ICRP

International Commission on Radiological Protection

2012 Annual Report

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On the cover: Translations of ICRP Publications.

ICRP 2012 Annual Report

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Chair's Foreword

2012 was the first full year for implementation of the ICRP Strategic Plan 2011-2017 finalised in late 2011. Significant progress in many areas has already been made, as outlined in the section of this annual report dedicated to the programme of work of the ICRP Main Commission.

ICRP is a registered charity relying on voluntary contributions and has limited financial reserves. To continue its proposed initiatives, ICRP will require considerably more resources than are currently available. However, progress has also been made in this area, having retained a professional fund raising firm with whom we will first undertake a feasibility and planning process, to help us decide whether, and if so how, ICRP might best raise the funds needed to fulfil its mandate.

2012 was also the first time that the ICRP Main Commission met in Japan since 1981. The meeting was held in Fukushima City in the autumn. Most important were the opportunities to speak to people in the area about how they are dealing with the aftermath of the Fukushima Daiichi nuclear power plant accident. The Main Commission members were able to visit a facility where bags of rice were being measured for caesium content, speak to a persimmon farmer in his field about the fate of his crops, and see a home where soil around the dwelling was being removed as part of the decontamination works. Meetings were held with local officials and other representatives to discuss various aspects of radiological protection, and the day-to-day challenges faced by the citizens of Fukushima. This first-hand experience left a lasting impression, and is sure to influence the recommendations of ICRP related to post-accident recovery. It also made very clear the need to do everything that is reasonably possible to avoid major releases of radionuclides into the environment in the future.

A key initiative of the Main Commission came to a close in 2012. The final report of Task Group 84 on Initial Lessons Learned from the NPP Accident in Japan vis-à-vis the ICRP System of Radiological Protection was presented during the meeting in Fukushima City, and a summary report released through the website shortly thereafter. The results of this project will be a important input on the programme of work for ICRP in the coming years, and some new tasks in the areas identified were already initiated in 2012.

Another important initiative, also related to Fukushima, has been the ICRP Fukushima Dialogue Initiative. This cooperative initiative serves a dual purpose: to help the people of Japan, and to gain a deeper insight into the situation to ensure that future recommendations of ICRP on post-accident recovery benefit from this experience.

Of special note in 2012 was the awarding of the Gold Medal for Radiation Protection to Keith Eckerman, a long-standing member of ICRP Committee 2. This medal is awarded once every four years by the Royal Swedish Academy of Sciences to a person who has made a highly valuable contribution to international radiation protection work during the preceding 10-year period.

Seven ICRP publications were produced in 2012, a record number in a single year for the Annals of the ICRP. Three were related to radiological protection in medicine: *Publication 117* on fluoroscopically guided procedures outside the imaging department, *Publication 120* on cardiology, and *Publication 121* on paediatric diagnostic and interventional radiology. Two were publications of dose coefficients: one, *Publication 119*, is a freely downloadable compendium of coefficients based on *Publication 60*, to serve as a comprehensive reference until coefficients based on *Publication 103* are published; the other, *Publication 116*, contains the first of these newer coefficients, specifically those for external exposures.

Publication 118 is of particular note as it contains an extensive assessment of the current state of knowledge on tissue reactions, which led to the ICRP Statement on Tissue Reactions, published under the same cover. This statement contains an important new recommendation on the occupational dose limit for exposure to the lens of the eye which has already been adopted by the International Atomic Energy Agency and the European Commission in their basic safety standards.

The seventh publication was the Proceedings of the First ICRP Symposium on the International System of Radiological Protection. The success of this event has led to preparations for the 2nd International Symposium on the System of Radiological Protection, which will be held in Abu Dhabi, October 22-24, 2013. Our series of international symposia have become the cornerstone of our efforts to better engage with the wider radiological protection community. It is an opportunity to listen, to speak, and to build relationships. I encourage all radiological protection professionals to support this effort by joining us in Abu Dhabi in October 2013.

Claire Cousins.

Dr Claire Cousins
ICRP Chair

The International Commission on Radiological Protection

Since 1928, the International Commission on Radiological Protection (ICRP) has successfully developed the System of Radiological Protection as the basis for radiological protection standards, legislation, guidance, programmes and practice worldwide.

ICRP is a charity established to provide independent recommendations and guidance on radiological protection for the public benefit.

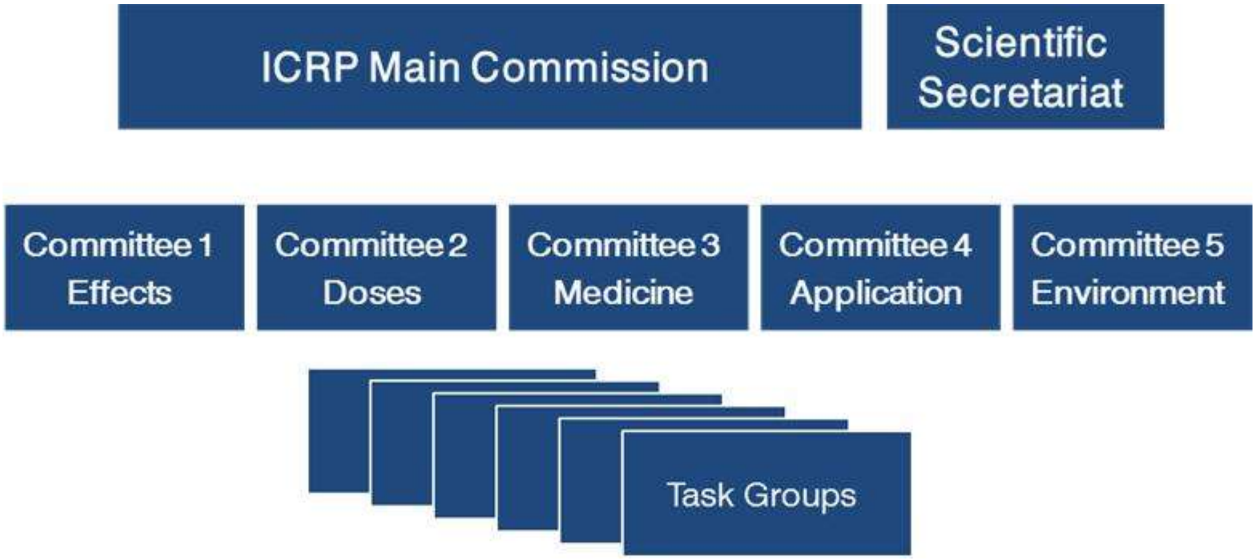
In preparing its recommendations, ICRP considers advances in scientific knowledge, evolving social values, and practical experience. Formulating standards, regulations, and codes of practice is the responsibility of other national and international organisations.

The objective of the work of ICRP is to contribute to an appropriate level of protection against the detrimental effects of ionising radiation exposure without unduly limiting the benefits associated with the use of radiation.

ICRP provides recommendations and guidance on protection against risks associated with exposure to ionising radiation from artificial sources widely used in medicine, general industry and nuclear enterprises, and from naturally occurring sources. These recommendations are published on behalf of the ICRP in the Annals of the ICRP. Each issue provides in-depth coverage of a specific subject area.

Structure

ICRP comprises the Main Commission, Scientific Secretariat; five standing Committees on: Radiation Effects, Doses from Radiation Exposure, Protection in Medicine, Application of ICRP Recommendations, and Protection of the Environment; and Task Groups established as needed to undertake specific work.



The structure of ICRP

This multi-tier structure provides a rigorous quality management system of peer review for the production of ICRP publications. The work of Task Groups is reviewed by the relevant Committee(s), and then by the Main Commission. Before draft ICRP reports are approved for publication, they are regularly circulated to a number of bodies and individual experts, and posted for public consultation through the ICRP web site.

Membership

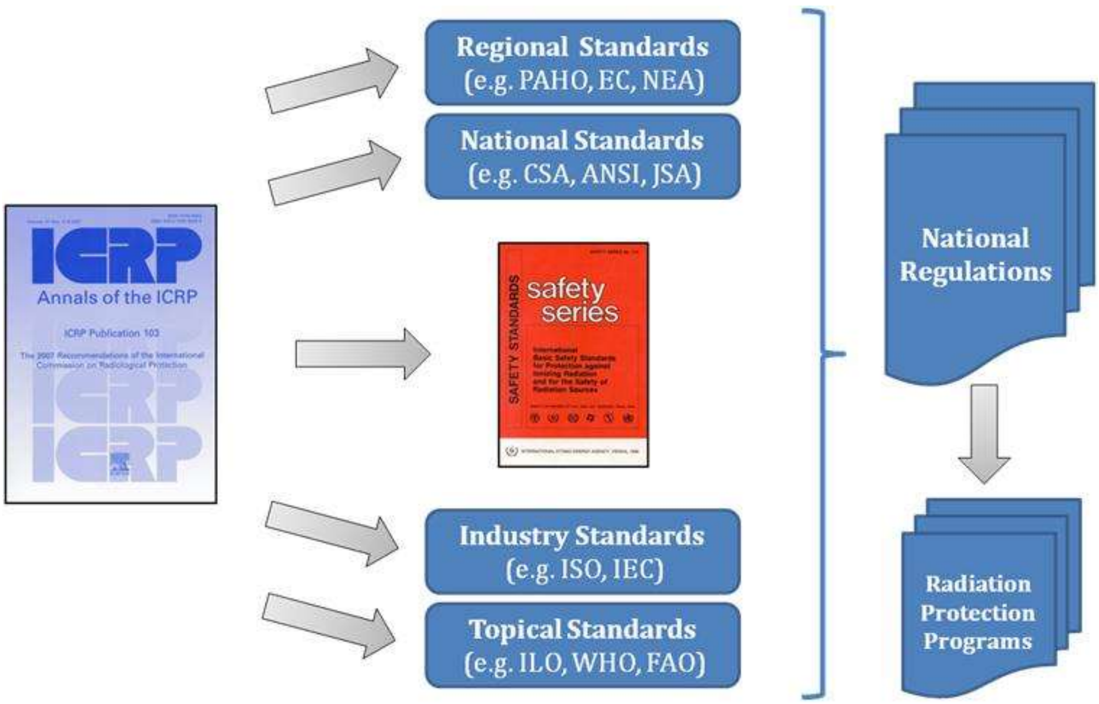
Members come from over 30 countries on six continents and from all disciplines relevant to radiological protection. Selected on the basis of their recognised competence and experience, members are volunteers invited to join ICRP as independent experts for four year terms. The current period runs from 2009 July 1st to 2013 June 30th.

The Work of ICRP

ICRP recommendations are based on scientific knowledge and expert judgement. Scientific data, such as those concerning health risks attributable to radiation exposure, are a necessary prerequisite, but philosophical and ethical considerations are similarly necessary, through which societal and economic aspects of protection are considered. All of those concerned with radiological protection have to make value judgements about the relative importance of different kinds of risk and about the balancing of risks and benefits. In this, radiological protection is no different from other fields concerned with the control of hazards.

ICRP has published over one hundred publications on all aspects of radiological protection. Most address a particular area, but a handful of publications, the fundamental recommendations, describe the overall system of radiological protection.

ICRP offers its recommendations to regulatory and advisory agencies and provides advice intended to be of help to management and professional staff with responsibilities for radiological protection. Legislation in most countries adheres closely to ICRP recommendations. The International Atomic Energy Agency (IAEA) International Basic Safety Standards for Protection against Ionizing Radiation and for the Safety of Radiation Sources is based heavily on ICRP recommendations, and the International Labour Organisation (ILO) Convention 115, Radiation Protection Convention, General Observation 1992, refers specifically to the recommendations of ICRP. ICRP recommendations form the basis of radiological protection standards, regulations, programmes, and practice worldwide.



The ICRP System of Radiological Protection forms the basis of radiological protection standards, regulations, programmes and practice world-wide

The Programme of Work of ICRP and Its Committees

Main Commission

The Main Commission consists of the Chair, up to twelve other members, and the Scientific Secretary[1]. The Main Commission is the governing body, setting the policy and programme of work, and approving all official publications.

The Main Commission in Fukushima, Japan, October 2012

The primary objective of ICRP, set out in its constitution, **is to advance for the public benefit the science of Radiological Protection, in particular by providing recommendations and guidance on all aspects of radiation protection**.

In 2011, ICRP developed a Strategic Plan for 2011-2017 which lays out six objectives and five initiatives for the period all aimed at fulfilling the primary objective of ICRP:

OBJECTIVES

- Improved dissemination of ICRP recommendations
- Scientific work focused on improving the System of Radiological Protection
- Raised awareness of radiological protection in medicine
- Protection of the environment fully integrated into the System of Radiological Protection

[1] The Scientific Secretary is an integral part of the Main Commission, but not formally a member, and therefore is appointed rather than elected, has no voting privileges, and is not a trustee of ICRP as a Registered Charity.

- Positive relationships with organisations interested in radiological protection
- Best practices applied to the governance of ICRP

INITIATIVES

- Making ICRP publications available at low or no cost
- Recommending research needed to strengthen the System of Radiological Protection
- Holding regular ICRP symposia
- Increasing ICRP participation in radiological protection and other forums
- Openly seeking nominations for new members

In 2012, progress was made on several of these objectives and initiatives e.g.:

- Task Group 82 on application of the ICRP's Approach to Environmental Protection under Different Exposure Situations, made significant headway, anticipating publication of a report in 2013
- A new policy on formal relations was developed to enable more effective and efficient relations with a broader group of organisations with an interest in radiological protection
- Thanks to financial support from the European Commission, *Publication 119* Compendium of Dose Coefficients based on ICRP *Publication 60* was made available for free download
- Building on the success of ICRP 2011, in Bethesda, USA, plans to hold more ICRP international symposia were advanced, with ICRP 2013 planned for October 2013 in Abu Dhabi, and initial discussions held with potential hosts for ICRP 2015
- ICRP Committee 3 members made more than 30 presentations on radiological protection in medicine at a variety of conferences, including at the first ever Professional Challenges session organised jointly by ICRP and the European Society of Radiology at the 2012 European Congress of Radiology, and an invited presentation at the IAEA International Conference on Radiation Protection in Medicine.
- An open call for nominations for Committee membership for the next term (July 1, 2013 to June 30, 2017) was held

These initiatives cannot be fully implemented with current funding. Therefore, in 2012 ICRP retained the services of a fund raising consulting firm to conduct a fund raising planning exercise. This exercise, which continued into 2013, is designed to assess the feasibility of launching a fund raising campaign.

Task Group 84 on Initial Lessons Learned from the NPP Accident in Japan vis-à-vis the ICRP System of Radiological Protection

Chair: Abel Julio González

The final report of this Task Group was accepted by the ICRP Main Commission on October 31, 2012 during the ICRP Main Commission meeting held in Fukushima City, Japan. Rather than trying to identify 'lessons learned', the summary report, released on the ICRP website on

November 22, 2012, identifies 18 issues and makes recommendations to the Commission that action should be taken by the Commission to ensure that:

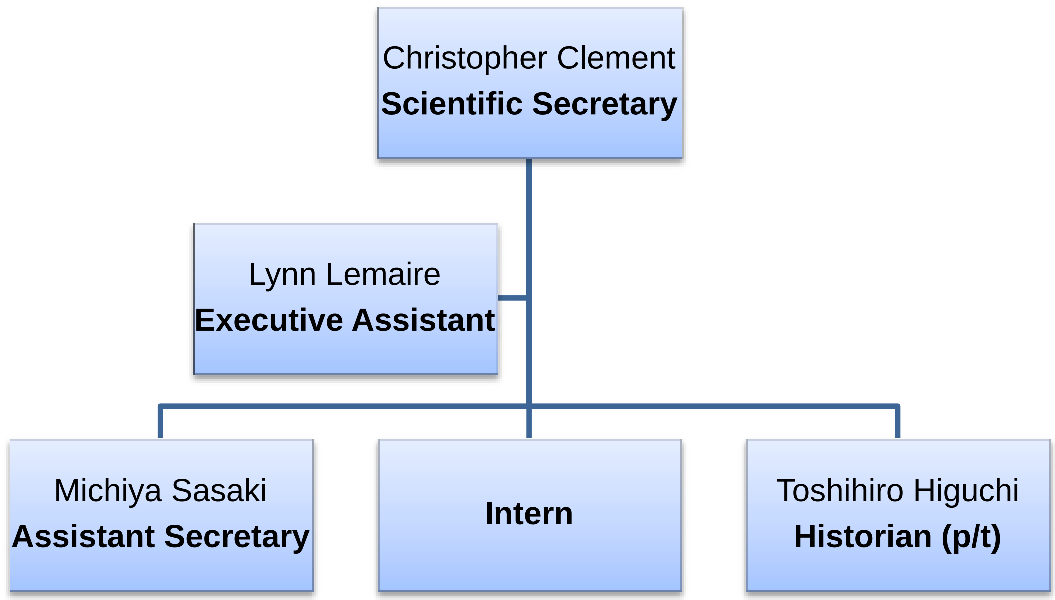
- radiation risk coefficients of potential health effects be properly interpreted;
- limitations of attributing radiation effects following low exposures be understood;
- confusion on protection quantities and units be resolved;
- potential hazard from the intake of radionuclides into the body be properly interpreted;
- rescuers and volunteers be protected with an ad hoc system;
- clear recommendations on crisis management, medical care, recovery, and rehabilitation be available;
- recommendations on public protection levels and related issues be consistent and understood;
- updated recommendations on public monitoring policy be available;
- tolerable contamination levels for consumer products, rubble and residues be defined;
- strategies for mitigating psychological consequences arising from radiological accidents be sought; and,
- failures in fostering information sharing on radiological protection policy after an accident be addressed with recommendations to minimize such communication lapses.

The report does not necessarily reflect the opinions of ICRP, but serves as an important input into the identification and prioritisation of actions. ICRP is already taking action based on some of the issues identified and recommendations made, and these issues and recommendations will continue to influence the ICRP programme of work for years to come.

The Task Group compiled a considerable amount of detailed information not reflected in the summary report. The Main Commission has encouraged the members of the Task Group to publish this information in the open literature.

Scientific Secretariat

ICRP operates its Scientific Secretariat in Ottawa, Canada, in an office provided as an in-kind contribution from the Canadian Nuclear Safety Commission. The seat of ICRP is in the United Kingdom where ICRP is an independent Registered Charity.



Structure of the ICRP Scientific Secretariat

The Scientific Secretariat includes two full-time paid employees: Scientific Secretary Christopher Clement, and Executive Assistant Lynn Lemaire. The position of Assistant Secretary is filled on a multi-year term basis by Michiya Sasaki, a cost-free staff loan from the Central Research Institute of Electric Power Industry of Japan (CRIEPI), and the position of intern is filled on a four-month rotating basis through the Canadian Nuclear Safety Commission co-op student program. The ICRP Historian is a part-time position filled on a voluntary basis by Toshihiro Higuchi.

The Scientific Secretariat manages the daily business of ICRP, including responding to regular queries regarding the work of ICRP, publication of the Annals of the ICRP, organising meetings of the Main Commission and the biennial meetings of the Main Commission and Committees, supporting Committee and Task Group meetings, managing correspondence, maintaining the ICRP archives, and keeping business and financial records.

In addition, the Scientific Secretary participates in all Main Commission meetings; is directly involved in aspects of the scientific and policy work of ICRP; and often represents ICRP at international meetings.

Committee 1 (Radiation Effects)

Committee 1 assesses scientific knowledge on radiation risk, examining possible implications on the System of Radiological Protection.

ICRP Committee 1 in Helsinki, Finland, September 2012

Committee 1 addresses issues of tissue reactions, risks of cancer and heritable diseases, radiation dose responses, effects of dose-rate and radiation quality. In addition, Committee 1 reviews data on effects in the embryo/fetus and genetic factors in radiation response, as well as uncertainties in providing judgments on radiation-induced health effects. The Committee advises the Main Commission on the biological basis of radiation-induced health effects and how epidemiological, experimental and theoretical data can be combined to make quantitative judgments on health risks to humans. The emphasis is on low radiation doses, in the form of detriment-adjusted nominal risk coefficients, where there are considerable uncertainties in both the biology and epidemiology. Furthermore, Committee 1 reviews recently published data from radiation epidemiology studies and new data on molecular and cellular effects of ionizing radiations that are pertinent to updating the basis for the 2007 Recommendations found in *Publication 103*. This work is undertaken through several Task Groups as described below. Committee 1 members have expertise in epidemiology, physics, statistics, medical sciences, animal sciences, molecular and cellular biology, biophysics, genetics, and ’omics technologies.

Task Group 63: Tissue Reactions and Other Non-cancer Effects of Radiation

Chair: Fiona Stewart

This Task Group revisited the basis and the new data for establishing revised threshold doses for non-cancer effects and produced *Publication 118*, published in 2012. This report provides a review of early and late effects of radiation in normal tissues and organs and updates estimates of ‘practical’ threshold doses for tissue injury defined at the level of 1% incidence. The organ systems comprise the hematopoietic, immune, reproductive, circulatory, respiratory, musculoskeletal, endocrine, and nervous systems; the digestive and urinary tracts; the skin; and the eye. Particular attention was paid to circulatory disease and cataracts because of recent evidence of higher incidences of injury than expected after lower doses. Most tissues show a sparing effect of dose fractionation, so that total doses for a given endpoint are higher if the dose is fractionated rather than when given as a single dose. However, for reactions manifesting very late after low total doses, particularly for cataracts and circulatory disease, it appears that the rate of dose delivery does not modify the low incidence. For these two tissues, a threshold dose of 0.5 Gy was proposed for practical purposes, irrespective of the dose rate. Future studies may modify this judgment at a later date.

Task Group 64: Alpha Emitters

Chair: Margot Tirmarche

This Task Group produced *Publication 115* on lung cancer risk from radon and is now considering the cancer risks for alpha emitters other than radon. They will use the recently published risk coefficients of lung cancer for a life-long risk calculation, in order to compare risk from plutonium with that from radon and also from external exposure(s). Selection of the appropriate model systems, accounting for differences between males and females, as well as smokers and non-smokers is being undertaken.

Task Group 75: Stem Cell Radiobiology

Chairs: Ohtsura Niwa and Jolyon Hendry

This Task Group was established in 2007 to review the current state of knowledge of stem cell biology and radiobiology and the potential impact of stem cell effects on radiation cancer risks. There has been an enormous increase in knowledge of stem cell biology in the past five years although less on radiation effects. The Task Group has reviewed the literature on stem cell radiobiology in relation to cancer risk estimation and establishing how knowledge of stem cell response can address uncertainties in risk estimation. The completion of the report was delayed mid-course, mainly by the March 2011 events in Japan but also by the sheer volume of information that the report has evaluated. Drafts of the report have been circulated and the text modified as appropriate in light of the reviewers comments.

Working Party on Dose and Dose Rate Effectiveness Factor

Chair: Werner Rühm

Pending approval by the Main Commission at the spring 2013 meeting, a working party on radiation risk inference at low dose and low dose rate exposure for radiation protection purposes will be constituted. The “Terms of Reference” for this working party have been proposed based on developments in the field and in conjunction with the Main Commission.

Working Party on Genetic Components of Radiation Risk

Proposed Chair: Ranajit Chakraborty

Pending approval by the Main commission at the spring 2013 meeting a working party to update cancer susceptibility and radiation risk in the context of cancer being a multifactorial disease, and any potential impact on risk estimates will be constituted. Inherent in the proposed analysis is the rationale to examine the molecular basis of the contributions of bystander effects, genomic instability, epigenetics and inter-individual variation in radiation sensitivity and how these might impact risk evaluation. A more specific “Terms of Reference” for this working party will be developed based on developments in the field and in conjunction with the Main Commission.

Other Review Activities

Committee 1 continues to review the recent literature on a number of topics related to the 2007 Recommendations in *Publication 103*:

- Radiation epidemiology
- Tissue reactions and non-cancer effects
- Individual susceptibility and its implications for radiation protection.
- Dosimetry and exposure
- Radiobiology
- Heritable effects
- Epigenetics
- DNA Repair and non-targeted effects
- Contributions of “systems biology” type research on radiation protection standards

Committee 2 (Doses from Radiation Exposures)

Committee 2 develops reference models and data, including dose coefficients, for the assessment of exposure to radiation.

ICRP Committee 2 in Rio de Janeiro, Brazil, September 2012

ICRP Committee 2 has the responsibility for providing the dosimetric data that are central to the operation of the system of protection recommended by ICRP. Sets of dose coefficients (dose per unit exposure) are calculated to allow users to evaluate equivalent and effective doses for intakes of radionuclides or exposure to external radiation for comparison with dose limits, constraints and reference levels. Following from the 2007 Recommendations, Committee 2 and its Task Groups embarked on a substantial programme of work to provide new dose coefficients for various conditions of radiation exposure.

The methodology being applied in the calculation of doses can be described as state of-the-art, in terms of the biokinetic models used to describe the behaviour of inhaled and ingested radionuclides and the dosimetric models used to model radiation transport for external and internal exposures. ICRP is at the forefront of developments in this area and its models are used for scientific as well as protection purposes. Thus, as well as their use in the calculation of dose coefficients for protection purposes, ICRP models can provide best estimates of organ and tissue absorbed dose for use in epidemiological studies and assessments of risk to individuals. Furthermore, it is important that methodology is continually refined and improved to take account of scientific developments and also in response to suggestions that ICRP dose assessments underestimate risks, particularly for internal exposures.

The Committee continues to work closely with the International Commission on Radiation Units and Measurements (ICRU) and issues joint reports as appropriate. The Committee is also concerned with conceptual aspects of radiation protection quantities and leads a Task Group on considerations of the applicability of the protection quantities, in particular effective dose, and proposals for alternatives where assessments of individual risk are required, for example in medical radiological procedures. Committee members support the work of the other ICRP Committees, providing members for Task Groups of Committees 1, 3 and 5.

A new initiative by the Committee, of relevance to emergency exposure situations including the assessment of doses following the Fukushima accident, is consideration of a new Task Group to provide dose coefficients for exposure of members of the public to sources of external radiation. The proposal is to provide dose coefficients calculated using ICRP reference phantoms for various situations of environmental exposure including whole body irradiation from a volume source in air, representing a radioactive cloud, a plane source on the ground representing fresh deposition of radioactive fall-out, and uniformly distributed sources in the ground.

Task Group 4: Dose Calculations (DOCAL)

Chair: Wesley Bolch

DOCAL is responsible for developing methods, computational models, and associated reference data for the calculation of absorbed, equivalent, and effective doses from both external and internal sources of radiation. Two major publications were completed in 2012 from the DOCAL Task Group, *Publication 116* – Conversion Coefficients for Radiological Protection Quantities for External Radiation Exposure and *Publication 119* – Compendium of Dose Coefficients based on ICRP *Publication 60*.

Publication 116 supersedes *Publication 74* and provides an extensive array of organ and effective dose coefficients for a broad range of particle types – photons, electrons, positrons, neutrons, protons, pions, muons, and helium ions – and over an extended range of kinetic energies of interest in occupational, environmental, aircrew, and astronaut exposure scenarios. These coefficients were derived using the *Publication 110* Adult Reference Phantoms and *Publication 103* radiation and tissues weighting factors. Annexes to *Publication 116* provide detailed descriptions of the complex dosimetry of skeletal tissues and approaches taken to the calculation of doses to the skin and lens of the eye.

Publication 119 Compendium of Dose Coefficients based on ICRP *Publication 60* provides a compilation of dose coefficients for intakes of radionuclides and external exposures by workers and members of the public taken from *Publications 68*, *72*, and *74*, and thus provides a single ICRP citation for ICRP reference dose coefficients pending completion of new coefficients based upon the 2007 Recommendations (*Publication 103*).

DOCAL is working on a publication to provide datasets of Specific Absorbed Fractions (SAFs) for radiations emitted from radionuclides retained in body organs and tissues of adults, used in the calculation of dose coefficients for inhaled and ingested radionuclides. SAFs represent the deposition of energy in all important organs/tissues (target regions) following emissions from radionuclides retained in body organs and tissues (source regions). Biokinetic models developed by the INDOS Task Group (see below) are used in the calculation of radioactive decays occurring in individual organs and tissues and these data, together with SAFs, allow the calculation of equivalent dose to organs and tissues and effective dose. The calculation of SAFs involves Monte Carlo radiation transport of photons, electrons, and neutrons for an extensive set of source/target organ pairs in both the reference adult male and adult female (*Publication 110*). Additional work has focused on microCT-based models of electron and alpha particle dosimetry of skeletal tissues, and revisions to electron and alpha particle dosimetry in the *Publication 66* and *Publication 100* models of the human respiratory and alimentary tracts.

The DOCAL work program also includes the completion of reference phantoms and associated SAFs for children, the developing fetus, and pregnant female.

Task Group 21: Internal Dosimetry (INDOS)

Chair: François Paquet

INDOS is responsible for the development of biokinetic models for the behaviour of inhaled and ingested radionuclides. Biokinetic models for individual elements and their radioisotopes are used to calculate the total number of radioactive decays (transformations) occurring within specific tissues, organs or body regions (source regions) during a given period of time (usually to age 70). Dosimetric models are then used to calculate the deposition of energy in all important organs/tissues (targets) for emissions in each source region, and hence organ absorbed and equivalent doses and effective dose.

Modifications made in the 2007 Recommendations (*Publication 103*) required a revision of all dose coefficients published to date. The work performed by INDOS during 2012 was focussed on the revision of biokinetic models for the inhalation and ingestion of different chemical forms of radionuclides by workers. Revisions have been made to the *Publication 66* human respiratory tract model and also to many models for the systemic biokinetics of radionuclides absorbed to blood, making them more physiologically realistic representations of uptake and retention in organs and tissues and of excretion. The models and the biokinetic data on which they are based will be published in a series of reports which will provide dose coefficients and also data for the interpretation of bioassay measurements.

The first reports of this series have been submitted for public consultation. The first volume provides introductory text describing the control of occupational exposures, biokinetic and dosimetric models, monitoring methods and programmes and retrospective dose assessment. Subsequent reports providing data on individual elements and their radioisotopes, including biokinetic data, models, dose coefficients and data for bioassay interpretation. The first reports will be published in 2014.

The INDOS work program includes the updating of biokinetic models for radionuclide ingestion and inhalation by children, and the transfer of radionuclides to the fetus and to newborn infants in breast-milk following intakes by the mother.

Task Group 67: Assessment of Radiation Exposure of Astronauts in Space

Chair: Günther Dietze

This Task Group has produced a report on the radiation exposure of astronauts during space missions. The complex primary cosmic radiation field in space includes a wide range of very high-energy charged particles, with heavy ions up to high values of Z and secondary particles produced in nuclear reactions of the primary particles with structural material and equipment in the space vehicles. Depending on the time present in space, mission doses to astronauts may be substantially greater than 100 mSv.

The report focuses on providing data on the radiation fields for the assessment of doses to astronauts and describes methods of radiation monitoring, of measuring radiation field parameters, and of individual monitoring of astronauts. Particle fluence-to-organ absorbed dose coefficients for organs and tissues of the human body have been calculated using the *Publication 110* reference phantoms and are given in an Annex. Additional data are presented comparing measured and calculated doses. The characteristics of the radiation field in space, with its large component of heavy ions, require modification of the radiological protection quantities to take account of radiation quality rather than use of radiation weighting factors. Radiation quality factors are given for the main radiation types, calculated using *Publication 60* methodology and an alternative methodology proposed by NASA. The report also includes consideration of operational measures with regard to the assessment of exposures during space missions. After a public consultation during summer 2012, the report has now been completed and publication is scheduled for 2013.

Task Group 79: The Use of Effective Dose

Chair: John Harrison

This Committee 2 led Task Group has members from Committees 1, 3 and 4 as well as external experts. Experience has shown that ‘effective dose’, introduced and defined by ICRP for radiological protection purposes, in particular for setting exposure limits and in the context of optimisation, is often used for purposes outside the intended scope of its application, including the estimation of risk to individuals from medical procedures.

Useful guidance on restrictions on the use of the quantity was provided by Committee 2 in Annex B to the 2007 Recommendations. This guidance needs to be further expanded, and proposals made for the control of exposures and risk management as well as risk assessment in situations where ‘effective dose’ is not directly applicable. An important focus of the report will be medical exposures. Effective dose can be a useful tool for comparisons of, for example, different diagnostic examinations and interventional procedures, the use of different technologies for the same medical examinations, and the use of similar technologies and procedures in different hospitals and countries. However, ‘effective dose’ was not intended for the assessment of risk to specific individuals, including children.

The Task Group intends to develop a draft report for consultation during 2014.

Committee 3 (Protection in Medicine)

Committee 3 develops recommendations and guidance on the protection of patients, staff, and the public against radiation exposure in medicine.

ICRP Committee 3 in Vienna, Austria, September 2012

Committee 3 evaluates aspects of radiological protection relevant to medicine with on-going Task Groups and Working Parties as described below.

Task Group 62: Radiological Protection in Cardiology

Chairs: Donald Miller and Claire Cousins

The results of this Task Group were released in December 2012 as *Publication 120*.

Task Group 78: Radiological Protection in Fluoroscopically Guided Procedures Performed outside the Imaging Department

Chair: Madan Rehani

The results of this Task Group were released in July 2012 as *Publication 117*.

Working Party on Radiological Protection in Paediatric Diagnostic and Interventional Radiology

Chairs: Pek-Lan Khong and Hans Ringertz

The results of this Task Group were released in December 2012 as *Publication 121*.

Task Group 87: Radiological Protection in Ion Beam therapy

Chair: Yoshiharu Yonekura

The Task Group is working to provide information necessary for radiation protection in ion beam radiotherapy, specifically with proton and carbon ions. The Task Group is cooperating with ICRU. Recommendations on imaging as a quality management plan are included. The Task Group indicates that cancer risk in long term is an area of research. Dose to the eye lens is being considered. The document is at advanced stage for finalization in 2013.

Task Group 85: Practical Radiological Protection Recommendations on Mitigating Secondary Cancer Risks in Modern Radiation Oncology

Chair: Mario Baeza

The Task Group is dealing with carcinogenic risks with newer therapy technology initially stated to be higher than conventional ones and considering information already provided in a recent NCRP document. The Task group is looking to produce a short, practical document of recommendations for clinical guidance.

Task Group 89: Occupational Radiological Protection in Brachytherapy

Chair: Lawrence Dauer

The Task Group aims at development of clear, concise and valid set of practical recommendations for clinicians. Since 'historical' brachytherapy techniques (e.g., radium, cobalt) may still be implemented in some countries, the Task Group is considering addressing the same.

Task Group 88: Radiological Protection in Cone Beam CT

Chair: Madan Rehani

In view of increasing use of CBCT in recent years and need of recommendations on dosimetric terms, the Task Group is reviewing information available from AAPM and IAEA and having consultation with ICRU. The document shall include radiological protection issues in diagnostic CBCT, C-arm CBCT and CBCT in radiotherapy. Short coverage of dental CBCT will also be included. Staff protection will also be covered in the document. Attention shall be drawn to eye lens dose in dental and cerebral CBCT.

Task Group 36: Dose to Patients from Radiopharmaceuticals

Chair: Sören Mattsson

This is a joint Task Group with Committee 2.The Task Group has developed dose coefficients for ^{18}F-FET, ^{18}F-FLT, ^{18}F- choline, ^{11}C-raclopride, ^{18}F-fluoride and some corrections in earlier text in *Publication 106* for ^{99m}Tc-tetrofosmin and ^{18}F-FDG. These will be available soon for public consultation.

Working Party on Justification in Medical Uses of Ionizing Radiation

Co-Chairs: Hans Ringertz and Katrine Åhlström Riklund

Task Group 86 on Justification in Imaging of Asymptomatic Individuals with Ionising Radiation was merged with this working party.

The working party will deal with issue of shared responsibility between radiological medical practitioner and referring medical practitioner, how the radiology department manages referrals for unjustified examinations and how to manage individual requests for whole body scanning. There will be recommendations on following process rather than requirements. Based on a draft to be received in its next meeting, Committee 3 will consider setting up a Task Group.

Working Party on Occupational Protection Issues in Interventional Procedures (Fluoroscopy Guided)

Chair: Pedro Ortiz- Lopez

This working party will address audience and topics not addressed already in ICRP *Publications 85*, *117* and *120*. This will include RPOs, regulators, dosimetry service providers and in relatively higher exposure situations. Based on draft to be received in its next meeting, Committee 3 will consider setting up a Task Group.

Working Party on the Radiological Protection in Therapy with Radiopharmaceuticals

Chair: Sören Mattsson

The working party shall consider combinations of the radiopharmaceutical therapy and external radiotherapies as well as new radionuclides and radiopharmaceuticals where fewer advices are available. This is based on need expressed by users. There will also be advice on occupational protection. Minimum infrastructure to start therapy could also form part of the document. Based on a draft to be received at its next meeting, Committee 3 will consider setting up a Task Group.

Working Party on Diagnostic Reference Levels (DRLs) for Diagnostic and Interventional Imaging

Chair: Eliseo Vano

There is clearly a need to expand on the application of the DRL concept to interventional procedures, nuclear medicine procedures, and other procedures that use more than one imaging modality (e.g., PET plus CT). There are discussions on using not only a percentile (e.g., 75th percentile) of the patient dose distributions but a more complete use of the full distribution to help in the further optimization of radiological protection for imaging procedures using ionizing radiation. Based on a draft to be received at its next meeting, Committee 3 will consider setting up a Task Group.

Topics to be explored in 2013

- Review existing documents by the IAEA and others on occupational protection issues in PET/CT and cyclotron use.
- Framework for optimization of individual patients.
- Dose quantities for display in imaging equipment for suggestions to IEC.
- Communication of benefits and radiation risks to medical professionals and public.

Involvement of ICRP Committee 3 in medical conferences

At the European Congress of Radiology (ECR) 2012, a Professional Challenges Sessions was organized jointly between European Society of Radiology and the ICRP which was first time in ECR. Invited presentation on behalf of ICRP was given at the International Conference on Radiation Protection in Medicine organized by the IAEA on 3-7 Dec 2012. ICRP Committee 3 members made more than 30 presentations in variety of conferences presenting work of ICRP. European Commission’s meetings of Article 31 group were regularly apprised about ICRPs work.

Committee 4 (Application of the Commission's Recommendations)

Committee 4 develops principles and recommendations on radiological protection of people in all exposure situations.

ICRP Committee 4 in Moscow, Russia, September 2012

Committee 4 advises the Main Commission on potential implications, applications, and policy issues for the System of Radiological Protection from (1) the on-going implementation of the system; (2) the underlying ethical basis, scientific information developed by Committee 1, and evolving social norms for protection; and (3) developments in other arenas of protection for humans and the environment having a bearing on radiological protection. Committee 4 works in conjunction with Committee 3 on issues related to occupational and public exposures in medical settings, and in conjunction with Committee 5 related to protection of the environment. Committee 4 also acts as a key point of contact with other international organizations and professional societies concerned with protection against ionizing radiation.

During the current 4-year term (2009 – 2013) the work of Committee 4 has been structured according three priorities:

- To develop advice on implementation of the recommendations in *Publication 103* and to contribute to their dissemination i.e. to review and update past publications, and develop recommendations for the application of the radiological protection principles in particular exposure situations;

- To review the ethical and social values underlying the principles and concepts of the system of radiological protection e.g.: precautionary principle, tolerability of risk, equity, sustainable development;
- To enhance the dialogue and cooperation with international organisations and professional societies.

In 2012, the Committee kept working through its Task Groups and other activities. It met in Moscow, Russia, September 24-28, 2012. The meeting was hosted by the Burnasyan Federal Medical Biophysical Centre (BFMBC). Observers from EC, IAEA, ILO, IRPA, NEA and WHO were also in attendance.

During the Moscow meeting Committee 4 members met with Angelina Guskova (Sievert Award 2000) and former Main Commission member Leonid Ilyn (In the center).

Committee members also discussed the future programme of work. In addition to updating *Publications 109* and *111*, the priorities will be to complete the series of publications under preparation on existing situations with a publication on contaminated sites from the legacy of past activities and to develop a Publication on the Ethics of radiological protection.

In addition to reviewing its current programme of work including several draft reports under preparation, the Committee also discussed the ethical basis of the system of radiological protection and its implementation in emergency and existing exposure situations. A review of the implications of the Fukushima accident for the system of radiological protection benefited from detailed presentations by Japanese members of the Committee as well as the involvement of several members of the Committee in the ICRP forum for dialogue in Fukushima (see below).

It was agreed that *Publications 109* and *111* have been useful for the management of the Fukushima Daiichi accident. However they should be updated and elaborated in the light of the return of the experience gained so far in Japan. Particular attention needs to be given to emergency responders and the transition from the emergency exposure situation to the existing one and the need to revisit the concept of tolerability of risk in the context of emergency and recovery situations.

The next meeting of Committee 4 will take place in Abu Dhabi, UAE, in October 2013, in conjunction with the joint meetings of the Main Commission and other ICRP Committees, as well as the second ICRP Symposium on the International System of Radiological Protection.

The programme of work of Committee 4 is described below.

Task Group 71: Protection of the Public and Workers in the Use of Ionizing Radiation in Screening Activities Applied to Persons and Cargo for Security Purposes

Chair: Donald A. Cool

Established by the Main Commission in Suzhou in 2010, the objective of the Task Group was to examine how the radiological protection principles recommended by ICRP for planned exposure situations should be interpreted and applied within the context of security screening. This includes justification, optimization with the use of dose constraints, and the concept of limitation of individual exposure. The Task Group report has been submitted for public consultation in September 2012 and should be published in 2013.

Task Group 76: Application of the Commission's Recommendations to NORM (Naturally Occurring Radioactive Materials)

Chair: Peter Burns

Established by the Main Commission in Berlin in 2007, the Task Group was re-launched in Porto in 2009 with a refined objective and a new membership. Its objective is to develop a general framework for the application of the radiation protection principles recommended by the Commission in cases of exposure arising from Naturally Occurring Radioactive Material (NORM). The Task Group report under preparation is intended to cover the entire range of activities associated with the processing, production or use of bulk materials with enhanced levels of naturally occurring radionuclides, as well as the presence of such materials in consumer products, particularly in construction materials. The preparation of the report will continue in 2013, with a draft for public consultation in 2014.

Task Group 80: Application of the Commission's Recommendations to the Geological Disposal of Long-lived Solid Radioactive Waste

Chair: Wolfgang Weiss

This Task Group was established in Porto, in October 2009 by the Main Commission. Its objective was to prepare a publication that clarifies the application of the 2007 Recommendations for the protection against occupational and public exposures that may result from the geological disposal of long-lived solid radioactive waste. Taking into account previous ICRP recommendations (*Publications 77* and *81*) and relevant materials from international organisations, the publication discusses how the key radiological protection principles for planned exposure situations apply to the successive phases of managing such type of disposal of long-lived solid radioactive waste. It also addresses the transition from a planned to an existing exposure situation in cases of loss of control of the storage facility. After public consultation, the Task Group report was completed by the end of 2011 and was accepted for publication in April 2012. The Committee also discussed the opportunity to complement this Publication by another covering the disposal of radioactive waste in surface and sub-surface and the Main Commission agreed the creation of a new Task Group. A Terms of Reference will be developed in close cooperation with the waste management community.

Task Group 81: Application of the Commission's Recommendations to Radon Exposure

Chair: Jean-François Lecomte

The Main Commission established this Task Group in Porto in 2009. The objective was to prepare a publication that describes and clarifies the application of the 2007 Recommendations for the protection of the public and workers (including uranium miners and other miners) against radon and thoron exposures in buildings (dwellings and workplaces) and others locations. The publication describes how the basic principles of justification and optimisation with restriction on individual doses (reference level) apply to the protection against radon exposure. It proposes an integrated, graded and ambitious approach.

The Task Group report was submitted for public consultation in the course of 2012. It will be published after the publication of revised dose coefficients for radon.

Task Group 83: Protection from Cosmic Radiation in Aviation

Chair: Jacques Lochard

This Task Group was proposed by the Main Commission in Porto in 2009 and the Terms of Reference approved in Cape Town in 2010. Its objective is to examine how the radiation protection principles recommended by ICRP for existing exposure situations should be interpreted and applied within the context of aviation to protect aircrew, frequent flyers and passengers. A particular attention is given to the optimization principle with the associated reference level. The final Task Group report is expected to be completed in 2013 and published in 2014.

Working Party on the Implementation of ICRP *Publications 109* and *111*

Chair: Michiaki Kai

The objectives of this working party is to review the experience of Fukushima in order to address the issues relevant to the implementation of the recommendations in *Publications 109* and *111* on the protection of people in emergency and existing exposure situations after a nuclear accident, and secondly to serve as an interactive mechanism for Committee 4 to stay engaged on the issues and questions related to the management of the Fukushima situation with Japanese colleagues.

Working Party on the Ethics of Radiological Protection

Chair: Jacques Lochard

The objective of this working party established in 2011 is to explore the ethical basis supporting the system of protection. Reflections have highlighted the links between the fundamental principles of radiation protection (justification, optimization, limitation) and the theories of normative ethics and the fact that the Recommendations of the Commission are designed to respect individual rights (deontological ethics), to promote the collective interest (utilitarian ethics) and favour prudence and equity (virtue ethics). It also identified the interest for the analysis of radiological protection system to distinguish the ethical values defining the standards by which action should be taken, the ethical procedures for integrating these values in decision making and in the implementation of the decisions, and the ethical behaviour corresponding to the values that are supposed to guide the conduct of the various actors. Because the radiation protection system is intended to be international, the reflection also emphasized the importance of promoting through the Recommendations, values common to different cultures such as autonomy, non-maleficence, beneficence and justice.

Committee 5 (Protection of the Environment)

Committee 5 develops reference models and data, and guidance on radiological protection of the environment.

ICRP Committee 5 in Sydney, Australia, June 2012

Committee 5 is concerned with radiological protection of the environment. It aims to ensure that the development and application of approaches to environmental protection are compatible with those for radiological protection of man, and with those for protection of the environment from other potential hazards.

Committee 5 continues to consider how the basic information that relates radiation exposure to dose, and dose to effect, for different types of animals and plants, can best be applied to different exposure situations, as well as advising on what additional databases are needed in order to improve the assessments that are made. The principal effort during 2012 has therefore been that of drawing together the necessary supporting evidence and advice relevant to implementing the Commission's framework across all exposure situations. This information formed a large Annex to the content of the work of Task Group 82 (see below).

The Committee met once in 2012, in Sydney, Australia. Whilst there, the opportunity was taken to discuss the potential relevance and application of the Commission's approach to environmental protection in relation to emergency and existing exposure situations with Stephen Solomon and Gillian Hirth (ARPANSA, Australia) who are Chairman and Rapporteur respectively of UNSCEAR's Fukushima Task Group 3, "Doses and effects in public and environment". A subgroup of UNSCEAR's TG3, on 'Non-human biota', is led by Per Strand, who is also a member of ICRP Committee 5.

Committee 5 in discussions with ARPANSA staff in relation to Fukushima, Sydney, 2012.

The science base relating to environmental protection was also further considered, particularly with regard to radiation weighting factors, and the development of more realistic dosimetry for the larger biotic types. A list of useful simple research that could be done to improve the Commission's approach, set out in PhD-sized projects, was also discussed and will be placed on the ICRP website.

The relative priorities for the Commission's next four year term were also discussed, with the conclusion that, as well as improving the basic science base of the Reference Animals and Plants, experience was needed in applying the Commission's framework to, in particular, existing exposure situations. It was also considered useful to explore the possibility of moving towards a Radionuclide Environmental Quality Standard (REQS) approach for planned exposure situations for nuclear sites. The needs of Committee 5 during the next four year term will be reflected in its new composition.

Joint C5/C4 Task Group 82: Application of the ICRP's Approach to Environmental Protection under Different Exposure Situations

Chair: R Jan Pentreath

This Task Group produced a draft report which was opened for public consultation in July 2012 and, as anticipated, received much attention and comment. The report expanded upon the Commission's objectives in relation to protection of the environment, in so far as it relates to the protection of animals and plants (biota) in their natural environment, and how these objectives can be met by the use of Reference Animals and Plants (RAPs); their Derived Consideration Reference Levels (DCRLs), which relate radiation effects to dose over and above their normal local background natural radiation levels; and different potential pathways of exposure. The report explained the different types of exposure situations to which its recommendations apply; the key principles that are relevant to protection of the environment; and hence how reference values based on the use of DCRLs can be used to inform on the appropriate level of effort relevant to different exposure situations. Further recommendations were made with regard to how the Commission's recommendations could be implemented to satisfy different forms of environmental protection objectives, which may require the use of Representative Organisms (ROs) specific to a site, and how these may be compared to, or compared with, the reference values. Additional information was also given with regard to, in particular, communication with other interested parties and stakeholders.

Many useful comments and suggestions were received and the Report is now being considered further for publication.

Task Group 72: RBE and Reference Animals and Plants

Chair: Kathryn Higley

This Task Group has reviewed the available information on RBE values for alpha and low energy beta (tritium) emitters in relation to the four biological endpoints relevant to protection of the environment: mortality, morbidity, reproductive success and chromosomal damage. This analysis has shown that RBE data, for alpha emitters and tritium, refer mainly to vertebrates, and the dose-rates used in the majority of the experiments are well above the bands of Derived Consideration Reference Levels. The information is therefore largely, but not entirely, more relevant to existing and emergency exposure situations than to planned exposure situations. The draft report is currently subject to an extensive internal review.

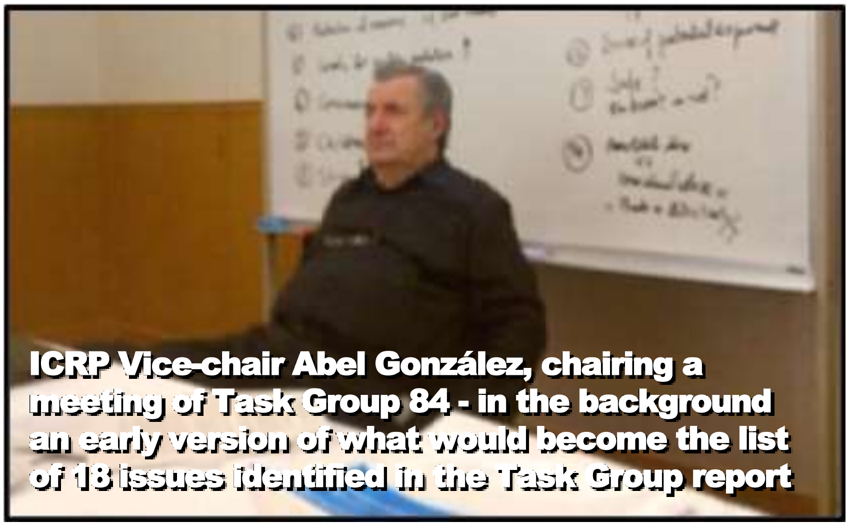
Task Group 74: More Realistic Dosimetry for Non-human Species

Chair: Alexander V. Ulanovsky

This Task Group has been reviewing aspects of the external exposure of terrestrial animals and plants due to submersion in radioactively contaminated air; concentration ratios for assessment of inhalation exposure of terrestrial mammals; and the exposure of terrestrial animals and plants to radon. There is also much interest in comparisons being made between the solid ellipsoid dosimetry calculations for the RAPs and the development of voxel phantom models of the larger RAPs now becoming available as a result of new research in the USA. A draft report is expected to become available later in 2013.

Response to the Fukushima Daiichi Nuclear Power Station Accident

"The International Commission on Radiological Protection (ICRP) does not normally comment on events in individual countries. However, we wish to express our deepest sympathy to those in Japan affected by the recent tragic events there. Our thoughts are with them." Thus began the message from ICRP released on March 21, 2011, just ten days after the initiation of the Fukushima Daiichi nuclear power station accident.


ICRP Vice-chair Abel González, chairing a meeting of Task Group 84 - in the background an early version of what would become the list of 18 issues identified in the Task Group report

At that time it was difficult to foresee how much effort the radiological protection community would focus on this event. In particular, it would have been difficult to predict the role that ICRP was to play.

As a non-governmental organisation and registered charity, ICRP has neither the mandate nor the resources to provide aid in the traditional sense. The core objective of ICRP is to advance for the public benefit the science of radiological protection, in particular by providing recommendations and guidance on all aspects of radiation protection.

Nonetheless ICRP found that it had a role to play within this mandate. On April 4, 2011, ICRP made downloadable free of charge *Publication 111* Application of the Commission's Recommendations to the Protection of People Living in Long-term Contaminated Areas After a Nuclear Accident or a Radiation Emergency. On June 20, 2011, ICRP established Task Group 84 on Initial Lessons Learned from the NPP Accident in Japan vis-à-vis the ICRP System of Radiological Protection. The summary report of this Task Group was released on the ICRP website on November 22, 2012, highlighting issues and providing recommendations for improvements to the system of radiological protection.


ICRP Scientific Secretary Christopher Clement presenting at the Fukushima Ministerial Conference on Nuclear Safety

ICRP has also responded to requests for advice, e.g.: participating in the September 2011 International Expert Symposium in Fukushima City organised by the Nippon

Foundation, and the follow-up meeting six months later organised by the Sasakawa Memorial Health Foundation; responding to requests for advice from the Japanese Government Cabinet Office Secretariat; and, making an invited presentation at The Fukushima Ministerial Conference on Nuclear Safety in December 2012.

ICRP Fukushima Dialogue Initiative Meeting in Date City
(Photo © Jun Takai)

Following a visit organized by Committee 4 in September 2011 to the contaminated territories of Belarus, a small group made up of Committee 4 and Main Commission members and the NGO "Radiation Safety Forum Japan" took the initiative in the fall of 2011 to organize a forum for dialogue with all concerned parties in the Fukushima Prefecture to identify the problems and the challenges of the rehabilitation of living conditions in the long-term contaminated territories.

This was an opportunity to share experience and promote radiological protection culture, in the spirit of self-help protection promoted by *Publication 111*. It was also an opportunity to learn directly from the citizens of Fukushima the difficulties being faced in the aftermath of the accident, gaining a deeper insight into the situation to ensure that future recommendations on post-accident recovery would benefit from this experience. This cooperative effort, led by ICRP, involved many other organisations from within and outside Japan; local, national, and international; governmental and non-governmental. By the end of 2012, four major (two-day) dialogue meetings had been held in Fukushima City and Date City, and several smaller dialogue meetings in Suetsugi (Fukushima Prefecture) and Hippo (Miyagi Prefecture).

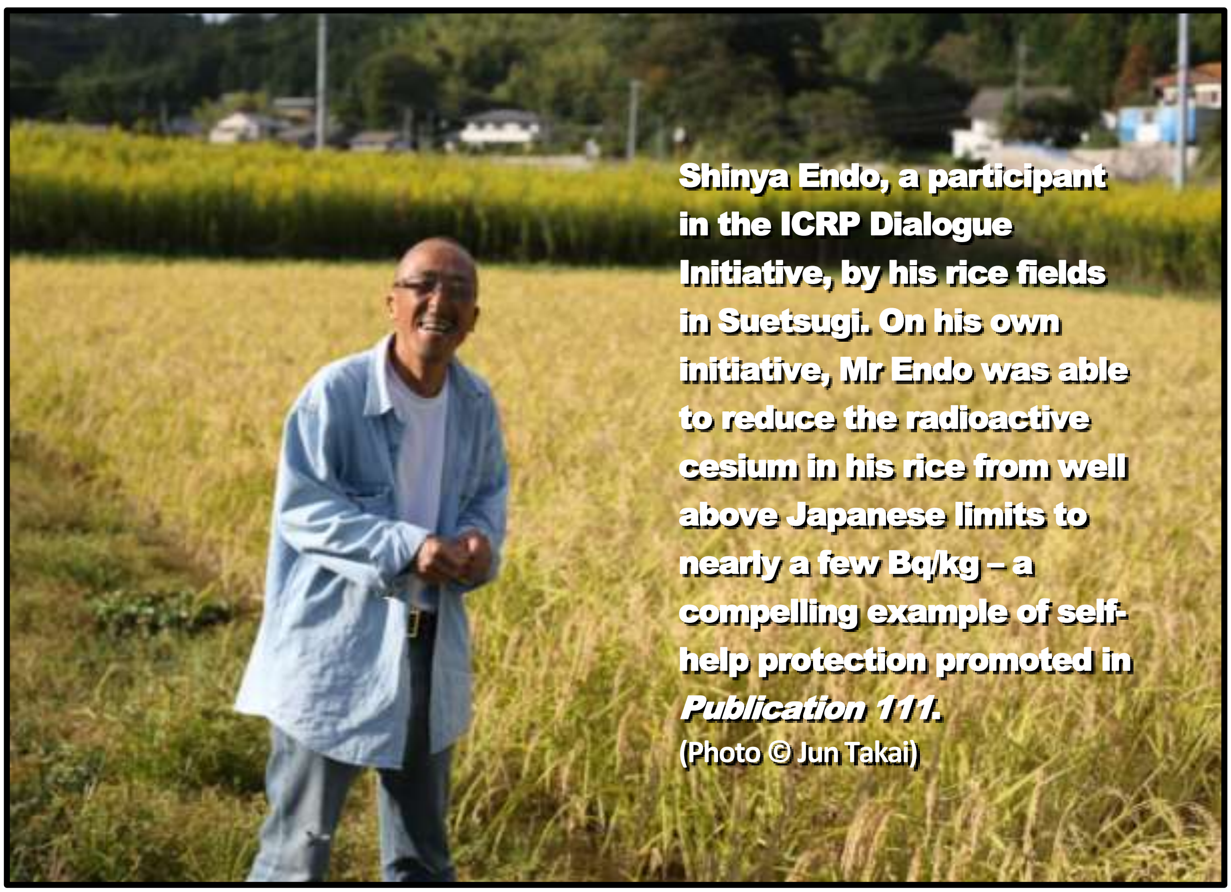
These dialogues emphasized the importance of characterizing the radiological situation at the individual level to allow everyone in the affected areas to understand where, when and how they are exposed so that they can protect themselves. The need to preserve traditions and local culture, to transmit the memory of the accident, and to strengthen solidarity between the people of Fukushima Prefecture and those of the rest of Japan and abroad were also underlined by the participants as a means to maintain the dignity of the inhabitants in the affected areas.

Plans are underway to update *Publications 109* and *111* based on the experience gained and in cooperation with local stakeholder groups drawn from those who have been involved in this initiative, as well as the work of Task Group 84.

In October 2012, the ICRP Main Commission met in Fukushima City, the first time the Main Commission had met in Japan since 1981. This provided opportunities for all Main Commission members to meet citizens of Fukushima and to see, first-hand, the situation.

One year after the start of the accident, on March 12, 2012, a second message issued by ICRP ended “We are optimistic that, while 2011 was an extremely difficult year, 2012 will be a year of recovery. There is no doubt that this recovery will continue for many years to come, and ICRP will continue to be actively involved.”

ICRP Committee 4 Chair Jacques Lochard, ICRP Assistant Secretary Michiya Sasaki, and ICRP Chair Claire Cousins at the Fukushima Decontamination Information Plaza, during the ICRP Main Commission meeting held in Fukushima City



Shinya Endo, a participant in the ICRP Dialogue Initiative, by his rice fields in Suetsugi. On his own initiative, Mr Endo was able to reduce the radioactive cesium in his rice from well above Japanese limits to nearly a few Bq/kg – a compelling example of self-help protection promoted in *Publication 111.*
(Photo © Jun Takai)

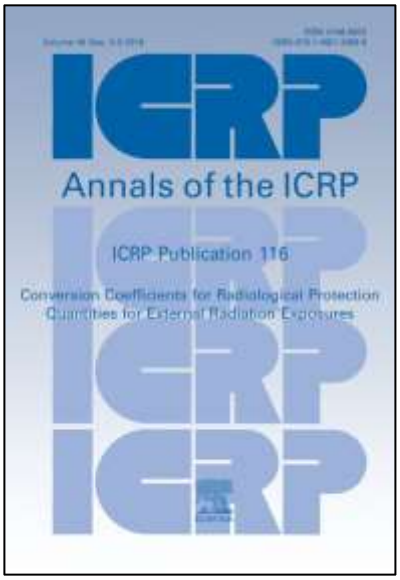
ICRP Publications in 2012

ICRP released seven reports in 2012, published in the Annals of the ICRP:

- *Publication 116*: Conversion Coefficients for Radiological Protection Quantities for External Radiation Exposures
- *Publication 117*: Radiological Protection in Fluoroscopically Guided Procedures outside the Imaging Department
- *Publication 118*: ICRP Statement on Tissue Reactions / Early and Late Effects of Radiation in Normal Tissues and Organs – Threshold Doses for Tissue Reactions in a Radiation Protection Context
- *Publication 119*: Compendium of Dose Coefficients based on ICRP *Publication 60*
- Proceedings of the First ICRP Symposium on the International System of Radiological Protection
- *Publication 120*: Radiological Protection in Cardiology
- *Publication 121*: Radiological Protection in Paediatric Diagnostic and Interventional Radiology

In addition, permission was granted for organisations to prepare and distribute translations of ICRP publications in various languages. An Italian translation of *Publication 112*, an Arabic translation of *Publication 113*, and a Romanian translation of *Publication 105* became available in 2012.

Thanks to financial support from the European Commission, *Publication 119* Compendium of Dose Coefficients based on ICRP *Publication 60*, and the accompanying supplementary data, were made available for free download through the ICRP web site.



Publication 116: Conversion Coefficients for Radiological Protection Quantities for External Radiation Exposures

N. Petoussi-Henss, W.E. Bolch, K.F. Eckerman, A. Endo, N. Hertel, J. Hunt, M. Pelliccioni, H. Schlattl, M. Zankl

This report gives fluence to dose conversion coefficients for both effective dose and organ absorbed doses for various types of external exposures, consistent with the 2007 Recommendations of the ICRP. These coefficients were calculated using the official ICRP/ICRU computational phantoms representing the Reference Adult Male and Reference Adult Female, in conjunction with Monte Carlo codes simulating the transport of radiation within the human body such as EGSnrc, FLUKA, GEANT4, MCNPX, and PHITS.

The incident radiations and energy ranges considered were external beams of mono-energetic photons of 10 keV–10 GeV, electrons and positrons of 50 keV–10 GeV, neutrons of 0.001 eV–10 GeV, protons of 1 MeV–10 GeV, pions (negative/positive) of 1 MeV–200 GeV, muons (negative/positive) of 1 MeV–10 GeV, and helium ions of 1 MeV/u–100 GeV/u.

For the simulations, idealised whole-body irradiation geometries were considered. These included unidirectional broad parallel beams along the antero-posterior, postero-anterior, left lateral and right lateral axes, and 360° rotational directions around the phantoms' longitudinal axis. Fully isotropic irradiation of the phantoms was also considered.

Simulations were performed specifically for this report by members of the Task Group. For quality assurance purposes, data sets for given radiations and irradiation geometries were generated by different groups using the same reference computational phantoms but different Monte Carlo codes.

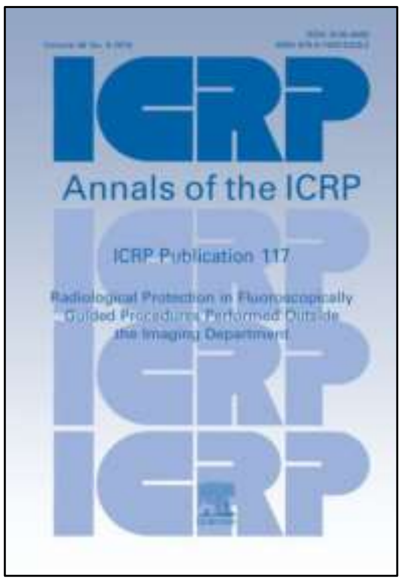
From the simulations, the absorbed dose to each organ within the reference phantoms was determined. The fluence to effective dose conversion coefficients were derived from the obtained organ dose conversion coefficients, the radiation weighting factor w_R and the tissue weighting factor w_T, following the procedure described in *Publication 103*.

The operational quantities for photons, neutrons, and electrons continue to provide a good approximation for the conversion coefficients for effective dose for the energy ranges considered in ICRP *Publication 74* and ICRU Report 57, but not at the higher energies considered in the present report.

The conversion coefficients obtained for this report represent the ICRP/ICRU reference values. They were established using various original data sets with the application of averaging, smoothing, and fitting techniques. They are partly tabulated in annexes, and fully tabulated in an accompanying CD in ASCII format and Microsoft Excel software.

Separate Monte Carlo simulations were made to determine the absorbed dose to the lens of the eye for incident photons, electrons, and neutrons using a stylised model of the eye. Similarly, localised skin-equivalent dose conversion coefficients for electrons and alpha particles are given as derived by Monte Carlo calculations simulating the transport of a normally incident, parallel beam on a tissue-equivalent slab.

Additionally, photon and neutron dose–response functions are given in this report, defined as the absorbed dose per particle fluence. Their use would compensate for the limited spatial resolution of the voxel geometry, as well as for dose enhancement or dose depression at the microscopic level of the marrow cavities.



Publication 117: Radiological Protection in Fluoroscopically Guided Procedures outside the Imaging Department

M.M. Rehani, O. Ciraj-Bjelac, E. Vaño, D.L. Miller, S. Walsh, B.D. Giordano, J. Persliden

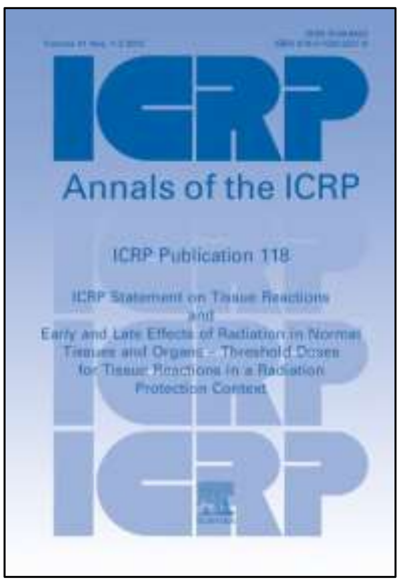
An increasing number of medical specialists are using fluoroscopy outside imaging departments, but there has been general neglect of radiological protection coverage of fluoroscopy machines used outside imaging departments. Lack of radiological protection training of those working with fluoroscopy outside imaging departments can increase the radiation risk to workers and patients. Procedures such as endovascular aneurysm repair, renal angioplasty, iliac angioplasty, ureteric stent placement, therapeutic endoscopic retrograde cholangio-pancreatography, and bile duct stenting and drainage have the potential to impart skin doses exceeding 1 Gy. Although tissue reactions among patients and workers from fluoroscopy procedures have, to date, only been reported in interventional radiology and cardiology, the level of fluoroscopy use outside imaging departments creates potential for such injuries.

A brief account of the health effects of ionising radiation and protection principles is presented in Section 2. Section 3 deals with general aspects of the protection of workers and patients that are common to all, whereas specific aspects are covered in Section 4 for vascular surgery, urology, orthopaedic surgery, obstetrics and gynaecology, gastroenterology and hepatobiliary system, and anaesthetics and pain management. Although sentinel lymph node biopsy involves the use of radio-isotopic methods rather than fluoroscopy, performance of this procedure in operating theatres is covered in this report as it is unlikely that this topic will be addressed in another ICRP publication in coming years. Information on radiation dose levels to patients and workers, and dose management is presented for each speciality.

Issues connected with pregnant patients and pregnant workers are covered in Section 5. Although ICRP has recently published a report on training, specific needs for the target groups in terms of orientation of training, competency of those who conduct and assess specialists, and guidelines on the curriculum are provided in Section 6.

This report emphasises that patient dose monitoring is essential whenever fluoroscopy is used.

It is recommended that manufacturers should develop systems to indicate patient dose indices with the possibility of producing patient dose reports that can be transferred to the hospital network, and shielding screens that can be effectively used for the protection of workers using fluoroscopy machines in operating theatres without hindering the clinical task.



Publication 118: ICRP Statement on Tissue Reactions / Early and Late Effects of Radiation in Normal Tissues and Organs – Threshold Doses for Tissue Reactions in a Radiation Protection Context

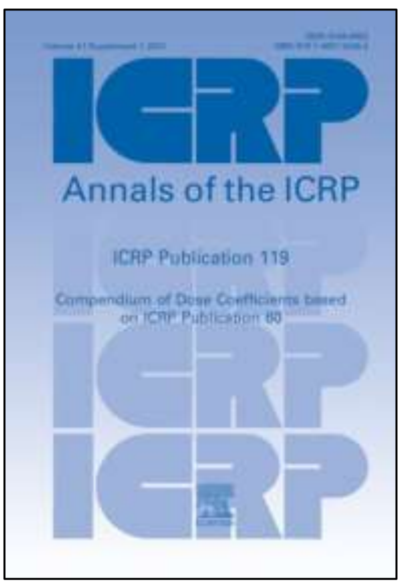
F.A. Stewart, A.V. Akleyev, M. Hauer-Jensen, J.H. Hendry, N.J. Kleiman, T.J. MacVittie, B.M. Aleman, A.B. Edgar, K. Mabuchi, C.R. Muirhead, R.E. Shore, W.H. Wallace

This report provides a review of early and late effects of radiation in normal tissues and organs with respect to radiation protection. It was instigated following a recommendation in *Publication 103*, and it provides updated estimates of 'practical' threshold doses for tissue injury defined at the level of 1% incidence. Estimates are given for morbidity and mortality endpoints in all organ systems following acute, fractionated, or chronic exposure. The organ systems comprise the haematopoietic, immune, reproductive, circulatory, respiratory, musculoskeletal, endocrine, and nervous systems; the digestive and urinary tracts; the skin; and the eye.

Particular attention is paid to circulatory disease and cataracts because of recent evidence of higher incidences of injury than expected after lower doses; hence, threshold doses appear to be lower than previously considered. This is largely because of the increasing incidences with increasing times after exposure. In the context of protection, it is the threshold doses for very long follow-up times that are the most relevant for workers and the public; for example, the atomic bomb survivors with 40–50 years of follow-up. Radiotherapy data generally apply for shorter follow-up times because of competing causes of death in cancer patients, and hence the risks of radiation-induced circulatory disease at those earlier times are lower.

A variety of biological response modifiers have been used to help reduce late reactions in many tissues. These include antioxidants, radical scavengers, inhibitors of apoptosis, anti-inflammatory drugs, angiotensin-converting enzyme inhibitors, growth factors, and cytokines. In many cases, these give dose modification factors of 1.1–1.2, and in a few cases 1.5–2, indicating the potential for increasing threshold doses in known exposure cases. In contrast, there are agents that enhance radiation responses, notably other cytotoxic agents such as antimetabolites, alkylating agents, anti-angiogenic drugs, and antibiotics, as well as genetic and comorbidity factors.

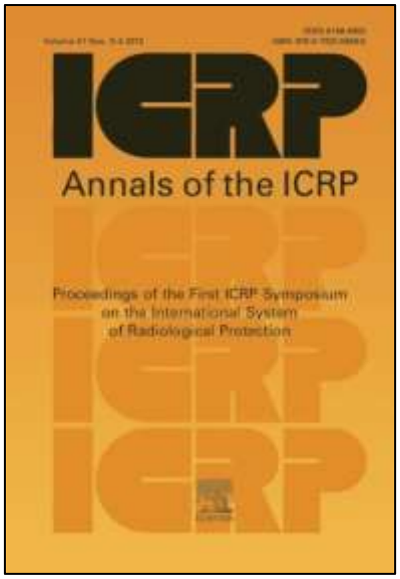
Most tissues show a sparing effect of dose fractionation, so that total doses for a given endpoint are higher if the dose is fractionated rather than when given as a single dose. However, for reactions manifesting very late after low total doses, particularly for cataracts and circulatory disease, it appears that the rate of dose delivery does not modify the low incidence. This implies that the injury in these cases and at these low dose levels is caused by single-hit irreparable-type events. For these two tissues, a threshold dose of 0.5 Gy is proposed herein for practical purposes, irrespective of the rate of dose delivery, and future studies may elucidate this judgement further.



Publication 119: Compendium of Dose Coefficients based on ICRP *Publication 60*

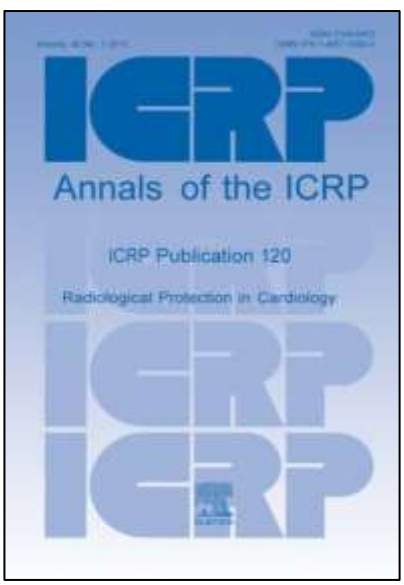
K. Eckerman, J. Harrison, H-G. Menzel, C.H. Clement

This report is a compilation of dose coefficients for intakes of radionuclides by workers and members of the public, and conversion coefficients for use in occupational radiological protection against external radiation from *Publications 68*, *72*, and *74*. It serves as a comprehensive reference for dose coefficients based on the primary radiation protection guidance given in the *Publication 60* recommendations. The coefficients tabulated in this publication will be superseded in due course by values based on the *Publication 103* recommendations.



Proceedings of the First ICRP Symposium on the International System of Radiological Protection

The First ICRP Symposium on the International System of Radiological Protection, or simply ICRP 2011, was held in Bethesda (Rockland) Maryland, just outside of Washington D.C., October 24–26, 2011. This symposium was open to anyone who wished to attend, and no registration fee was charged. Approximately 400 people from 35 countries attended the 17 sessions held over 3 days. The papers in this publication, the Proceedings of the First ICRP Symposium on the International System of Radiological Protection, represent a cross-section of the subjects presented during ICRP 2011. These papers are not recommendations of ICRP and do not necessarily represent the views of ICRP; they are the work of the individual authors. Given the success of ICRP 2011, as evidenced by the great turnout and many very positive remarks from participants, ICRP intends to hold another similar symposium in conjunction with its next joint meeting of the ICRP Main Commission and Committees. The Second ICRP Symposium on the International System of Radiological Protection, ICRP 2013, is now being planned. It will be held in Abu Dhabi in late October 2013, with the financial support of the Federal Authority for Nuclear Regulation of the United Arab Emirates. The search for a venue, and a host, for the third symposium, ICRP 2015, is already underway.



Publication 120: Radiological Protection in Cardiology

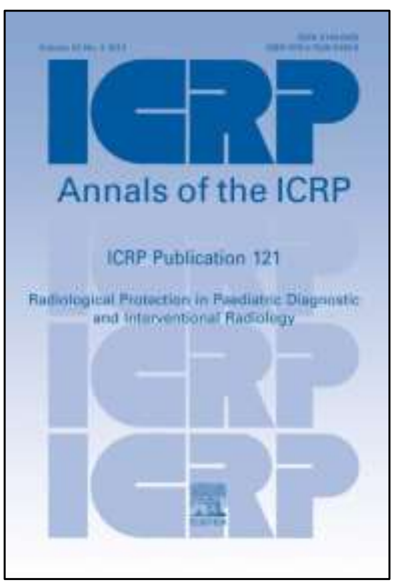
C. Cousins, D. L. Miller, G. Bernardi, M.M. Rehani, P. Schofield, E. Vaño , A.J. Einstein, B. Geiger, P. Heintz, R. Padovani, K-H. Sim

Cardiac nuclear medicine, cardiac computed tomography (CT), interventional cardiology procedures, and electrophysiology procedures are increasing in number and account for an important share of patient radiation exposure in medicine. Complex percutaneous coronary interventions and cardiac electrophysiology procedures are associated with high radiation doses. These procedures can result in patient skin doses that are high enough to cause radiation injury and an increased risk of cancer. Treatment of congenital heart disease in children is of particular concern. Additionally, staff1 in cardiac catheterisation laboratories may receive high doses of radiation if radiological protection tools are not used properly.

The Commission provided recommendations for radiological protection during fluoroscopically guided interventions in *Publication 85*, for radiological protection in CT in *Publications 87* and *102*, and for training in radiological protection in *Publication 113*. This report is focused specifically on cardiology, and brings together information relevant to cardiology from the Commission's published documents. There is emphasis on those imaging procedures and interventions specific to cardiology. The material and recommendations in the current document have been updated to reflect the most recent recommendations of the Commission.

This report provides guidance to assist the cardiologist with justification procedures and optimisation of protection in cardiac CT studies, cardiac nuclear medicine studies, and fluoroscopically guided cardiac interventions. It includes discussions of the biological effects of radiation, principles of radiological protection, protection of staff during fluoroscopically guided interventions, radiological protection training, and establishment of a quality assurance programme for cardiac imaging and intervention.

As tissue injury, principally skin injury, is a risk for fluoroscopically guided interventions, particular attention is devoted to clinical examples of radiation-related skin injuries from cardiac interventions, methods to reduce patient radiation dose, training recommendations, and quality assurance programmes for interventional fluoroscopy.



Publication 121: Radiological Protection in Paediatric Diagnostic and Interventional Radiology

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Paediatric patients have a higher average risk of developing cancer compared with adults receiving the same dose. The longer life expectancy in children allows more time for any harmful effects of radiation to manifest, and developing organs and tissues are more sensitive to the effects of radiation. This publication aims to provide guiding principles of radiological protection for referring clinicians and clinical staff performing diagnostic imaging and interventional procedures for paediatric patients. It begins with a brief description of the basic concepts of radiological protection, followed by the general aspects of radiological protection, including principles of justification and optimisation. Guidelines and suggestions for radiological protection in specific modalities – radiography and fluoroscopy, interventional radiology, and computed tomography – are subsequently covered in depth. The report concludes with a summary and recommendations.

The importance of rigorous justification of radiological procedures is emphasised for every procedure involving ionising radiation, and the use of imaging modalities that are non-ionising should always be considered. The basic aim of optimisation of radiological protection is to adjust imaging parameters and institute protective measures such that the required image is obtained with the lowest possible dose of radiation, and that net benefit is maximised to maintain sufficient quality for diagnostic interpretation. Special consideration should be given to the availability of dose reduction measures when purchasing new imaging equipment for paediatric use. One of the unique aspects of paediatric imaging is with regards to the wide range in patient size (and weight), therefore requiring special attention to optimisation and modification of equipment, technique, and imaging parameters. Examples of good radiographic and fluoroscopic technique include attention to patient positioning, field size and adequate collimation, use of protective shielding, optimisation of exposure factors, use of pulsed fluoroscopy, limiting fluoroscopy time, etc. Major paediatric interventional procedures should be performed by experienced paediatric interventional operators, and a second, specific level of training in radiological protection is desirable (in some countries, this is mandatory). For computed tomography, dose reduction should be optimised by the adjustment of scan parameters (such as mA, kVp, and pitch) according to patient weight or age, region scanned, and study indication (e.g. images with greater noise should be accepted if they are of sufficient diagnostic quality). Other strategies include restricting multiphase examination protocols, avoiding overlapping of scan regions, and only scanning the area in question. Up-to-date dose reduction technology such as tube current modulation, organ-based dose modulation, auto kV technology, and iterative reconstruction should be utilised when appropriate.

It is anticipated that this publication will assist institutions in encouraging the standardisation of procedures, and that it may help increase awareness and ultimately improve practices for the benefit of patients.

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Summary Financial Information 2008-2012

ITEM	2012	2011	2010	2009	2008
INCOME STATEMENT					
Incoming Resources					
Contributions Received	533 025	650,955	617 168	418 408	412 100
Royalties *	199 058	70,071	107 551	107 231	84 596
Interest	88	78	0	1 138	5 935
Other Income	1 243	0	0	2 109	1 516
Total Incoming Resources	733 414	721 104	724 719	528 886	504 147
Resources Expended					
Promotion of Radiological Protection	401 855	627 326	552 953	532 464	326 444
Governance Costs †	269 846	288 646	169 027	133 095	140 175
Other Resources Expended	13 034	21 873	2 752	(22 834)	33 418
Total Resources Expended	684 735	937 845	724 732	642 725	500 037
Net Movement in Resources	48 679	(216 741)	(13)	(113 89)	4 110
Total Funds Carried Forward	**222 078**	**173 399**	**390 140**	**390 153**	**503 922**
BALANCE SHEET					
Tangible Fixed Assets	1 032	2 680	4 329	5 977	3 109
Current Assets	107 572	236 567	391 445	400 563	529 296
Debtors (falling due within one year)	242 167	38 498	168 413	0	0
Creditors (falling due within the year)	(128 693)	(104 346)	(174 047)	(16 387)	(28 413)
Net Assets	**222 078**	**173 399**	**390 140**	**390 153**	**503 992**

This is a summary of ICRP annual financial statements as audited by Tudor John Chartered Accountants, Epsom, UK. All amounts are expressed in US dollars.

* In 2012 ICRP reverted to the accruals concept of accounting for royalties. Historically royalties have been accounted for on a cash basis (the royalties earned in any given calendar year being physically received in cash and recognised as income in the accounts in the following year's financial statements). As a result of this change, the royalties figure for 2012 includes both royalties received in 2012 (relating to the calendar year 2011) and royalties relating to the calendar year 2012 (which have all been received subsequent to 31st December 2012).

† The increase in governance costs in 2011 relates primarily to an adjustment to more appropriately allocate secretariat costs.

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- European Commission
- Finnish Radiation and Nuclear Safety Authority
- French Institute of Radiation Protection and Nuclear Safety
- German Ministry of the Environment
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- International Atomic Energy Agency
- International Radiation Protection Association
- International Society of Radiology
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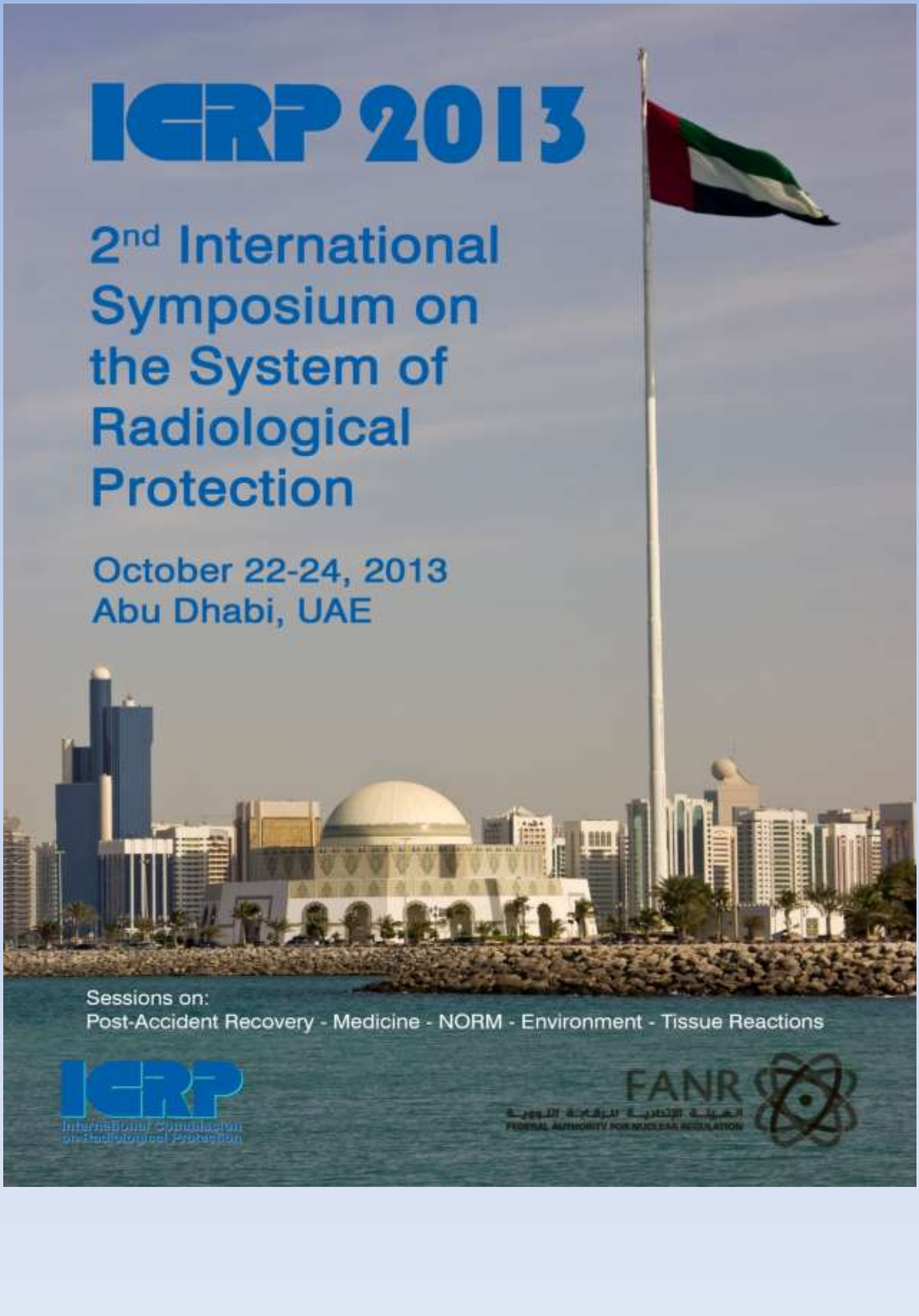
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