current status of Fukushima environmental contamination and recovery activities, Asian country viewpoints, and Asian regional science and value issues focusing on the views of young professionals. Plenary Session 2 was devoted to presentations on science and values that set the scene for the subsequent three concurrent breakout sessions dealing with the three topical areas identified for the workshop. The second and third mornings of the workshop were devoted to facilitated breakout sessions on each of the three topical areas. Participants in each of the three breakout sessions represented a balance of stakeholder interests. Plenary Session 3 allowed for more invited presentations to inform participants on specific aspects of each of the topical areas. The programme for the workshop can be found in Annex 2 to this document.¹

The facilitated discussions conducted in the breakout sessions provided an opportunity to discuss the current scientific issues and challenges in radiological protection, with a particular focus on values issues. The term “values” in this context means consideration of

1. Further information and plenary session presentations can be found at www.nea.fr/rp/workshops/tokyo2012.

both the ethical and societal influences used in decision making involving radiological protection. The plenary summary presentations for each topical area breakout session, which were prepared by the Rapporteur of each topical area and were delivered in the last afternoon of the workshop, were used as the basis for the conclusions and recommendations provided in this report.

BACKGROUND:
**FUKUSHIMA ENVIRONMENTAL CONTAMINATION AND RECOVERY ACTIVITIES,
ASIAN COUNTRY VIEWPOINTS, AND YOUNG PROFESSIONALS' VIEWS**

Fukushima environmental contamination and recovery activities

The session began with a presentation by Kimiaki Saito, Fukushima Environmental Safety Center, Japan Atomic Energy Agency (JAEA), "Current Status of Environmental Contamination and Recovery Activities". The JAEA has completed a series of three campaigns (June 2011-November 2011, December 2011-June 2012, and July 2012-ongoing at the time of Workshop 2012) to construct detailed mapping of radionuclide deposition and dose rates in the environment based upon actual monitoring data gathered in the area of Fukushima, to conduct studies on the radionuclide migration in the natural environment, to construct a database, and to predict contamination conditions into the future. This mapping allowed for the estimation of the impact of the accident on people and the environment and to begin taking appropriate countermeasures to reduce radiation exposures to the population as data became available. The mapping projects included the identification of radionuclide deposition and dose rates in air, studies on radionuclide migration in the natural environment, construction of a measurements database, and predictions of areas of contamination in the future. Following the analyses of contamination conditions following the Fukushima accident, caesium [(Cs) ^{134}Cs and ^{137}Cs] was identified as the most important radionuclide from the viewpoint of potential radiation exposures during future remediation or decontamination. These analyses also showed that environmental contamination has decreased since the accident and countermeasures implemented to reduce radioactive contamination have reduced dose rates at many locations. Studies of radionuclide migration have shown that by December 2011 most caesium existed within the top 5 cm of soil and that migration since that time has been due to movement by water. Caesium concentrations in air have not been high and the effectiveness of dose rate reduction countermeasures has depended upon land use (faster in urban and water areas, while slow in evergreen areas), topography of the area, and local levels of contamination. Priority was given for dose reduction activities targeting the areas of highest contamination.

On 1 January 2012, new Japanese legislation, "Special Measures Concerning the Handling of Radioactive Pollution (Policy)", went into effect to promote and provide support for ongoing and future decontamination efforts. As explained by the JAEA, under the new Policy, 11 municipalities in the former restricted zone and planned evacuation zones were identified for decontamination based on survey results. The municipalities implemented decontamination activities with the national government providing financial and technical support. Interim decontamination goals for 2012 and 2013 were included in this Policy. After 2014, the aim is to reduce additional exposure doses to less than 1 mSv/year as a long-term goal. The Policy also includes a provision to check, evaluate the two-year decontamination results, and consider proper actions and revise implementation plans as needed. Issues identified in the Policy for future consideration include:

- accurate monitoring and prediction of contamination conditions;
- dose reconstruction;
- optimisation of decontamination;
- appropriate risk communications;

- flexible choices for inhabitants;
- continuous medical examination of inhabitants;
- compilation of accumulated data and knowledge;
- studies on radiation effects on the environment.

Asian country viewpoints

The plenary session also provided participants with the viewpoints from several Asian countries including Korea, Malaysia, Vietnam, and Russia on challenges they faced as a result of the Fukushima accident.

The Korean presentation, by Jaiki Lee, Hanyang University, identified that the events in Japan have raised many questions related to the protection of the public from radiation such as the selection of the appropriate dose limits for the public, including children, and the safe criteria for foodstuff. Confusion has arisen since the Fukushima accident when applying the current system of radiological protection. The confusion arises in determining the system of radiological protection provisions and recommendations to apply as the situation transitions from the initial emergency response phase, with its associated system of radiation protection provisions, to the longer-term situation of people living in a contaminated area. It is not clear if the long-term situation should come under the provisions in the current system of radiological protection specific to an existing exposure situation or a planned exposure situation. This confusion has led to the situation where many people are attempting to use the wrong “measuring stick” of 1 mSv per year for their given situation. Dr. Lee stated that the protection of the public is a complicated issue because of the “collision” between science and values.

The Malaysian presentation, by Noriah Mod Ali of the Malaysian Nuclear Agency (NUKLEAR), shared that there were public fears and warnings spread in text messages and on the Internet regarding radioactive clouds and acid rains that were said to be reaching Malaysia and contaminating water, food and humans. NUKLEAR received large numbers of enquiries regarding safety, including whether airline passengers and food from Japan should be considered as being contaminated with radioactive material. Malaysian authorities quickly mobilised resources and expertise to handle and respond to these enquiries concerning the Fukushima accident and its potential impact on Malaysia. A national call centre was activated and operated 24/7, Frequently Asked Questions (FAQs) were created and posted on the Atomic Energy Licensing Board website, press releases were issued and media visits organised for reporters to see that response operations were co-ordinated. Six environmental monitoring stations were installed throughout Malaysia providing real time information on radiation levels around the country. Environmental sampling of water, soil and vegetation from various parts of the country were collected and assessed. Airline passengers as well as ships, cars, and electronics from Japan were also screened. Foodstuff from Japan and local foodstuff were also collected, monitored, and released as appropriate. Further efforts are focusing on improving radiation-monitoring operations that should be available, exercised, and effective to be better prepared to respond to future accidents. The National Security Council issued Directive No. 20, entitled: “Disaster with Regards to Radiological Accident”. This Directive establishes an “On Scene Command Post” and specifies the organisational structure and responsibilities to be in place to deal with future accidents. Dr. Ali concluded her presentation by stating that the experience gained in response to the Fukushima accident has provided NUKLEAR with valuable input for enhancing and harmonising

their emergency preparedness and response framework and for enhancing national radiation monitoring capabilities in order to ensure public safety and avoid societal confusion and mistrust.

The Vietnamese presentation, by Dang Duc Nhan, Senior Consultant to the Vietnam Atomic Energy Institute, noted that the reliance of the current system of radiological

protection upon the linear non-threshold (LNT) relationship causes fear. The constraints inherent in the conduct of studies of health risks at low dose and dose rate (e.g. environmental influences, lifestyle choices, diet and the quality of dosimetry data) have created a challenge to the profession to effectively communicate with stakeholders concerning the risk of exposure to radiation. Dr. Nhan indicated that there is evidence that radiation interacts with living molecules randomly, but not with the same probability as is assumed in the LNT relationship. Irradiated cells, according to some studies, may be able to protect themselves through adaptive responses that then do not lead to an adverse impact. He shared that there are also studies that show a threshold dose for some adverse health effects in humans. He further stated that, "The fears associated with the concept of LNT and the idea that any dose, even the smallest, is carcinogenic lacks scientific justification!" In looking at the constraints on studies of health risks at low dose and dose rate he indicated that radiation is but a single factor in causing carcinogenesis. Environmental factors, smoking habits, and diet can be confounding factors and not all laboratories could have precise dosimetry upon which to base their study results. He concluded by identifying the need to harmonise the interests of the legislature, industry and the medical sector, and science. The interests of the legislature are to promote radiation protection, the interests of industry and the medical sector are social and economic profit, and the interest of science is to provide scientific evidence upon which to make informed decisions.

Two speakers delivered the Russian presentation. The first, by Nataliya Shandala, of the Federal Medical Biological Agency (FMBA), stated that shortly after the Fukushima accident, in March 2011, the Russian Ambassador to Japan requested the FMBA to deploy a team of experts to the Russian Embassy in Tokyo to perform the following functions:

- 1) Assess doses of external and internal radiation exposure.
- 2) Provide recommendations to their Ambassador on:
 - a) the need for measures to protect Russian citizens living in Japan;
 - b) the need to limit visits to Japan by Russian citizens for tourism, business, and other private/personal activities.

The six-person FMBA team made three trips to Tokyo (April and September 2011, and September 2012) to take measurements at the Russian Embassy in Tokyo, Japan and interview Russian citizens in Tokyo. The interviews were done to determine their residence history and dietary habits from 11 March 2011 to the date of measurements. During the April 2011 visit, 268 people were monitored for iodine-131 (¹³¹I) in the thyroid and for ¹³⁴Cs and ¹³⁷Cs in the body. During the September 2011 and 2012 visits, 289 and 227 people were monitored respectively, for ¹³⁴Cs and ¹³⁷Cs in the body. Measurements for ¹³⁴Cs and ¹³⁷Cs were also made on foodstuffs and air samples were also taken and analysed.

During the April 2011 visit only 3 people of 268 exceeded the minimum detectable activity (MDA) of the detectors (100 Bq¹³¹I), with the highest activity reading being 130 Bq ¹³¹I. Based upon these measurements, the absorbed dose to the thyroid for these Russian citizens living in Tokyo was 2 mGy for the adults and 4 mGy for a one-year-old child. During the three visits, none of the 784 people monitored exceeded the 1 800 Bq MDA of the detector for ¹³⁷Cs. Based upon these direct, whole-body measurements for ¹³⁴Cs and ¹³⁷Cs, the average effective dose to those monitored did not exceed 10 µSv per year.

The ambient air dose equivalent in Tokyo before the Fukushima accident was in the range of 0.03-0.05 µSv per hour (µSv/h) and based upon their independent air monitoring, the post-Fukushima ambient air dose equivalent rate in Tokyo was found to be in the range of 0.08-0.11 µSv/h. The existing ambient dose equivalent rate for air in Moscow at the time was in the range of 0.12-0.20 µSv/h. Consequently it was determined that the external exposure to residents in Tokyo, considering natural background plus the contribution from the Fukushima accident, was less than the typical external exposure from natural background for residents living in Moscow.

The MDA for the equipment used to monitor the foodstuffs was 10 Bq per kilogram (Bq/kg) for ^{134}Cs and ^{137}Cs . Rice, milk, dry algae, cabbage, blueberries, Pacific cod, radishes, and tap water brought in by the Russian embassy staff from local shops for monitoring were all found to be below the MDA. The only foodstuffs above the MDA were pumpkin, with readings of 22 ± 8 Bq/kg for ^{137}Cs and 13 ± 6 Bq/kg for ^{134}Cs and imported cowberries from Sweden, with a reading of 70 ± 15 Bq/kg for ^{137}Cs .

Following the results of the independent measurements, the FMBA recommended that:

- 1) No restrictions on lifestyle or dietary habits of Russian citizens in Japan were needed due to the radiation measurements performed.
- 2) The Russian Ministry of Foreign Affairs should remove restrictions for Russian citizens visiting Japan, excepting for areas that Japan authorities prohibited visiting.
- 3) Because the highest measured absorbed dose to the thyroid from ^{131}I for Russian-residing Tokyo residents was a few mGy, there was no need to administer prophylactic iodine to Tokyo residents after the accident.
- 4) Measurements on foodstuffs and tap water met requirements imposed by the Japanese authorities, so consumption of foodstuffs and water was safe.
- 5) Because the average effective dose to Russian residents in Tokyo from ^{134}Cs and ^{137}Cs did not exceed $10 \mu\text{Sv/y}$, no additional protective measures or restrictions were needed for Tokyo residents.
- 6) Measured external exposure rates to the residents of Tokyo from radioactive releases of the Fukushima accident are substantially less than those from natural background in other parts of the world where people are living.

The second Russian speaker was E. Ivanov, of the Institute of Nuclear Power Plants, who concluded that there are several challenges facing Russian nuclear power plants following the accident at Fukushima. These challenges are the:

- 1) classification of accidents at nuclear power plants in order to urgently initiate decision making for intervention, including taking protective measures;
- 2) zoning of areas around power plants in order to plan protection measures in case of a nuclear accident;
- 3) unification or standardisation of instrumentation and methods for radiation monitoring of near-land air in the vicinity of power plants;
- 4) resolving the difficulties and ethical problems associated with the trans-boundary exchange of foodstuffs due to differing numerical country values for the permissible activity of contaminants;
- 5) need to enhance emergency response at the early stages of an accident;
- 6) determining and communicating the radiation levels below which factual measurements should be interpreted as being of least concern and not worrying to the public.

Young professionals' views

In organising Workshop 2012, it was felt that inclusion of young professionals' views and ideas would be important for participants since many of these young professionals will be dealing with post-Fukushima issues throughout their careers. To facilitate this idea, the Young Researchers' Association (YRA), which was established in 1988 by the Japan Health Physics Society (JHPS) for members under the age of 35, was contacted to solicit insights for Workshop 2012. By participating in the workshop, the YRA members were provided a unique opportunity to meet and interact with senior members of the JHPS, government officials, stakeholders, and members of the ICRP. Their thoughts and perspectives were of particular

interest to organisers and fellow participants who learned how the younger professionals viewed the current system of radiation protection in the aftermath of the Fukushima accident.

Kensuke Otsuka, President of the Young Radiation Biologist's Association of Japan (YRBAJ) who also works at the Japanese Radiation Safety Research Center, provided a presentation entitled "Scientific Challenges to Radiation Research – Views of Young Investigators". The YRBAJ has been active since the Fukushima accident in providing answers to questions posted on the web, participating in national monitoring and sampling programmes, providing seminars to the public, and writing and translating publications at the local level. As a result of these experiences, they believe that there is a need for additional study of long-term low dose rate effects, mechanisms behind epidemiological findings, and science-based risk assessment for use in radiation protection. They stressed that our understanding and use of the LNT model and the use of the dose and dose rate effectiveness factor (DDREF), including the biological evaluation of mechanisms involved in mutations leading to cancer, would benefit from further scientific research. The need for science-based risk communications to inform public awareness was identified as one of the key lessons learned from the Fukushima accident.

Haruyuki Ogino, representing YRA and the Japanese Central Research Institute of the Electric Power Industry, provided a presentation entitled, "Social Values: Radiological Issues and Future Perspectives on Fukushima Nuclear Accident from the Viewpoint of Young Researchers and Students". He stated that while YRA members were "shocked" by the Fukushima accident and tsunami devastation, they remain highly inspired to provide assistance and to overcome the national difficulties resulting from the accident.

To assist in answering questions posed by the public, the YRA created a website² where people can post questions and get answers, with translation into six languages (Chinese, Korean, Malaysian, Vietnamese, Russian, and French). Seventy-two per cent (72%) of those posting questions were female, with 54% of those in the 30-39 age group, and 63% of all women posting questions stating that they are full-time homemakers. For males posting questions, 33% were between the ages of 40-49, 28% were ages 30-39, and 59% of all men posting questions stated that they were company employees. The YRA procedure is to carefully reply to each question, stating objective facts in plain language, then modestly add personal opinions or advice. Each response must be respectful and must not tarnish the reputation of the JHPS. The YRA has received positive feedback on its website, noting that users have stated that the responses received appear to be honest and reliable, and to be based upon technical knowledge and expertise. They are explained in plain language, and even predominantly quantitative answers give insight, rather than just saying "don't worry". The negative feedback received indicated that any opinions stating, "don't worry" tend to stir up more anxiety rather than to help alleviate concerns regarding radiation.

The YRA noted that in some cases, questions regarding the government dose assessments were asked with concern whether or not they are reliable due to differences observed between the governments' assessments and views presented in the media.

The YRA volunteers found it particularly challenging to respond to feelings of risk aversion. As a result, they are shifting their activities from a focus on radiation dose assessment to a more comprehensive health risk assessment where they compare lifetime risk as a result of daily life activities. The YRA also identified difficulties in the practical application of the nominal concept in radiation protection (i.e. the use of sex and age averaged lifetime risk estimates to representative populations in determining health impacts from radiation exposure) to respond to the individual interests of stakeholders in a post-accident situation. The use of the nominal concept is of particular concern when dealing with the protection of children after the Fukushima accident where more specific information and protection measures are desired by parents and the community.

2. <http://radi-info.com/>.

The YRA wishes to continue assisting citizens in making their behavioural decisions, and to reflect their voices and concerns in the evolution of the system of radiological protection post-Fukushima. The YRA members view the challenges for the future to lie in the area of communication of radiological risk. Their experiences following the Fukushima accident suggest that the nominal concept in radiological protection is insufficient for explaining radiation risk to the public. Practical and agreed upon definitions for “emergency” and “existing” exposure situations should be developed to avoid the (current) existing confusion about these terms in Japan. They suggest as well that the radiological protection system should take a retrospective review of the effectiveness of countermeasures used during the Fukushima accident. The YRA hopes that their experience can help to provide a firm foundation from which constructive discussion can develop resulting in further evolution of the system of radiological protection.

**TOPICAL AREA 1:
ASSESSMENT AND MANAGEMENT OF LOW
DOSE EXPOSURES AND PUBLIC HEALTH**

Following the session providing background information regarding the post-Fukushima accident situation in Japan and in Asia, Workshop 2012 proceeded to prepare for and conduct three concurrent topical area breakout sessions. In order to inform the further discussions in the breakout sessions, invited speakers provided plenary presentations on topics of particular relevance to the science and values for each of the three topical areas. Participants then broke up into subgroups to discuss their preferred topical area in two sessions lasting several hours.

This section of the report summarises the plenary presentations for Topical Area 1, provides additional referenced information on science and values relevant to this topical area for readers, and presents the agreed upon conclusions and recommendations of the breakout sessions, as prepared by the Rapporteur for Topical Area 1 and presented in the last plenary session of Workshop 2012.

Scientific basis

With regard to Topical Area 1, it is important to understand the basis and foundation of the current system of radiological protection for dealing with low dose and low dose rate radiation exposures as recommended by the International Commission on Radiological Protection (ICRP). Paragraph 36 of ICRP Publication 103 states:

At radiation doses below around 100 mSv in a year, the increase in the incidence of stochastic effects is assumed by the Commission to occur with small probability and in proportion to the increase in radiation dose over the background dose. Use of this so-called linear non-threshold (LNT) model is considered by the Commission to be the best practical approach to managing risk from radiation exposure and commensurate with the 'precautionary principle' (UNESCO, 2005). The Commission considers that the LNT model remains a prudent basis for radiological protection at low doses and low dose rates. (ICRP, 2005b, 2007)

Using the latest studies on the health effects of radiation exposures (e.g. atomic bomb survivors, patients exposed in medical procedures) the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) has reported that there is about a 5% increased risk in the likelihood for a radiation-induced solid cancer per 1 Sievert (Sv) of exposure (UNSCEAR, 2006).

In addition, the ICRP recommends the concept of "reference levels" to manage radiation exposures for the protection of people living in contaminated areas. Specifically, ICRP Publication 111 in paragraph 24 states that "reference levels are used during the optimisation process to plan protection strategies that would result in estimated residual doses lower than these [existing exposure] levels." (ICRP, 2009)

Paragraph 48 of ICRP Publication 111 goes on to state:

In the case of an existing exposure situation following an emergency exposure situation, the radiation source is under control but the controllability of the situation may remain difficult and require constant vigilance by the inhabitants in their day-to-day life. ...As a consequence, when the level of contamination is not too high to prevent sustainable human activities, authorities will preferably implement all the necessary protective measures to allow people to continue to

live in contaminated areas instead of abandoning them. These considerations suggest that appropriate reference levels should preferably be chosen in the 1-20 mSv [per year] band proposed by the Commission. (ICRP, 2009)

Paragraph 50 of ICRP Publication 111 also states:

As the long-term objective for existing exposure situations is ‘to reduce exposures to levels that are close or similar to situations considered as normal’ (ICRP, 2007, Para. 288), the Commission recommends that the reference level for the optimisation of protection of people living in contaminated areas should be selected from the lower part of the 1-20 mSv/year band recommended in Publication 103 for the management of this category of exposure situation. Past experience has demonstrated that a typical value used for constraining the optimisation process in long-term post-accident situations is 1 mSv/year (see Annex A [of ICRP Report 111]). National authorities may take into account the prevailing circumstances and also take advantage of the timing of the overall rehabilitation programme to adopt intermediate reference levels to improve the situation progressively. (ICRP, 2009)

In addition to the above background information on the scientific basis of the current system of radiological protection, Plenary Session 2 of Workshop 2012 included a presentation on new European initiatives to better understand and inform our knowledge concerning radiation exposures and their management. Wolfgang Weiss, Chair of UNSCEAR, gave a presentation describing the activities of the Multidisciplinary European Low Dose Initiative (MELODI) and Low Dose Research Towards Multidisciplinary Integration (DoReMi) projects. These two projects were implemented to develop a better understanding of new scientific knowledge to optimise radiation protection measures for workers, the public, and the environment in order to improve the protection of the public health and safety. The MELODI project takes a three-level approach to enhance an understanding of low dose and low dose rate effects by conducting fundamental and molecular research, epidemiological research, and mathematical modelling. The main focus areas are: induction of cancers, non-cancer effects, radiosensitivity of individuals and tissues, effects of radiation quality, effects of internal contamination and mixed exposures. Important scientific research results of the DoReMi project are contributing to the work of MELODI and have established infrastructure such as cohorts, radiation sources, data- and bio-banking as well as high throughput analysis platforms. The DoReMi project has also contributed to the education and training activities of the MELODI project.

Values

In Plenary Session 2, François Rollinger of the Institut de Radioprotection et de Sûreté Nucléaire (IRSN), France, provided a presentation on stakeholder participation as background for the discussion of values during the Topical Area 1 breakout sessions. The Low Doses Working Group, which included members from industry, qualified experts, non-governmental organisations (NGOs), trade unions, public bodies, and foreign research bodies, concluded that scientific development for a better understanding of the risk cannot be accomplished without sharing a common knowledge between scientists and stakeholders, using simple words and including ethical aspects. The working group went on to recommend, in part, that: possible ways to make scientific publications more accessible to the public should be explored, and written bibliographies synthesising the current state of knowledge on specific topics of interest be developed, clarifying what is known, or not, including uncertainties.

In Plenary Session 3, Jacques Lochar, of Le Centre d'étude sur l'Évaluation de la Protection dans le domaine Nucléaire (CEPN), France, provided the insights of ICRP Committee 4 on the ethical and social values in ICRP Publication 111 (ICRP, 2009). His presentation noted that the three pillars of the ICRP radiological protection system are science, values, and experience. The basic principles of radiological protection (justification, optimisation, and limitation) are rooted in the three theories of normative ethics (e.g. how humans ought to behave), which are virtue ethics, utilitarian ethics, and deontological ethics. His presentation illustrated that ICRP Recommendations aim to respect individual rights

(deontological ethics), to promote collective interest (utilitarian ethics), and favour vigilance and fairness (virtue ethics).

Breakout session discussions and conclusions

With the above as background, the facilitated breakout discussions for Topical Area 1 were conducted in two sessions during Days 2 and 3 of Workshop 2012. The two sessions allowed for a productive, valuable, and free-flowing exchange of ideas, concepts, experience, and concerns of the spectrum of stakeholders participating. Where possible, clarification was provided by the members of the ICRP.

The discussions identified two key, distinct questions to address when dealing with low dose and low dose rate exposures:

- 1) Is there more risk when the dose changes?
- 2) Is there more risk when the dose rate changes?

With regard to the first question, the discussions identified that, historically, radiation protection has used a reduction factor when determining risk factors from low doses and dose rates because of the need to extrapolate from risk factors determined from high doses of radiation. New and current information and advanced analysis now require no reduction factors in determining the risk factor for low doses. This is confirmed by the analysis conducted by UNSCEAR, using the latest information and analysis, and the risk factor for the increase in cancer risk remains at around 5% per Sv (estimated to be between 3.6% and 7.7%) (UNSCEAR, 2006).

With regard to the second question, currently scientific evidence shows that there is about one interaction per cell, per year at a dose rate of 1 mSv/y, at the energy range for caesium. There is some evidence of dose rate effects, but both the experts and participants in Workshop 2012 believed that there is not currently enough new scientific information to modify or change our understanding of risk associated with dose rate changes in the current system of radiation protection.

The breakout sessions also discussed the issue of hormesis (i.e. the belief that low doses of radiation provide beneficial health effects). It was felt that hormesis is an issue of interest to be dealt with and would benefit from a proactive approach. There is some evidence of hermetic biological effects reported in some situations, but the feeling was that hermetic effects cannot be generalised. The ICRP considered hormesis in ICRP Publication 99, and given the high probability of no demonstrable change of the risk factor at low doses, the risk factor has prudently remained at around 5% per Sv (ICRP, 2005).

The breakout sessions also discussed the concept of “risk”. It was felt that the concept of risk is a term-of-art used by professionals and is not well understood by laypersons. The use of the term “safe” is effective when communicating with laypersons, but it was acknowledged that the term is a situation- and circumstance-specific judgment. It was also noted that the ICRP does not define the term “safe”. It was felt that the profession would benefit from a clear presentation, in layman’s terms, of the rationale for, and numerical values used in the current system of radiological protection.

The breakout sessions identified that communications amongst stakeholders is critical to create a productive environment leading to informed decision making. The sessions identified that communications must be inclusive, open, transparent, factual, timely, understandable, and conducted as a two-way dialogue. There was also the recognition that proactive initiatives can be taken to enhance communications.

In low dose exposure situations such as Fukushima, the group identified that in order to manage the situation, support informed decisions, and reassure the population it is essential to establish a Health Surveillance and Monitoring Programme. This programme should perform external and internal dose evaluations, including whole body counting, for all interested individuals. It was felt to be equally important to also establish real-time

monitoring programmes for consumer goods. The programme will allow experts to be more effective by identifying radiological results and trends in the population, which can aid efforts to understand and communicate their significance. With health surveillance and monitoring results in hand, experts can also make concrete recommendations for the protection of individuals, and team with them to help understand the information and take actions to reduce their radiation exposure. This combination of information gathering, interpretation, and subsequent action can begin to diminish uncertainty and rebuild trust between stakeholders. Moreover, the availability of health surveillance data, and the organisation of the monitoring programme itself, can foster an integrated approach to dealing with health-related issues facing authorities and all stakeholders.

Recommendations

The breakout session participants recommended a systematic review of the evidence of dose rate effects on health effects risk factors and a clarification of the term “causation” by the ICRP. The participants also felt that there is still a need for more research into the concept of hormesis, and cautioned that currently care must be taken in the use of the term “hormesis” in radiological protection programmes.

The group also noted that it would be beneficial if the profession would better explain, in the simplest of terms to be understood by laypersons, the rationale for numerical values (e.g. dose constraints, reference levels) used and how the current system of radiological protection is designed to work and be implemented. It was stated that it would be helpful for the ICRP to clarify numerical “values” (e.g. 1 mSv, 20 mSv, 100 mSv) as goals and not as cut-off thresholds of acceptable or unacceptable risk. It would also be helpful if the ICRP would better explain “total dose,” particularly in post-accident situations where the doses are changing with time. Clarification of the concept of “risk” would also be helpful to assist laypersons to grasp the concept and its importance. Using comparisons and references to familiar activities was thought to be a beneficial approach. For instance, in Japan the practice of stopping trains during high wind situations is used as an example of actions taken to reduce risk.

In addressing the issue of communications, the participants felt there were a number of actions that could be taken to enhance the radiological protection profession’s effectiveness. The role of the “experts” needs to be clarified and their responsibilities identified. The identification and proper preparation of a “spokesperson” to represent authorities would also improve communications. International and national organisations should make a clear statement recognising that proper training, education, and experience are needed for experts and spokespersons to effectively engage with stakeholders for productive communications and dialogue. There is also a need to proactively develop short- and long-term communications strategies for outreach to all stakeholders. These strategies should include flexibility so that implementation can be customised to the situation and be responsive to stakeholder interests and needs. Following these recommendations was seen to be a critical pathway towards establishing open and transparent dialogue with stakeholders to facilitate informed decision making.

TOPIC AREA 2: PROTECTION OF CHILDREN AND SELF-HELP BEHAVIOURAL APPROACHES

Following the session providing background information regarding the post-Fukushima situation in Japan and in Asia, Workshop 2012 proceeded to prepare for and conduct three concurrent topical area breakout sessions. In order to inform the further discussions in the breakout sessions, invited speakers provided plenary presentations on topics of particular relevance to the science and values for each of the three topical areas. Participants then broke up into subgroups to discuss their preferred topical area in two sessions lasting several hours.

This section of the report summarises the plenary presentations introducing the workshop's Topical Area 2, provides additional referenced information on science and values relevant to this topical area, and presents the agreed-upon conclusions and recommendations of the related breakout sessions, as prepared by the Rapporteur for Topical Area 2 and presented in the last plenary session of Workshop 2012.

Scientific basis

In Plenary Session 2, as background for discussions during the Topical Area 2 breakout sessions, Yoshiya Shimada, of Japan's National Institute of Radiological Sciences, provided a presentation on "Effects of Radiation Exposure on Children". He demonstrated that high levels of radiation exposure during pregnancy, or *in utero*, could induce embryonic death, malformation, and mental retardation. These health effects are termed "deterministic effects", meaning that they have a known level of radiation exposure, or threshold, that has to be exceeded in order to cause them. Cumulative or total radiation exposure above the threshold can decrease the time of onset and/or increase the severity of the deterministic health effect depending on many biological factors specific and unique to the individual, such as age when exposed, overall health, lifestyle, and genetic predisposition. A radiation exposure below the threshold then does not cause this health effect. These health effects are also tissue-dependent, meaning that some tissues of the body are more susceptible to have a health effect from radiation exposure. There is also a susceptible age window for these effects, for example the head, eyes, thyroid, and heart are most susceptible to having an adverse health effect if they receive a high level of radiation exposure during weeks 2 to 3 of pregnancy.

Dr. Shimada stated that the magnitude of cancer risk is lower for the irradiated embryo or fetus than an irradiated young child. Furthermore, as stated by UNSCEAR, "Lifetime solid cancer risk estimates for those exposed as children might be factors of 2-3 higher than the estimates for the general population." (UNSCEAR, 2006) He went on to explain that genetic factors profoundly influence cancer risk of ionising radiation and that cancer is a disease of multistage processes and is preventable, at least in part.

The ICRP also has addressed the protection of the embryo, fetus, pregnant women, and children. In ICRP Publication 103, paragraph 95 states, "...the Commission judges that risks of malformation after *in utero* exposure to doses well below 100 mGy are not expected." (ICRP, 2007) Paragraph 96 of this publication states, "...any effects on IQ following *in utero* doses under 100 mGy would be of no practical significance." Later, paragraph 97 concludes that:

The Commission recognises that there are particular uncertainties on the risk of radiation-induced solid cancers following in utero exposure. The Commission considered that it is

prudent to assume that life-time cancer risk following in utero exposure will be similar to that following irradiation in early childhood, i.e. at most, about three times that of the population as a whole. (ICRP, 2007)

When considering pregnant women and children in a post-accident situation, ICRP also states in paragraph 280, "...planned protection measures should evolve to best address the actual conditions of all exposed populations being considered. Particular attention should be given to pregnant women and children." (ICRP, 2007)

ICRP Publication 111 also discusses reduction of exposures and protection of subgroups, stating in paragraph 45, "During implementation of the optimisation process, particular attention should be given to reduce individual exposures that may remain above the reference level. Specific groups such as children and pregnant women should also be given particular attention." Paragraph 78, goes on to state, "...long-term health surveillance programmes will have to cover the following objectives: ...the 'medical monitoring' of the general population, which consists of investigating for potential adverse effects (mainly incidence of radiation-induced cancers). A subcategory of medical monitoring is the follow-up of potentially 'sensitive subgroups' (e.g. children, pregnant women)..." (ICRP, 2009)

The ICRP also addresses self-help initiatives in ICRP Publication 111. Paragraph 30 states:

In existing exposure situations, justification should be considered for all protective actions that may be included in a protection strategy: those implemented centrally and locally by authorities, experts, and professionals; and those directly implemented by the exposed individuals as self-help protective actions with the support of the authorities. The protection strategy defined by the authorities should take into account both categories of protective actions, and should enable affected individuals to take self-help initiatives. However, as self-help protective actions are implemented – and thus largely decided – by the inhabitants themselves, they must be properly informed and, if relevant, trained (to use the means and equipment provided by the authorities) in order to take informed decisions concerning their own protection, with a net benefit. The balance to be considered by the individuals includes, on one side, their desire to improve the situation and, on the other side, the "burden" induced by the implementation of protective actions. (ICRP, 2009)

The ICRP Publication 111, in paragraph 62 goes on to state, "...authorities will have to set up infrastructures to support the implementation of all protection strategies, including self-help strategies implemented by the affected population." (ICRP, 2009)

Values

In Plenary Session 2, as background for discussions during the Topical Area 2 breakout sessions, Dr. Shimada's presentation, as introduced in the previous section, also mentioned the results of a study that asked mothers dealing with concerns about radiation, "Whom do you worry about [regarding] what will become of the future?" The mothers overwhelmingly (98.1%) stated they were worried about the future of their children. It is interesting to note that only 0.5% worried about their husbands and 0.6% worried about themselves.

In the Plenary Session 2 presentation "Call for Applied Ethics in Nuclear Science and Technology – Lessons from Fukushima", Professor Michio Miyasaka, of Fukushima Medical University, noted that the Fukushima accident has put everyone into an ambiguous situation when discussing the risks of radiation. The total amount of radioisotopes released was large, widely distributed into air, soil, and water, and resulted in relatively low doses to a widespread area. As there is not an agreed upon risk factor for adverse health effects from low doses of radiation the risks of long-term exposure to low dose radiation remains a contentious issue. Low dose studies have yielded conflicting data, and experts have not yet agreed on a threshold radiation dose needed to initiate adverse health effects, or if there even is one. These facts make it difficult to clearly identify and articulate what the health risks are to an exposed population. Professor Miyasaka also suggested that the accident has highlighted the question of who should have been (or should be) entitled to participate in the

decision making process to initially site a nuclear power plant in order to give informed consent to build the plant. He noted that the professional ethics in Japanese nuclear sciences is one of “monotheism”, in which only experts have the honour of judging the risk of nuclear power plants, including how the risk should be estimated and which criteria should be adopted. Professor Miyasaka postulates that this may be why the safety of nuclear power plants was “mythicised”, that is, shared and decided only within the nuclear science profession with no stakeholder input and where pluralistic points of view were dismissed. In concluding, he stated that the most meaningful lesson from the Fukushima accident should be how a democratic industrial society could dismiss such pluralistic points of view.

In Plenary Session 3, Jean-François Lecomte, of ISRN, France, delivered a presentation entitled “Post-Accident Protection of Children: ICRP Recommendations and Experience from Belarus and Fukushima.” The presentation brought to the attention of participants that there are no specific ICRP recommendations for the protection of pregnant women and children in emergency or post-accident situations. Lecomte noted however that the general objective of the ICRP is to keep exposures below 100 mSv per year, taking into consideration the characteristics of the exposure situation. The ICRP has recommended a three-band dose scale: 0-1 mSv/year, 1-20 mSv/year, and 20-100 mSv/year, in order to select the individual dose restrictions (dose constraint and reference levels) to be applied in the optimisation process.

Lecomte explained that experience in contaminated areas, such as Belarus after the April 1986 Chernobyl accident and now Fukushima, has shown that:

- 1) Radioactive contamination is a “worrisome presence”.
- 2) There are typically no words in the local, common vocabulary to describe radioactive contamination.
- 3) Residing in a contaminated area affects all dimensions of daily life.
- 4) When contamination is widespread there is a need to identify the most exposed individuals as soon as possible.
- 5) Finally, there is strong concern by the people about the future, and in particular, about the future health of children.

In Belarus, the objective for the protection of children, in law, was established to be a maximum exposure of 1 mSv/year by 1991, and 0.1 mSv/year by 2001, five and fifteen years respectively after the Chernobyl accident. Strategies to achieve this included providing “safe food” in the schools and additional health surveillance in schools to identify children with higher doses. Trips away to spend several weeks in sanatoriums and foreign countries were viewed as necessary to reduce the dose to children and were provided. It was important to establish a radiation protection culture in the local community and the schools, as well as mobilise professionals to help engage and inform the affected stakeholders on protection measures and actions they could take to minimise the dose to children.

Breakout session discussions and conclusions

The breakout sessions for this Topical Area began with a short review of the ICRP Publication 111 concerning protection strategies following nuclear and radiological accidents. It was noted that authorities, experts, and professionals implement protective actions both centrally and locally. With the support of the authorities, the exposed individuals themselves directly implement “self-help protective actions”.

Self-help protective actions are informed actions taken by inhabitants of affected areas to reduce their exposure and the exposure of the people for whom they have responsibility (e.g. children and the elderly). Such actions are useful because: i) radiation exposure is largely driven by individual behaviour; ii) self-help protective actions allow individuals to regain control of their own situation; iii) inhabitants have local knowledge that allows them to better

manage their individual exposure. Self-help protective actions complement and are supported by protective actions taken by authorities.

The breakout session identified five necessary factors underlying effective self-help actions in a locality contaminated by radioactivity:

- 1) There is a *desire* to improve living conditions.
- 2) *Shared information* on the levels of contamination in the environment and foodstuffs is readily available.
- 3) *Equipment and training* are provided so local individuals and populations can take their own radiation measurements.
- 4) *Knowledge about how to reduce exposures* is acquired by the population.
- 5) *Support for improvement projects* is provided.

These factors were explored in the breakout session through dialogue between a diversity of stakeholders from the radiation protection profession and other professions as well as from the affected communities of Fukushima. Participants explored a case study to better understand the science and values associated with protection of children and self-help approaches to radiological protection decision making in response to the Fukushima accident.

The case study regarded actions taken to improve conditions at the Tominari Elementary School in Date City within the Fukushima Prefecture. Ms. Satsuki Katsumi, the former principle of the elementary school, and Mayor Shoji Nishida of Date City presented the case study. They described the situation they faced in late March 2011. Initially the local community and officials had received late and incomplete information from authorities. Ten days after the accident, a flood of complex technical information arrived. As the local impact of the Fukushima accident began to be realised, members of the local community had different values: some felt like running away while others wished to stay. In the midst of uncertainty, the community was hit with a strong sense of concern for children, and parents thought that the administrations or authorities were not quick enough to protect them, which produced mistrust. The mayor reached out to the national specialists who came to the area, and asked them to join forces with him in helping the local population. The municipality conducted meetings in order to provide the public with facts about the accident and listen to public concerns. Whether to stay or to evacuate the area was a major issue for individuals and families. To help identify elements for decision, community leaders began to conduct research online. They unearthed the following “scientific” factors that were subsequently considered by residents:

- 1) Many people live in areas with high background radiation (e.g. in Brazil and China) without adverse health impacts.
- 2) Nuclear weapons were used in the past and the level of radiation was high but people generally have stayed healthy.
- 3) Astronauts in outer space apparently were not affected by cosmic rays.
- 4) Horrible stories appear in the media, but ordinary people apparently continue to live healthy lives.
- 5) Immediate evacuation from affected areas is itself a considerable source of psychological stress.

Desire to improve living conditions

Residents expressed concern about the safety of the 60 children attending the Tominari Elementary School and a decision had to be made on whether the students could attend the school or should be sent to another school. Children began to experience difficulties when they noticed contradictions between the comments made by their teachers or by their

mother. Overall, the situation was confusing and in this context, the people started to desire improvements.

The Tominari school is located in a peaceful mountain setting, and it is surrounded with beautiful flowering trees and shrubs. Initially the community was very concerned to find that the schoolyard had an exposure rate of 3.5 μSv per hour. Children were made to wear long sleeves and stay indoors. As spring progressed and summer approached the children wished to go outside. By early May 2011, a team formed of school officials, parents, local leaders, and radiological protection professionals decided to take action to reduce the exposure rate. They removed topsoil and some plants from the school grounds, and blasted away the top layer of asphalted areas of the school. Thanks to this decontamination, performed in several waves, the school became the “safest” place in their mountainous, wooded area with some parents wanting their children to spend the nights at the school as well.

The decontamination effort required the school leaders to ask for the co-operation of the local farmers, too. These accepted the runoff from school grounds when they were presented with data confirming that the contamination level was low. Some parents remained resistant, however, to letting their children swim in the decontaminated pool despite its renewal with clean water. Many meetings were held. A profound change in attitude occurred among parents when Dr. Tanaka (Director of the Nuclear Power Engineering Center, the Institute of Applied Energy), who was born in Fukushima Prefecture, demonstrated that the children could safely use the decontaminated swimming pool at the school. Although they still had concerns about the future health of their children 20 to 30 years from now, Dr. Tanaka provided them with an explanation of the scientific evidence that they understood and relied upon in order to inform their decision to stay. Residents compared the pros and cons of staying and found the pros outweighed the cons. The breakout session observed that when a “tipping point” was reached, with improved confidence in the safety of their home place, community members realised that they did not want to evacuate, and were able to identify reasons to stay. This experience illustrated that affected populations want to listen to experts who can provide reasonable information supporting a decision to stay.

The case study discussion brought insight into why the residents committed themselves to self-help protective actions. They felt that since the school had existed for 134 years in its peaceful and beautiful setting, it needed to be preserved for future generations. This motivation created a team spirit to achieve the decontamination work. There was a general belief that the cultural heritage was worth preserving and sustaining. Breakout session participants drew a comparison with experience in the contaminated territories post-Chernobyl. There too, the people felt they were not just fighting becquerels, but were restoring the quality of their homeland. People commit themselves to staying and to decontaminating their area in order to honour and maintain their cultural heritage.

Shared information

Information useful for self-help actions was shared on several levels. Principle Katsumi stated that when she received alarming calls from worried residents shortly after the accident, she searched the web in order to inform herself about their concerns and find information she could share. Principle Katsumi pointed out that much radiation protection information requires an understanding of probabilities. Although probabilities are included in the Japanese school curriculum, the concepts remain difficult to understand for both children and parents. It was thus appreciable that the experts working with community members used explanatory diagrams and concrete demonstrations. On this basis, residents were able to observe the reliability of the scientific evidence first hand. In addition, detailed and interesting experiments by experts mobilised the children. These events helped community members to decide to move ahead, with trust for the specialists who were working with them.

Many types of radiation protection information were shared. Residents exchanged text messages on specific radiation readings in precise areas. Handouts with detailed information

on dose in play areas were given to parents so that they knew the radiation dose their children were receiving. In August 2012, the municipal authorities provided integrating dosimeters for children. Radiation measurements and average dosimetry results for various school districts were reported in municipal bulletins throughout the autumn. Individual dosimetry readings for children have shown that most children were and still are receiving only very low doses. It should be noted that these readings were sent directly to the families, not through the schools. Since November 2012, adults too have been issued dosimeters.

The breakout session noted that the timing of information is crucial in risk communications. Because people's confidence in the specialists will be influenced by their first impressions, scientists and authorities must be present on time to provide correct information, even if better science will become available later. The media should report success stories as well as bad news. Overall, when communities may potentially be affected by the nuclear activities in their sector, the best time to communicate and build relationships is *before* an accident.

Equipment and training

Mayor Nishida explained that his municipality made a significant investment in equipment, distributing individual dosimeters to the population, including children, adults, and also the elderly (supplementing the 12 000 units issued by central government). He considers that some people may wear dosimeters for the symbolic protection they provide, comparable to that of the respiratory masks seen commonly throughout Japan. Beyond that, however, the readings give all individuals a direct basis on which to observe that their situation is improving, or identify a need for further action. Training of teachers on radiation protection was also found to improve the understanding of countermeasures being put in place to help reduce exposures.

Knowledge of how to reduce exposure

It was agreed and understood in the Tominari community that special consideration was needed for the protection of children. Ms. Katsumi indicated that initially after the accident, televised warnings instructed the wearing of long sleeves and masks, sheltering, and not touching the soil. She therefore no longer required skirts for girls at school. Typically children were encouraged to walk up to 2 km to the school, however immediately after the Fukushima accident, rides to school were promoted to reduce exposure.

The breakout session observed that knowing, deciding, and taking action are three distinct steps. People need peer support to successfully pass through each step. As they described in the breakout sessions, Mayor Nishida and Principle Katsumi took it upon themselves to initially search the Internet for information until specialist help arrived to assist them. They understood the need to repeatedly organise meetings and dialogues so that all members of the community could gain knowledge. When Dr. Tanaka and colleagues committed to working by their side, the community and their leadership could make informed decisions and take appropriate actions necessary to reduce radiation exposures.

Support for improvement projects

Mayor Nishida stated that in the days following the accident, the lack of resources and the tradition of waiting for resources and instructions from the central government hindered initial actions. By early May 2011, the community realised the school playgrounds needed to be decontaminated. The Mayor decided to fund the Tominari School decontamination work, air conditioning in 28 schools, and integrating dosimeters for children, allocating JPY 1 billion (EUR 8.6 million) from the municipal budget. This provision of support restored a degree of confidence among the people. Community support and solidarity were also needed for the disposal of rubble resulting from decontamination actions at the school. Finding a site to bury the rubble was a challenge. The school and municipal leaders met with local farmers and on

the strength of radiological information provided by experts, permission was finally secured to bury contaminated rubble. Finding a solution to disposal of the rubble has enabled an acceleration of the decontamination process in residential areas, further reducing radiation doses to children and the public.

How it all comes together

The Tominari experience demonstrated the relationship of science, values, and process to effectively deal with a post-accident situation. It is important to keep in mind the key players that were involved in the Tominari Elementary School decontamination process:

- 1) local authorities and community leaders who were determined to help the affected population;
- 2) committed specialists who made themselves available as volunteers;
- 3) city officials and staff who were present daily to deal with issues and answer public concerns;
- 4) local educators and health professionals;
- 5) experts coming to the scene, making measurements, and talking to residents;
- 6) parents, husbands, wives, and neighbours coming together to help;
- 7) the children themselves.

It was observed that the technical decontamination actions were no different at Tominari School than they would have been elsewhere. What helps to understand the Tominari story is the shared desire to protect the children. This consensus enabled the co-operation of all players (professionals, authorities, families, and the children) to reach a collective decision to clean the school, thereby also enabling the community to stay. The decision-making process, considering both technical and value issues, and ensuing action were well-supported and successful, resulting in the school becoming the safest place in the immediate area.

This experience, like others in the recent past, demonstrates that the roles and responsibilities of the expert/scientist are evolving. Traditionally the expert/scientist stayed in the laboratory or office. In the post-accident context, roles and responsibilities have broadened to include going into the field, in direct contact with day-to-day needs and operations, and to learn how to improve the situation with a community. Radiological protection here relies on experts/scientists and researchers coming to the actual scene, to better understand the issues, and on the population sharing their concerns, experiences and achievements with the scientific community. The role of experts is not only to provide scientific information, but primarily to help people solve practical problems. Time must be spent to help the affected population understand the science so that the terms, numbers, and figures produced by the experts/scientists become understandable, resulting in a source of assurance and support for action. This new responsibility in turn requires governments and organisations to commit supplemental resources, opening a new avenue of learning for both the professionals and the affected populations.

The Tominari experience also demonstrates how science can contribute to establishing a sense of security for impacted populations. A sense of security is gained when people engage themselves and look at the facts (with help from experts to better understand the science) and are empowered to make informed decisions about their future. It was found that when people become active in their own protection, radiological dose figures no longer produce worry, but become tools. Continued support will be essential in order to establish ongoing and future actions to enhance the quality of life for those impacted by the Fukushima accident. Gathering information, determining what can be done, and working together to improve the situation will rebuild the sense of security.

The breakout session participants reflected together on the universal motivation to protect children, and on the response by children in post-accident situations. Experience in

both Tominari and in the contaminated territories post-Chernobyl has shown that children have a high level of awareness of the suffering of their parents and adults. However, children are more adaptable to new situations and take reality as it is – that is their strength! They have confidence in adults to make the right decisions and take the right action. Children in Date City, even small children, express determination for the future. It is important to allow children to speak about their feelings and share their views with other children who have had similar experiences – and also with children from other cities or abroad, who have never lived through an accident. It was determined that rather than to try and forget, it is important to build the memory of what happened so that the children of Fukushima have a heritage to pass on to future generations. As illustrated, it should be remembered that children are individuals too (i.e. they are subjects, not objects), and to treat them that way when education is provided.

Recommendations

Although a great deal has been accomplished for the protection of children at the Tominari Elementary School, there are still opportunities to enhance the protection of children, other sensitive populations, and families by:

- 1) conducting whole body measurement campaigns (perhaps in schools) to identify the most contaminated children and people;
- 2) continuing the dialogue with concerned families to identify the main sources of contamination and taking action to mitigate those sources;
- 3) making available the measurement of foodstuffs that are brought into the home for consumption by families to better manage exposures;
- 4) the implementation (as needed) of corrective actions by families;
- 5) following up on the evolution of whole body contamination of the children and others with ongoing monitoring programmes.

These are all experiences that should be considered by local and national authorities, in full partnership with the community, to further enhance the protection provided to the affected individuals, including potentially sensitive populations such as children and pregnant women.

It is also recommended that governments and organisations commit supplemental resources and establish long-term programmes to get experts/scientists and researchers into communities and to the scene of accidents to make a greater contribution to addressing and resolving resulting issues on a real-time basis.

The Tominari Elementary School experience demonstrates that successful radiation protection was not so much about setting reference levels, but rather recognising the community's desire to take particular care of children and of their heritage. A special priority was placed upon the protection of children with resources dedicated there first. Based on these experiences, the breakout session participants recommended that ICRP should re-evaluate their recommendations to reflect the priority given to sensitive populations and demonstrate that their recommendations are protective of sensitive populations such as children and pregnant women. It was also recommended that the ICRP clarify the risk to children when implementing the "optimisation" approach.

Date City and Tominari were pioneers in self-help protective actions. Good practice spread by example, and decontamination has by now been repeated in many schools. However, the people of Tominari recognise that the post-accident situation is still ongoing. They observe that strong leadership and trustful team spirit have not always emerged in other localities affected by the Fukushima accident. They ponder whether their children will continue to receive the same support from professionals. They call attention to the figure of 20 000 children reported to be displaced, and in need of psychological support. They strongly wish that their own positive experience, and the lessons learned, may help others. The

Tominari Elementary School can be viewed as a symbol of action and hope. For this reason, its story should be disseminated locally, nationally, and internationally.

TOPIC AREA 3: NON-CANCER EFFECTS

Following the session providing background information regarding the post-Fukushima situation in Japan and in Asia, Workshop 2012 proceeded to prepare for and conduct three concurrent topical area breakout sessions. In order to inform the further discussions in the breakout sessions, invited speakers provided plenary presentations on topics of particular relevance to the science and values for each of the three topical areas. Participants then broke up into subgroups to discuss their preferred topical area in two sessions lasting several hours.

This section of the report summarises the plenary presentations introducing the workshop's Topical Area 3, provides additional referenced information on science and values relevant to this topical area, and presents the agreed upon conclusions and recommendations of the related breakout sessions, as prepared by the Rapporteur for Topical Area 3 and presented in the last plenary session of Workshop 2012.

Scientific basis

Scientific knowledge on radiation-induced non-cancer effects has evolved since the second Science and Values workshop held in 2009. In Plenary Session 2, as background for discussions during the Topical Area 3 breakout sessions, Jolyon Hendry of Christie Hospital and University of Manchester, provided a presentation on the recently-published ICRP Publication 118 dealing with tissue reactions (deterministic effects) (ICRP, 2012). The following paragraphs provide some highlights regarding these new developments in epidemiology as well as radiobiology.

Epidemiology

Dr. Hendry stated that based on the follow-up of large cohorts studies, epidemiology has provided findings that suggest that a whole body exposure at 0.5 Gy or less can increase the risk of stroke and heart disease. Some results illustrating this point are provided in Tables 1-3. Excess relative risk (ERR) could be in the same order of magnitude for both cancer and non-cancer effects. It is still unclear however, whether or not the 0.5 Gy threshold is the same for acute, fractionated, and chronic exposures, as outlined in ICRP Publication 118.

Table 1 illustrates that for a population of women that were treated with radiotherapy for breast cancer, the risk to develop "all heart diseases" (last row of Table 1) is a factor of 1.08 higher than for women who did not received such a treatment.

Table 2 provides ERR values for different cohorts (populations) and pathologies. Basically, when the ERR is statistically higher than zero, this means that for a given population that has been exposed to ionising radiation [i.e. atomic bomb (A-bomb) survivors in rows 1 and 2 of Table 2), the risk to develop a disease (e.g. cardiovascular or cerebrovascular disease in Table 2, columns 2 and 3) is higher than for a population that has not been exposed to ionising radiation.

Table 3 shows that the ERR for various circulatory diseases is higher than zero for "low" doses (~0.5 Gy) even when considering different statistical methods.

Table 1: Relative risk for incidence of heart disease in women treated with radiotherapy for breast cancer (McGale, 2011)

Disease type	Incidence ratio
Myocardial infarct	1.22
Angina	1.25
Pericarditis	1.61
Valvular disease	1.70
All heart disease	1.08

Table 2: Studies reporting increased risks after mean doses < 1.5 Gy (Little, 2010)

Study	Cardiovascular ERR*	Cerebrovascular ERR*
A-bomb mortality	0.14	0.09
A-bomb incidence	0.05	0.07
Peptic ulcer mortality	0.10	
Chernobyl morbidity	0.41	0.45
BNFW mortality	0.70	0.43
Mayak incidence	0.11	0.46

* Excess relative risk (ERR) per Gy of exposure.

Table 3: Systematic review and meta-analysis circulatory disease from low doses (mean < 0.5 Gy) (EHP, 2012)

Disease	Fixed effect ERR ^{a,b}	Random effect ERR ^{a,b}
Ischemic heart disease	0.10 (0.05 to 0.15) ^b	0.10 (0.04 to 0.15)
Non-ischemic heart disease	0.12 (0.01 to 0.25)	0.08 (-0.12 to 0.28)
Cerebrovascular disease	0.20 (0.14 to 0.25)	0.21 (0.02 to 0.39)
Other circulatory disease	0.10 (0.05 to 0.14)	0.19 (-0.00 to 0.38)

^a Excess relative risk (ERR) per Sievert (Sv) of exposure.

^b Confidence intervals are provided for all calculated ERR values in parentheses. When the lower value of the confidence interval is less than zero, this means that the result is statistically insignificant.

Radiobiology

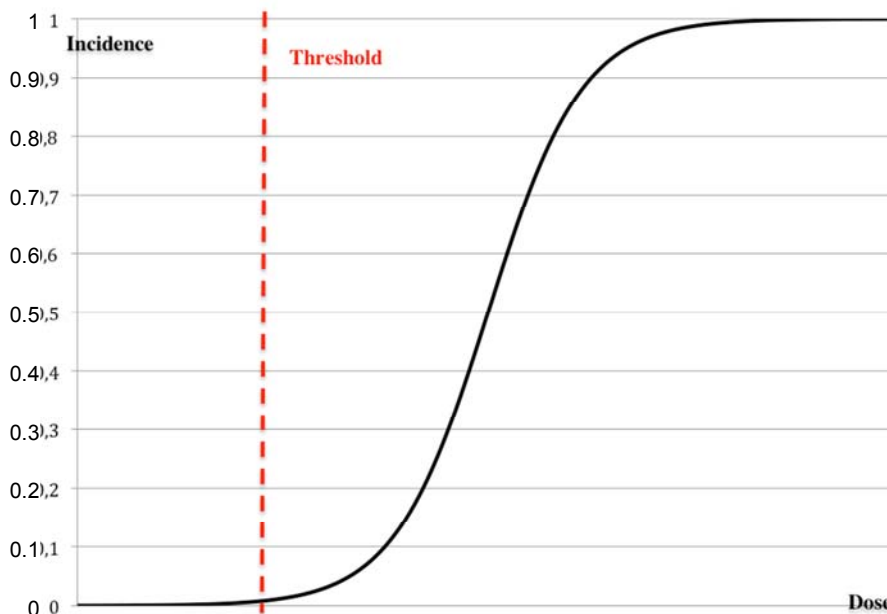
The mechanisms underlying the induction of these diseases following ionising radiation exposure are still debated questions: What are the pathologies and mechanisms underlying radiation induced cardiovascular disease? What is the contribution of atherosclerosis versus microvascular damage? Are there different mechanisms at low and high doses? Nevertheless,

radiobiology has provided interesting inputs in recent years, even if there is still not a clear and agreed consensus on the mechanisms.

Based on current knowledge, mechanisms of cardiovascular damage are likely to be different at low and high doses of radiation. Low doses of radiation (defined here as less than 0.5 Gy) seem to inhibit atherosclerosis, while higher doses of radiation seem to increase inflammatory atherosclerotic lesions. Some possible mechanisms involved in cardiovascular damage after irradiation are local (e.g. inflammatory/thrombotic changes, oxidative stress, fibrotic response, accelerated ageing of microvasculature, accelerated atherosclerosis) while others are systemic (e.g. elevated cholesterol events, depressed immune system, hypertension, metabolic changes).

As stated earlier, the shape of the dose response curve is also a debated issue, and improvement of knowledge on involved mechanisms could provide valuable information in the “design” of the most appropriate curve. Discussions highlighted that the best choice of curve shape could be described by an extended logistic function, as outlined in Figure 1. This could accommodate a threshold dose and a sigmoid dose incidence curve with zero slope both at low doses and at very high doses. The logistic function has been used to quantify dose incidence curves for tissue reactions after higher therapeutic dose ranges, but has not been used to date in a protection context.

Figure 1: Example of an extended logistic function curve and associated threshold outcomes for the radiation protection system



Such new scientific knowledge raises questions for the system of radiation protection as provided by ICRP:

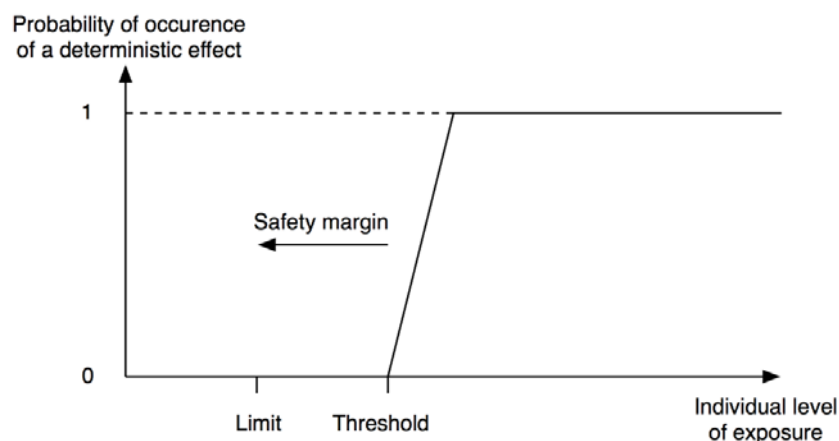
- 1) How much additional risk (e.g. increase in the detriment) is suggested by new scientific evidence?
- 2) Is evidence sufficient to require a precautionary approach?
- 3) In that case, how should this risk be taken into account in overall risk management?

Before answering these questions, it is important to remember that in the current system, two types of effect are distinguished: tissue reactions and stochastic effects.

Tissue reactions (deterministic effects) are those for which the severity of the effect varies with the dose and for which a threshold occurs. Under this threshold, no tissue reaction is

generally observed. To prevent individuals from the occurrence of such effects, it is necessary to maintain the individual level of exposure below the threshold. This is achieved with the setting-up of limits as detailed in Figure 2. On this basis, the management of tissue reactions can be translated into national regulations.

Figure 2: Illustration of the threshold model for tissue reactions



Stochastic effects are those for which the probability of an effect occurring, rather than its severity, is regarded as a function of dose, without threshold. The management of stochastic effects relies on the linear non-threshold model. It is based on the assumption that any increment of the dose leads to a proportional increment of the risk to develop a radiation-induced effect (cancer or hereditary effect). This precautionary assumption was already expressed in the ICRP general recommendations published in 1966 and has never been totally discounted by any general body of scientific evidence (ICRP, 1966). The management of stochastic effects is mainly achieved with the implementation of the optimisation principle: the likelihood of incurring exposures, the number of people exposed, and the magnitude of their individual doses should all be kept as low as reasonably achievable (ALARA), taking into account economic and societal factors.

Regarding non-cancer effects, it is not so clear if they have to be managed as tissue reactions, thereby begging the question: Is science able to demonstrate the absence of any effect for exposure under 0.5 Gy? Or should they be managed as stochastic effects? In this latter case, a dose incidence curve may be necessary so as to assess detriment associated with these effects for low dose and low dose rates.

In the first case, if an approach similar to that for the lens of the eye was followed [see ICRP Publication 118 (ICRP, 2012)] with a threshold at 0.5 Gy, this would imply that an occupational exposure of 0.02 Gy would be the annual limit, which is consistent with the current whole body exposure limit. This result is based on the assumption that the threshold is the same for acute, fractionated, or chronic exposures and that an individual received 25 years of cumulative exposure at the dose limit, or optimisation by restricting annual doses so that the total dose limit would not be exceeded over a working life.

In the second case, it would be necessary to assess the increase in detriment due to non-cancer effects according to a dose incidence function and to emphasise the need for optimisation. Basic calculations show a 20-50% increase in the detriment using a very conservative hypothesis.

The increase of detriment associated with tissue reactions was also debated. The “detriment” is defined as the total harm to health experienced by an exposed group and its descendants as a result of the group’s exposure to a radiation source (ICRP, 2007). Thus it appears that in order to ensure that radiation protection ethical values fully apply the issue of the detriment due to deterministic effects must be clarified. This means an extra component in the calculation of the detriment that accounts for the probability of attributable tissue

reactions (even if not life-threatening). Once scientists agree on the shape of the dose incidence curve (for cancer effects, a mathematical model is needed to quantify detriment), this can be achieved. It must be kept in mind that the detriment refers to a representative individual with the aim to “nominalise” the information.

Going back to ICRP Publication 9 in 1966, it was stated that:

The mechanism of the induction by radiation of leukaemia and other types of malignancy is not known. Such induction has so far been clearly established after doses of more than 100 rads (1 Gy), but it is unknown whether a threshold dose exists below which no malignancy is produced. If such a threshold dose did exist, there would be no risk of the induction of malignancy, as long as the threshold was not exceeded. As the existence of a threshold dose is unknown, it has been assumed that even the smallest doses involve a proportionately small risk of induction of malignancies. (ICRP, 1966)

Values

In Plenary Session 2, Thierry Schneider of CEPN provided a presentation entitled “Potential Impacts of Circulatory Diseases on the Radiation Health Detriment: A First Appraisal” as background for the discussion of values during the Topical Area 3 breakout sessions. In his presentation he notes that ICRP Publication 118 on tissue reaction effects suggests that “absorbed dose threshold for circulatory disease may be as low as 0.5 Gy to the heart and brain” and “particular emphasis should be placed on optimisation”. This appraisal of the impact of the new ICRP Publication 118 suggests that the current ICRP health detriment of 5% per Sv may have to be increased. The presentation goes on to acknowledge, however, that these preliminary conclusions need to be considered with caution.

Breakout session discussions and conclusions

New epidemiological evidence suggests that chronic exposure at levels as low as 500 mSv may cause a small excess risk of stroke and heart disease. A cautious attitude is needed in the interpretation of epidemiological studies because of confounding factors (smoking and drinking habits, etc.). There are many models in the literature that have been tested so as to derive a dose incidence function. According to some experts, the most appropriate model may be a logistic curve, but this has not been used thus far for radiation protection purposes.

Current biological understanding of radiation effects provides mechanisms that might apply at different dose ranges. A better understanding of these mechanisms is still needed and it would be helpful in deriving the most appropriate dose response function.

Based on current knowledge, it seems relevant to address the issue of non-cancer effects within the system of radiation protection. The system, as provided by ICRP, will of course not change immediately; time is needed for a shared reflection to clarify the issue. Additionally, it seems that the system is robust enough so that major conceptual changes are not expected.

Recommendations

As Abel González (ICRP) stated in his breakout Session 3 presentation, “Ethics and Deterministic Effects”, in order to ensure our ethical values are fully applied, the issue of the detriment due to deterministic effects must be clarified. This must be achieved in close co-operation with experts from the radiation protection community and from all fields. Breakout session participants recommended that the ICRP set up a task group devoted to assessment of the detriment associated with tissue reactions (deterministic effects) produced by radiation exposures.

Because there are still uncertainties regarding epidemiology as well as radiobiology, it was recommended that research efforts be maintained in order to improve knowledge and decrease uncertainties.

Based on scientific studies, there appears to be more information on non-cancer effects than was available in 1966. A delicate remaining question if non-cancer effects are to be considered in the radiation protection system is the issue of imputation: “What are we going to say in 10 years to a Fukushima worker who develops a cardiovascular disease? What about people who are chronically exposed in contaminated territories?” Therefore it is time to re-evaluate the consequences of new scientific findings for non-cancer effects in the radiation protection system provided by the ICRP.

A final recommendation was made for the ICRP to clarify its system of radiological protection using common language so that these radiation protection principles, philosophy, rationale, and ethics can be understood by individuals, communities, and their leaders to make informed decisions and take appropriate actions necessary to reduce radiation exposures.

WORKSHOP 2012 CONCLUDING REMARKS

In addition to the conclusions and recommendations as presented in each section of this report, the workshop concluded with an opportunity for participants to share their views on the usefulness and effectiveness of Workshop 2012. Representatives of organisations expressed satisfaction at obtaining clarification and stakeholder input that will further inform their decisions. Regulators and young professionals gained significant knowledge from the opportunity to engage directly with members of the ICRP, fellow Japanese professionals, and Fukushima residents at the workshop. ICRP members expressed appreciation for the input they received from stakeholders and participants concerning the implementation of their recommendations and the need for their further clarification in the real-world, post-Fukushima environment.

The workshop met its objectives in better understanding how science and value aspects influence the evolution of the system of radiological protection through the conduct of presentations and breakout sessions which allowed for direct discussions and sharing of experiences in a post-Fukushima environment. Participants also gained an understanding of how radiation protection decision making should be accomplished and articulated in a transparent manner.

As Claire Mays, Rapporteur for the Topical Area 2 breakout session stated, it is clear that one factor that allowed residents [participating at the workshop] to regain hope is the opportunity to dialogue, to meet with peers (from the Fukushima area, from Japan, from the international context), to tell what is valued and what is not, to observe what is shared and is dividing, to build plans and assess what has already been done, and to feel friendship.

There is still much to be done to address issues associated with the Fukushima accident, but the current system of radiological protection was found to be sound. Further opportunities to evolve the current radiological protection system were identified by workshop participants based on the events and lessons learned to date from the Fukushima accident and are provided as recommendations in this report.

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ANNEX 2: WORKSHOP PROGRAMME

Day 1 – 6 November 2012

Workshop Opening: Welcome from Workshop Host Organisations

Dr. Ann McGarry, CRPPH Chair, RPII CEO

Dr. Kayoko Nakamura, Commissioner, Nuclear Regulation Authority (NRA)

Mr. Masaaki Tanaka, Senior Deputy Director-General Science and Technology Policy Bureau, Ministry of Education, Culture, Sports, Science and Technology (MEXT)

Professor Yoshiharu Yonekura, President, National Institute of Radiological Sciences (NIRS)
(presented by Dr. Kazuo Sakai)

Plenary Session 1: Managing the Consequences of the Fukushima Accident

Chair: Dr. Kazuo Sakai (CRPPH Bureau, NIRS)

Overview of the Accident and its Consequences

Current Status of Environmental Contamination and Recovery Activities

Mr. Kimiaki Saito (Japan Atomic Energy Agency)

Post-Fukushima Challenges: Asian Country Viewpoints

Korean Viewpoints

Dr. Jaiki Lee (ICRP Main Commission)

Malaysian Viewpoints

Dr. Noriah Bt. Mod Ali (Malaysian Nuclear Agency)

Vietnamese Viewpoints

Dr. Dang Duc Nhan (Vietnam Atomic Energy Institute)

Russian Viewpoints

Dr. Nataliya Shandala (BFMBC, ICRP Main Commission)

Asian Regional and Science and Values Issues

Scientific Challenges: Scientific Challenges to Radiation Research – Views of Young Investigators

Dr. Kensuke Otsuka (CRIEPI)

Social Values: Radiological Issues and Future Perspectives on Fukushima Nuclear Accident from the Viewpoint of Young Researchers and Students

Dr. Haruyuki Ogino (CRIEPI)

ICRP Dialogue Initiative: Process, Results, and Moving Forward

Dr. Otsura Niwa (ICRP Main Commission)

Plenary Session 2: Setting the Scene for Breakout Discussions

Chair: Dr. Abel Gonzalez (Vice-Chair of ICRP)

Introduction to Breakout Format

Dr. Ted Lazo (NEA Secretariat)

Topic 1: Assessment and Management of Low Dose/Dose Rate Exposures and Public Health

Science Aspects: Ongoing Research and Remaining Challenges; Experience from MELODIE

Dr. Wolfgang Weiss (CRPPH Bureau, BfS)

Value Aspects: Stakeholder Consultation on the IRSN Research Programme on the Effects of Low Dose and Low Dose Rate Exposures

Dr. François Rollinger (IRSN)

Topic 2: Protection of Children and Self-Help Behavioural Approaches

Science Aspects: Effects of Radiation Exposure on Children

Dr. Yoshiya Shimada (NIRS)

Value Aspects: A Call for “Applied Ethics” in Nuclear Science and Technology: Lessons from Fukushima

Dr. Michio Miyasaka (Faculty of Medicine, Niigata University)

Topic 3: Non-Cancer Effects

Science Aspects

Dr. Jolyon Hendry (ICRP)

Value Aspects: Potential Impact of Circulatory Diseases on Radiation Health Detriment

Dr. Thierry Schneider (CEPN)

Day 2 – 7 November 2012

Parallel Sessions – Breakout A

Topic 1: Breakout A – Assessment and Management of Low Dose/Dose Rate Exposures and Public Health

Chair: Dr. Bill Morgan (Chair of ICRP Committee 1)

Rapporteur: Dr. Rick Jones (NEA Consultant)

- Views of public health official regarding experience with establishing and reporting on health surveillance programmes

Topic 2: Breakout A – Protection of Children and Self-Help Behavioural Approaches

Chair: Mr. Chris Clement (ICRP Scientific Secretariat)

Rapporteur: Ms. Claire Mays (NEA Consultant)

- Views of people who have been directly facing the problem around Fukushima or around Chernobyl, for example parents, school director, local municipality official

Topic 3: Breakout A – Non-Cancer Effects

Chair: Dr. Fiona Stewart (Netherlands Cancer Institute)

Co-Chair: Dr. Gen Suzuki (International University of Health and Welfare)

Rapporteur: Dr. Ludovic Vaillant (CEPN, NEA Consultant)

- Views of regulatory authorities on possible implications of accounting for non-cancer risks in the system of radiological protection

Plenary Session 3: Specific Aspects of Breakout Topics

Chair: Dr. Michael Siemann (NEA)

Attributing Health Effects and Inferring Risk from Low Dose Exposure Situations

Dr. Abel Gonzalez (Vice-Chair of ICRP)

Science and Value Aspects: An ICRP Committee 4 Viewpoint

Dr. Jacques Lochard (Chair of ICRP Committee 4)

Review of Epidemiological Studies of Non-Cancer Diseases

Dr. Gen Suzuki (International University of Health and Welfare)

What is the Rationale and Scientific Basis for Recommendations on Low Dose Radiation Effects

Dr. Bill Morgan (Chair of ICRP Committee 1)

Post-Accident Protection of Children: ICRP Recommendations and Experience from Belarus and Fukushima

Dr. Jean-François Lecomte (IRSN)

Current Issues of the Radiation Risk Communication in Fukushima

Dr. Makoto Miyazaki (Fukushima Medical University)

IAEA Incorporation of Stakeholder Involvement for the Development and Implementation of International Safety Standards

Dr. Tony Colgan (IAEA)

Day 3 – 8 November 2012**Parallel Sessions (cont.) – Breakout B****Topic 1: Breakout B – Assessment and Management of Low Dose/Dose Rate Exposures and Public Health**

Chair: Dr. Bill Morgan (Chair of ICRP Committee 1)

Rapporteur: Dr. Rick Jones (NEA Consultant)

Topic 2: Breakout B – Protection of Children and Self-Help Behavioural Approaches

Chair: Mr. Chris Clement (ICRP Scientific Secretariat)

Rapporteur: Ms. Claire Mays (NEA Consultant)

Topic 3: Breakout A – Non-Cancer Effects

Chair: Dr. Jolyon Hendry (Christie Hospital and University of Manchester)

Co-Chair: Dr. Gen Suzuki (International University of Health and Welfare)

Rapporteur: Dr. Ludovic Vaillant (CEPN, NEA Consultant)

Plenary Session 4: Breakout Sessions Summary

Chair: Dr. Wolfgang Weiss (CRPPH Bureau, BfS)

Topic 1: Assessment and Management of Low Dose/Dose Rate Exposures and Public Health

Summary of Breakout Discussions presented by the Chair and Rapporteur
Discussion of Topic 1 Breakout Results

Topic 2: Protection of Children and Self-Help Behavioural Approaches

Summary of Breakout Discussions presented by the Chair and Rapporteur
Discussion of Topic 2 Breakout Results

Topic 3: Non-Cancer Effects

Summary of Breakout Discussions presented by the Chair and Rapporteur
Discussion of Topic 3 Breakout Results

Key Workshop Conclusions

- Dr. Ann McGarry (CRPPH Chair, RPII)
- Japanese Host

Workshop Close