International Commission on Radiological Protection

2015 Annual Report

www.icrp.org

ICRP 2015 Annual Report

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ON THE COVER

ICRP members at the 3rd International Symposium on the System of Radiological Protection, Seoul, Korea, October 2015

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CHAIR'S FOREWORD

ICRP 2015, the 3rd International Symposium on the System of Radiological Protection, was the highlight event of the year for ICRP. Now that there have been three in the ongoing series of biennial symposia, this cornerstone of our broader effort to increase engagement with professionals, policy-makers, and the public is well cemented into the foundation of ICRP.

These symposia have become well known within the radiological protection community for an unparalleled level of quality. Anecdotally, many have said that they are the best international gatherings in radiological protection that they have ever attended. More objectively, 95% of respondents to our post-symposium surveys have recommended attending the next one. It is important for ICRP to have the opportunity to discuss its work with the broader radiological protection community to get direct feedback on areas in which we are doing well, in addition to those which could be improved.

Results like this inspire us to continue. Preparations for ICRP 2017 in Paris are well advanced, and several organisations have expressed an interest in hosting our symposia in 2019 and 2021. More expressions of interest are welcome; we want to make every effort to bring our series of symposia to your part of the world in the coming years, and an enthusiastic host is key to making this happen.

We also continue our effort to promote awareness of radiological protection and broaden access to ICRP publications. To this end, I was very pleased to announce during ICRP 2015 that we have opened access to the first fifty years of ICRP publications. Everything from the 1928 recommendations to *Publication 28*, published in 1978, is now available free to download. This is a significant first step in delivering on our Strategic Plan initiative to make ICRP publications available at low or no cost.

Most important are our efforts to maintain and continue to improve the System of Radiological Protection. As always, we review and assess science, values, and experience to ensure our recommendations remain current, and constantly evaluate emerging technologies to ensure our recommendations remain relevant. In a rapidly changing world, where the demands on ICRP are higher than ever before, we must strengthen the logistical and financial framework that keeps ICRP operating at peak efficiency and effectiveness.

None of these important and ambitious efforts are easy, especially for an independent charity. All rely on the sincere dedication of our nearly 250 volunteer expert members, and the many more who offer their expertise in other ways. They also depend on the continuing financial investment of dozens of organisations with a stake in radiological protection. I hope you will remember the importance of our work, which forms the basis of all standards, regulations, and practice of radiological protection across the world, and recognise the satisfaction that can be gained from being a part of it, should you take the opportunity of making a contribution.

Finally, I would like to pay tribute to Dr Bill Morgan, Chair of Committee 1, a friend and colleague, who sadly died in November 2015. His sudden death was shock to all and a reminder that life can sometimes be abruptly cut short.

Claire Cousins

Claire Cousins, ICRP Chair

THE INTERNATIONAL COMMISSION ON RADIOLOGICAL PROTECTION

ICRP develops the System of Radiological Protection for the public benefit. The System takes account of the latest scientific knowledge, ethical values, and practical experience. It is the basis of standards, legislation, guidance, programmes, and practice worldwide.

The objective of the System is to contribute to an appropriate level of protection for people and the environment against the harmful effects of radiation exposure without unduly limiting the individual or societal benefits of activities involving radiation.

Originally established at the Second International Congress of Radiology in 1928 as the International X-ray and Radium Protection Committee, today ICRP is an independent international charity registered in the UK.

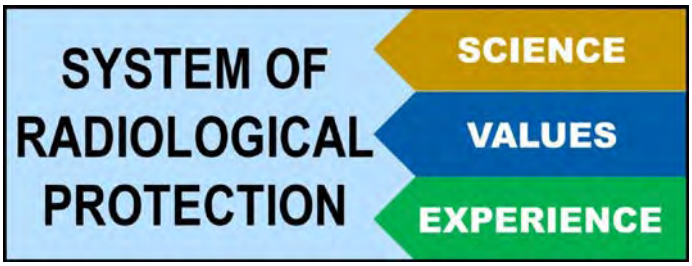
Members come from over 30 countries and all disciplines relevant to radiological protection. They are invited to join ICRP as independent experts on a volunteer basis for four-year terms.

ICRP consists of the Main Commission, the Scientific Secretariat, five standing Committees, and Task Groups established as needed to undertake specific work. Representatives of organisations in formal relations with ICRP are regularly invited to advise the Main Commission, and occasionally invited to participate in meetings of the Committees. Individuals may be invited to be members of Task Groups or to review drafts of work in progress, where their expertise is particularly relevant.

This structure supports a rigorous system of peer review. The work of Task Groups is reviewed by the relevant Committee(s), and then reviewed and approved by the Main Commission. During development, most reports are circulated to a number of organisations and individual experts for critical review, and posted for public consultation through the ICRP website.

The System of Radiological Protection

ICRP has produced well over one hundred publications on all aspects of protection against ionising radiation. A few describe the overall **System of Radiological Protection**, most recently ICRP *Publication 103*, The 2007 Recommendations of the International Commission on Radiological Protection. The rest provide more detailed guidance in a particular area, supporting technical information needed to implement the System, or examine the radiological protection implications of the latest science.



The ICRP System of Radiological Protection is based on the latest science, social and ethical values, and more than a century of experience

ICRP recommendations are used world-wide by intergovernmental and non-governmental advisory and standard setting agencies; government health and other regulatory authorities; educational, scientific, and healthcare institutes; operators, individual professionals; and others with an interest in radiological protection.

Independence and Collaboration

An important strength of ICRP is its ability to provide independent recommendations and guidance. However, independence does not mean isolation; engaging with other organisations benefits ICRP's aim to advance radiological protection for the public benefit. ICRP interacts with many organisations with an interest in radiological protection, and (as of December 31, 2015) maintains formal relations with twenty-one such organisations.

Code of Ethics

ICRP has a formal Code of Ethics, available at www.icrp.org, to guide its conduct. Briefly, in carrying out its work, ICRP is:

- Committed to public benefit
- Independent of governments and organisations, including industry and other users of radiation
- Impartial in its development of recommendations
- Transparent in its actions and judgements
- Accountable to the framework that governs the activities of a charity

Main Commission

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

Main Commission in Seoul, October 2015 – From left to right back: Hua Liu, John Harrison, Ohtsura Niwa, Christopher Clement (Scientific Secretary[1]), William Morgan, Sergey Romanov, Hans-Georg Menzel. Front left to right front: John Boice, Eliseo Vañó, Jai-Ki Lee, Claire Cousins (Chair), Jacques Lochard (Vice-Chair), Donald Cool, Carl-Magnus Larsson.

Formally, the Main Commission is ICRP, and the members are also the trustees of ICRP as a registered charity.

The Main Commission provides overall direction and oversight to the larger organisation. This includes setting the programme of work, and approving all draft reports prior to public consultation, and all final publications.

The Main Commission met twice in 2015: in Sydney in April and Seoul in October.

[1] Although not formally a member, the Scientific Secretary is an integral part of the Main Commission, organising and participating in all Main Commission meetings, and often acting as the representative of ICRP.

Scientific Secretariat

The Scientific Secretariat manages the daily business of ICRP, and the Scientific Secretary often represents ICRP at international meetings.

Scientific Secretariat in Seoul, October 2015 – From left to right: Nguyen Tat Thanh (Intern), Yuto Moriwake (Intern), Nobuyuki Hamada (Assistant Scientific Secretary), Christopher Clement (Scientific Secretary), Lynn Lemaire (Executive Assistant), Chantal Yacoub (Intern). Inset: Toshihiro Higuchi (Historian).

Under the leadership of the Scientific Secretary, the Scientific Secretariat is responsible for conducting the day-to-day business of ICRP. It is located in Ottawa, Canada, in an office provided as an in-kind contribution from the Canadian Nuclear Safety Commission.

The Scientific Secretariat includes two full-time paid employees (the Scientific Secretary and Executive Assistant) and three others. The full-time position of Assistant Scientific Secretary is filled through a multi-year cost-free staff loan, currently provided by the Central Research Institute of Electric Power Industry of Japan (CRIEPI). The full-time position of Intern is filled on a four-month rotating basis through the Canadian Nuclear Safety Commission co-op student programme. ICRP Historian is a part-time position filled on a voluntary basis.

Committee 1 (Radiation Effects)

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

Committee 1 in Seoul, October 2015 – From left to right back: Quanfu Sun, Dan Stram, Dominique Laurier, Richard Wakeford, Wolfgang Dörr, Andrzej Wojcik, Nobuhiko Ban. From left to right front: Ranajit Chakraborty, Tamara Azizova, Sisko Salomaa, William Morgan (Chair), Simon Bouffler (Vice-Chair), Werner Rühm (Secretary), Michael Hauptmann. Inset: Margot Tirmarche, Preetha Rajaraman.

Bill Morgan, the Chair of Committee 1, died suddenly on November 13th, 2015, only three weeks after the ICRP 2015 Symposium in which he played a major role. Dr Morgan was a member of C1 for more than 10 years. His profound scientific knowledge and his continuous advice in radiation protection issues will be greatly missed.

Committee 1 addresses issues pertinent to tissue reactions, risks of cancer and heritable diseases, radiation dose responses, effects of dose rate and radiation quality. Committee 1 also 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 regularly discusses the status of international radiation effects research programmes.

The report of Task Group 75 on Stem Cell Biology was released as *Publication 131* in 2015. The report provides a review of stem cells/progenitor cells and their responses to ionising radiation in relation to stochastic effects of radiation of radiation exposure that form a major part of the System of Radiological Protection.

Task Group 64 produced *Publication 115* "Lung Cancer Risk from Radon and Progeny and Statement on Radon" in 2010 and is now extending this report to consider cancer risks from other alpha emitters including plutonium and uranium. Specific topics being addressed are: cancer risk per organ dose (dose response relationship), dosimetric approaches used in several epidemiological studies and their implication on the risk coefficient, and comparison with external gamma exposure.

Task Group 91 is reviewing the current literature on sub-cellular, cellular, animal and human data with an emphasis on low dose and low dose-rate effects. A meta-analysis of all relevant radio-epidemiological data was initiated. In 2015, the Task Group participated in a workshop on "Dose and Dose-rate Effects Related to Radiation Effects" that took place in Kyoto, Japan, in May 2015.

A Working Group on detriment initially discussed the mechanisms and possible implications of circulatory disease. This effort has been broadened to document a robust and transparent methodology for calculating radiation detriment. For this, efforts are being made to analyse the current methodology outlined in Annex A of ICRP *Publication 103*.

Outlook

The committee will continue to focus on cancer risks from incorporated alpha emitters, radiation effects of low doses and low dose-rates, and methodologies to calculate radiation detriment. Further issues being monitored by Committee 1 include: radiation sensitivity and individual susceptibility, sequencing and omics technologies, high background radiation areas, CT in children, and the impact of epigenetics on radiological protection. To inform the radiation protection research community and the public on its activities, C1 will in 2016 organise open symposia in Hiroshima and Tokyo, Japan, and present its recent findings at the International Conference on Radiation Biology 2016 in Chennai, India.

Committee 2 (Doses from Radiation Exposures)

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

Committee 2 in Seoul, October 2015 –From left to right back: Nina Petoussi-Henß, Jizeng Ma, Akira Endo, Wesley Bolch (Secretary), Luiz Bertelli, Dietmar Noßke, Chan Hyeong Kim, Michael Bailey. From left to right front: Christian Streffer (MC Emeritus Member and former C2 Chair), François Paquet (Vice-Chair), John Harrison (Chair), Marina Degteva, Hans-Georg Menzel (MC Member and former C2 Chair), John Hunt. Inset: Frank Wissman, Douglas Chambers, Vladimir Berkovski, Rich Leggett.

Committee 2 develops reference models and data, including dose coefficients, for the assessment of exposure to radiation from both internal and external sources. It has a large programme of work to provide data based on *Publication 103*, taking into account methodological advances.

Task Group 96 is developing reference anatomical phantoms for use in the revision of dose coefficients for both external and internal sources. A report on Radiation Transport Calculations for Adult Phantoms provides the computational data for internal dose calculations using the ICRP reference adult phantoms of *Publication 110*. The draft report completed public consultation in October 2015 and will be published during 2016.

Task Group 95 provides revised dose coefficients and associated data for inhalation and ingestion of radionuclides by workers and members of the public. Occupational Intakes of Radionuclides part 1 was released in 2015 as *Publication 130*. It is an introduction to the series of reports that will replace *Publications 30* and *68*.

Task Group 90 will, for the first time, provide dose coefficients for members of the public, including adults and children of different ages, for exposures to external sources of radiation, e.g. possible exposures after accidental releases of radionuclides to the environment.

Task Group 79 on Use of Effective Dose is developing advice on the use of effective dose, including in medical applications. A Task Group meeting was held in Oxford in 2015, and a draft report was prepared for initial consideration by the Committees and Main Commission.

Task Group 36 reports to both C2 and C3 with the remit to develop dose coefficients for radiopharmaceuticals administered to patients in diagnostic nuclear medicine. A Task Group meeting was held in Munich, August 2015. The main work is to update *Publication 128* published in 2015 by providing values calculated using new ICRP adult and paediatric reference voxel phantoms and *Publication 103* methodology.

Outlook

Forthcoming Committee 2 reports will provide reference phantoms and radiation transport calculations for children of different ages and the fetus and pregnant mother. These reference phantoms will be used in the calculation of dose coefficients for external and internal exposures. In addition, to ensure that the best methodology continues to be applied in dose calculations, work is in progress to convert the voxel-type *Publication 110* phantoms into high-quality mesh format phantoms including all source and target tissues. These new phantoms will allow all calculations to be performed without recourse to separate models for the smallest source/target regions within, for example, the eyes, skin, and respiratory tract. Having confirmed the technical feasibility of this approach, the intention is to form a Task Group to undertake the work.

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.

Committee 3 in Seoul, October 2016 – From left to right back: Ola Holmberg (IAEA representative), Sandor Demeter, Colin Martin, Katrine Åhlström Riklund, Pierre Scalliet, Keon Kang, Michel Bourguignon and Reinhard Loose. From left to right front: Baorong Yue, Pedro Ortiz-López, Madan Rehani (Secretary), Eliseo Vañó (Chair), Donald Miller (Vice-Chair), Kimberly Applegate, Pek-Lan Khong. Inset: Yoshiharu Yonekura, Lawrence Dauer.

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

In 2015, the report of Task Group 36 on radiopharmaceuticals was issued as *Publication 128*. The report provides a compendium of current information relating to radiation dose to patients, including biokinetic models, biokinetic data, dose coefficients for organ and tissue absorbed doses, and effective dose for major radiopharmaceuticals based on the radiation protection guidance given in *Publication 60*. In 2015, the report of Task Group 88 on Cone Beam Computed Tomography (CBCT) was issued as *Publication 129*. The report provides guidance on radiological

protection in the new technology of CBCT and recommendations on radiation dose management directed at different stakeholders, and covers principles of radiological protection, training, and quality assurance aspects.

Outlook

In radiotherapy, ongoing work includes occupational radiological protection in brachytherapy. In nuclear medicine, radiological protection in therapy with radiopharmaceuticals is being reviewed. In a separate effort, Committee 3 continues to work with Committee 2 on dose to patients from radiopharmaceuticals. Occupational protection is covered in all Committee 3 documents, but a working party is paying specific attention to occupational protection issues in fluoroscopy- and CT-guided interventional procedures. The importance of this topic is due in part to the impact in medicine of the newly recommended occupational dose limit for the lens of the eye. A final draft document on Diagnostic Reference Levels in Medical Imaging was completed and a document on justification in medical imaging is in progress.

Committee 3 is working with Committee 1 on individual human sensitivity to ionising radiation and is also participating in the Committee 2 Task Group on Effective Dose, and the Main Commission Task Group on Terminology and Definitions. Committee 3 prepares educational slides for each of its publications and makes them available on the ICRP website for free download. Committee 3 has also completed a final draft for an educational document on Radiation Protection for Health Care Providers.

Areas for future work and topics to be kept under surveillance include: the framework for optimisation in medical imaging for individual patients; monitoring radiation dose quantities in imaging; risk assessment and management in radiotherapy; protection of the lens of the eye, cardiovascular system, and brain: implications for medicine of *Publication 118*; and, unintended exposures in medicine.

Committee 4 (Application of the Commission's Recommendations)

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

Committee 4 in Seoul, October 2015 – From left to right back: Michiaki Kai, Analia Canoba, Ann McGarry, Deborah Oughton, Thiagan Pather, Senlin Liu. From left to right front: John Takala, Sergey Shinkarev, Jean-François Lecomte (Secretary), Donald Cool (Chair), Anne Nisbet, Kun-Woo Cho (Vice-Chair), François Bochud, Michael Boyd. Inset: Toshimitsu Homma, Eduardo Gallego.

The Committee 4 programme of work encompasses several broad areas, including a series of reports covering various aspects of existing exposure situations, leading the ICRP effort to update and elaborate recommendations in light of the accident at Fukushima Daiichi for emergencies and living in contaminated areas, elaborating the underpinnings of the System of Radiological Protection, and developing focused reports on specific topic areas in consultation with organisations in formal relations with ICRP ('liaison organisations').

The report of Task Group 83 on Cosmic radiation in aviation was approved for publication. The report provides updated guidance on the radiological protection from cosmic radiation in aviation taking into account the current System of Radiological

Protection, the latest available data on exposures in aviation and the experience gained worldwide in their management.

Task Group 94 on Ethics of Radiological Protection is developing a report that elaborates on the underpinnings of the System of Radiological Protection, and is intended to improve our understanding and use of the System, and assist in developing decision approaches and communications. The Task Group has benefited from a series of workshops organised in cooperation with the International Radiation Protection Association (IRPA), resulting in a preliminary draft made available for discussion by the IRPA associate societies for the Congress in 2016.

Task Group 93 is contributing to ICRP's review of lessons from the Fukushima Daiichi accident, and will update *Publications 109* and *111*. This work is being conducted in conjunction with the ICRP Fukushima Dialogue initiative.

Outlook

Task Group 76 is developing a report that examines the issues of applying the System of Radiological Protection to Naturally Occurring Radioactive Materials (NORM). NORM industries are particularly challenging because of the wide range of possible situations and the lack of radiological protection cultures in many long established industries.

Task Group 98 on application of the Commission's Recommendations to exposures resulting from contaminated sites from past industrial, military and nuclear activities will complement the Task Group 93 work on living in contaminated areas, and complete the initial suite of reports on existing exposure situations. In 2015, the Task Group met multiple times by teleconference, and a full meeting in conjunction with a workshop in Oslo.

As part of the interactions with ICRP's liaison organisations, Committee 4 worked with the International Labour Organization to update their General Observations. The Committee also continues to consider possible topics for future focused reports based on suggestions from our liaison organisations.

Committee 5 (Protection of the Environment)

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

Committee 5 in Seoul, October 2015 – From left to right back: Per Strand, Almudena Real (Vice-Chair), Kazuo Sakai, David Copplestone (Secretary). From left to right front: Li Jianguo, Kathryn Higley (Chair), Carl-Magnus Larsson, Jacqueline Garnier-Laplace, Alexander Ulanovsky. Inset: Jordi Vives i Batlle.

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.

In 2015, the Main Commission approved the creation of Task Group 99 on Reference Animals and Plants (RAPs) Monographs. The main objective is to gather and update basic data and give guidance for the best use and practices of RAPs, in support of the application of the System of Radiological Protection of the environment in planned, emergency and existing exposure situations. The work will extend, verify, validate and supplement the databases of *Publications 108* and *114*; and thus will consolidate the scientific basis of the System of Radiological Protection with respect to the

environment and complement the application of the System described in *Publication* 124.

Committee 5 is currently finalising the work of two task groups that will provide further depth to the System outlined above, namely on improved dosimetry and dosimetric tools for biota; and on relative biological effectiveness including its significance in relation to environmental protection.

During the year, Carl-Magnus Larsson stepped down as Committee 5 Chair (while remaining a member of the Main Commission), and Kathryn Higley was elected to this position.

Outlook

Future work will focus on the scientific foundation for our understanding of the primary components of an ecological risk assessment, namely transfer and dosimetry to biota, radiation effects on biota, and implications at higher levels of ecological organisations (populations, communities, ecosystems) when characterising the radiological risk.

Additionally, Committee 5 together with Committee 4 will further develop the methodology to consider the environment when applying the System of Radiological Protection. The aim is to provide specific recommendations with respect to radiological and other non-radiological considerations for existing and emergency exposure situations. Case studies will be used to consider how optimisation and justification should apply in the context of both humans and biota, noting that human radiological protection will always take precedence for example in emergencies. Consideration will also be given to converting the Derived Consideration Reference Levels (DCRLs) into environmental concentrations and other measures (e.g. ambient dose equivalent) to aid communication and understanding for existing and emergency situations.

Task Groups

Active as of December 31, 2015:

C2/3 TG 36 **Radiopharmaceuticals**, Chair D. Noßke

C1 TG 64 **Cancer Risk from Alpha Emitters**, Chair Margot Tirmarche

C5 TG 72 **RBE and Reference Animals and Plants**, Chair Kathryn Higley

C5 TG 74 **More Realistic Dosimetry for Non-human Species**, Chair Alexander Ulanovsky

C4 TG 76 **Application of the Commission's Recommendations to NORM (Naturally Occurring Radioactive Material)**, Chair by Jean-François Lecomte

C2 TG 79 **The Use of Effective Dose as a Risk Related Radiological Protection Quantity**, Chair John Harrison

C4 TG 83 **Protection of Aircraft Crew against Cosmic Radiation Exposure**, Chair Jacques Lochard

C3 TG 89 **Occupational Radiological Protection in Brachytherapy**, Chair Lawrence Dauer

C2 TG 90 **Age-dependent Dose Conversion Coefficients for External Exposures to Environmental Sources**, Chair Nina Petoussi-Henß

C1 TG 91 **Radiation Risk Inference at Low-dose and Low-dose Rate Exposure for Radiological Protection Purposes**, Chair Werner Rühm

MC TG 92 **Terminology and Definitions**, Chair Wolfgang Dörr

C4 TG 93 **Update of ICRP *Publications 109* and *111***, Chair Michiaki Kai

C4 TG 94 **Ethics of Radiological Protection**, Chair Kun-Woo Cho

C2 TG 95 **Internal Dose Coefficients**, Chair François Paquet

C2 TG 96 **Computational Phantoms and Radiation Transport**, Chair Wesley Bolch

C4 TG 97 **Application of the Commission's Recommendations for Surface and Near Surface Disposal of Solid Radioactive Waste**, Chair Thiagan Pather

C4 TG 98 **Application of the Commission's Recommendations to Exposures Resulting from Contaminated Sites from Past Industrial**, **Military and Nuclear Activities**, Chair Michael Boyd

C5 TG 99 **Reference Animals and Plants (RAPs) Monographs**, Chair Jacqueline Garnier-Laplace

MC TG 100 **ICRP Reflection Group on NCRP Council Committee 1**, Chair Jacques Lochard

Relations with Other Organisations

ICRP recognises the need to remain independent from undue influence, while maintaining good working relationships with other organisations with an interest in radiological protection. To this end, ICRP works with a wide variety of organisations from many sectors, and establishes formal relations with relevant international organisations. National organisations are considered where no international organisation exists that could reasonably represent their views. Currently, these include:

- European ALARA Network (EAN)
- European Commission (EC)
- European Nuclear Installations Safety Standards Initiative (ENISS)
- European Platform on Preparedness for Nuclear and Radiological Emergency Response and Recovery (NERIS)
- European Radiation Dosimetry Group (EURADOS)
- European Radioecology Alliance (ALLIANCE)
- Heads of the European Radiological Protection Competent Authorities (HERCA)
- Ibero American Forum of Radiological and Nuclear Regulatory Organisations (FORO)
- IndustriAll Global Union's International Network (INWUN)
- Information System on Occupational Exposure (ISOE)
- International Atomic Energy Agency (IAEA)
- International Commission on Radiation Units and Measurements (ICRU)
- International Labour Organisation (ILO)
- International Radiation Protection Association (IRPA)
- Multidisciplinary European Low Dose Initiative (MELODI)
- OECD Nuclear Energy Agency (NEA)
- United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR)
- US Conference of Radiation Control Program Directors (CRCPD)
- US National Council for Radiation Protection and Measurements (NCRP)
- World Health Organisation (WHO)
- World Nuclear Association (WNA)

Meetings with senior representatives of these organisations to discuss issues of strategic importance are held regularly. In addition, representatives of these organisations may be invited to provide expertise in specific ICRP Committee sessions, or to participate as members of ICRP Task Groups where their expertise is central to the objectives of the group.

MEMBERSHIP

ICRP membership totals approximately 250 experts from more than 30 countries. The membership of the Main Commission, Scientific Secretariat, and Committees as of December 31, 2015 is shown below. The membership of Task Groups can be found at www.icrp.org.

Main Commission

Claire Cousins (Chair)
Addenbrooke's Hospital, UK

Jacques Lochard (Vice-Chair)
Centre d'étude sur l'Evaluation de la Protection dans le domaine Nucléaire, France

John D Boice Jr
National Council on Radiation Protection and Measurements, USA

Donald A Cool (C4 Chair)
Electric Power Research Institute, USA

John D Harrison (C2 Chair)
Oxford Brookes University, UK

Carl-Magnus Larsson
Australian Radiation Protection and Nuclear Safety Agency, Australia

Jai-Ki Lee
Hanyang University, Korea

Hua Liu
National Nuclear Safety Administration, Ministry of Environment Protection, China

Hans-Georg Menzel
CERN (Retired), Switzerland

Ohtsura Niwa
Radiation Effect Research Foundation, Japan

Sergey Romanov
Southern Ural Biophysics Institute, Russian Federation

Eliseo Vañó (C3 Chair)
Complutense University, Spain

Christopher Clement (Scientific Secretary)
International Commission on Radiological Protection, Canada

Emeritus members: Roger H Clarke, Bo Lindell, Charles B Meinhold, Fred A Mettler, R Jan Pentreath, Christian Streffer

Scientific Secretariat

Christopher Clement (Scientific Secretary)
Nobuyuki Hamada (Assistant Scientific Secretary)
Lynn Lemaire (Executive Assistant)
Toshihiro Higuchi (Historian, p/t)
Intern (rotating)

Committee 1 (Radiation Effects)

Simon Bouffler (Vice-Chair)
Werner Rühm (Secretary)
Tamara Azizova
Nobuhiko Ban
Ranajit Chakraborty
Wolfgang Dörr
Michael Hauptmann
Dominique Laurier
Preetha Rajaraman
Sisko Salomaa
Dan Stram
Quanfu Sun
Margot Tirmarche
Richard Wakeford
Andrzej Wojcik

Committee 2 (Doses from Radiation Exposures)

John D Harrison (Chair)
François Paquet (Vice-Chair)
Wesley E Bolch (Secretary)
Michael R Bailey
Vladimir Berkovski
Luiz Bertelli
Douglas Chambers
Marina Degteva
Akira Endo
John G S Hunt
Chan Hyeong Kim
Richard Leggett
Jizeng Ma
Dietmar Noßke
Nina Petoussi-Henß
Frank Wissmann

Emeritus member: Keith Eckerman

Committee 3 (Protection in Medicine)

Eliseo Vañó (Chair)
Donald L Miller (Vice-Chair)
Madan M Rehani (Secretary)
Kimberly E Applegate
Michel Bourguignon
Lawrence T Dauer
Sandor Demeter
Keon Kang
Pek-Lan Khong
Reinhard Loose
Pedro Ortiz Lopez
Colin Martin
Katrine Åhlström-Riklund
Pierre Scalliet
Yoshiharu Yonekura
Baorong Yue

Emeritus members: Sören Mattson, Marvin Rosenstein

Committee 4 (Application of the Commission's Recommendations)

Donald A Cool (Chair)
Kun-Woo Cho (Vice-Chair)
Jean-François Lecomte (Secretary)
François Bochud
Michael Boyd
Analia Canoba
Mark Doruff
Eduardo Gallego
Toshimitsu Homma
Michiaki Kai
Senlin Liu
Ann McGarry
Anne Nisbet
Deborah Oughton
Thiagan Pather
Sergey Shinkarev
John Takala

Committee 5 (Protection of the Environment)

Kathryn A Higley (Chair)
Almudena Real (Vice-Chair)
David Copplestone (Secretary)
Jordi Vives i Batlle
Jacqueline Garnier-Laplace
Jianguo Li
Kazuo Sakai
Per Strand
Alexander Ulanovsky

ICRP 2015

THE THIRD INTERNATIONAL SYMPOSIUM ON THE SYSTEM OF RADIOLOGICAL PROTECTION

ICRP's 3rd International Symposium on the System of Radiological Protection was held in Seoul, Korea on 20-22 October 2015 and attracted nearly 400 participants from 46 countries. The event was hosted by the Korean Association for Radiation Protection (KARP), and supported by a large number of organisations including: Korea Institute of Nuclear Safety (KINS), Korea Hydro & Nuclear Power (KHNP), and Korea Atomic Energy Research Institute (KAERI). The full list of supporters is found on pages 31 and 32.

The three-day Symposium began with an introductory session, 'Advancing together after 87 years,' dedicated to presenting ICRP and outlining the ICRP programme of work, followed by five topical sessions.

Proceedings of the Symposium will be published in the Annals of the ICRP. Thanks to support from the German Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety, the pdf version of the proceedings will be free to download, and registered participants are eligible to receive a printed copy at no charge.

Exploring Existing Exposure Situations

This session presented the wide variety of circumstances that fall within the existing exposure situation, including exposures to cosmic radiation, living in a contaminated area while dealing with post-accident recovery, and the problem of sites contaminated by past practices.

Radiological Protection in Medicine Today

This session began with a review of eight decades of experience, continued with a discussion of current issues in Korea and worldwide, and examined the state of the art with a review of recently released ICRP recommendations on radiological protection in ion beam radiotherapy, and web-based resources that provide information on radiation risks and benefits to healthcare providers.

The Science Behind Radiation Doses

This session gave those present an insight into the work of ICRP Committee 2 and the related work of Committee 5, particularly in terms of looking at the major task of developing dose coefficients. In addition, information was provided on a new approach being considered for operational quantities by our sister organisation, the International Commission on Radiation Units and Measurements, and on ICRP's effort to provide additional guidance on the use of effective dose.

New Developments in Understanding Radiation Effects

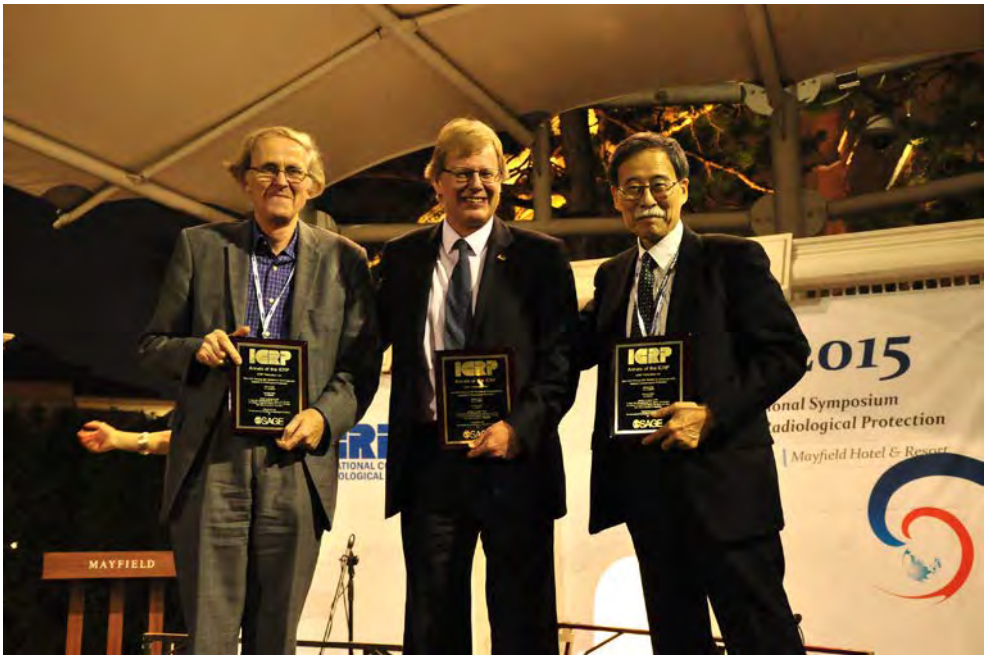
Some of the latest scientific findings, and the potential implications for the System of Radiological Protection, were presented in this session, looking at stem cell biology, dose-rate effects, variations in human radiosensitivity, and risks of non-cancer effects.

Ethics in Radiological Protection

The final session of the symposium was on ‘Ethics in radiological protection’, the subject of an ICRP Task Group, and a topic that has engaged many in the

radiological protection profession since ICRP began to review it in earnest in 2012. This ICRP effort, and this symposium session, focussed on the ethical values inherent in the System of Radiological Protection.

Given the success of an ICRP's series of symposia, planning has already begun for the **4th International Symposium on Radiological Protection**. It will be held in **Paris, France, 10-12 October 2017**, in conjunction with the next biennial joint meetings of the Main Commission and Committees.



PUBLICATIONS

Five reports were published in the Annals of the ICRP in 2015. Their abstracts are on the following pages.

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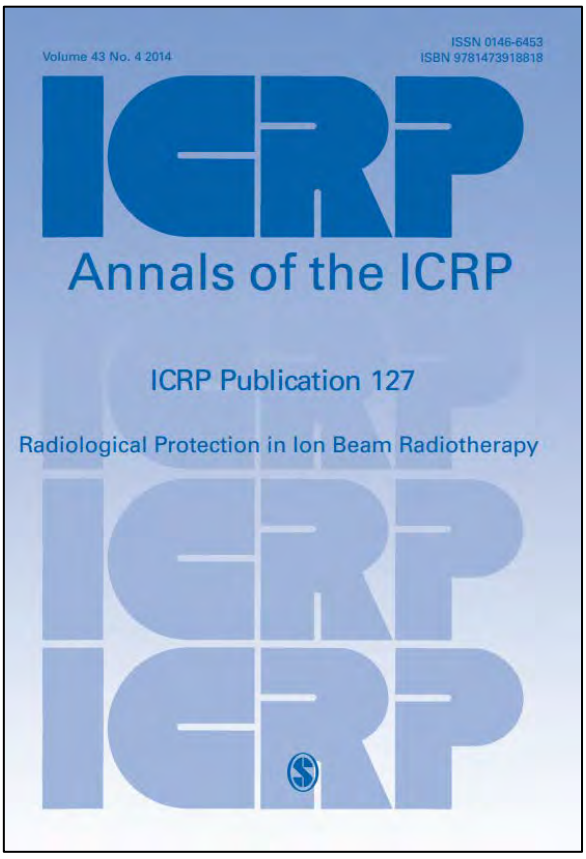
We want to make more of our publications available free of charge, and are working hard to raise the necessary financial support to do so. If you or your organisation would like to learn more about how you can help, please contact Christopher Clement, ICRP Scientific Secretary, at sci.sec@icrp.org.

Publication 127 Radiological Protection in Ion Beam Radiotherapy

Y. Yonekura, H. Tsujii, J.W. Hopewell, P. Ortiz Lopez, J-M. Cosset, H. Paganetti, A. Montelius, D. Schardt, B. Jones, T. Nakamura

The goal of external-beam radiotherapy is to provide precise dose localisation in the treatment volume of the target with minimal damage to the surrounding normal tissue. Ion beams, such as protons and carbon ions, provide excellent dose distributions due primarily to their finite range, allowing a significant reduction of undesired exposure of normal tissue. Careful treatment planning is required for the given type and localisation of the tumour to be treated in order to maximise treatment efficiency and minimise the dose to normal tissue. Radiation exposure in out-of-field volumes arises from secondary neutrons and photons, particle fragments, and photons from activated materials. These unavoidable doses should be considered from the standpoint of radiological protection of the patient.

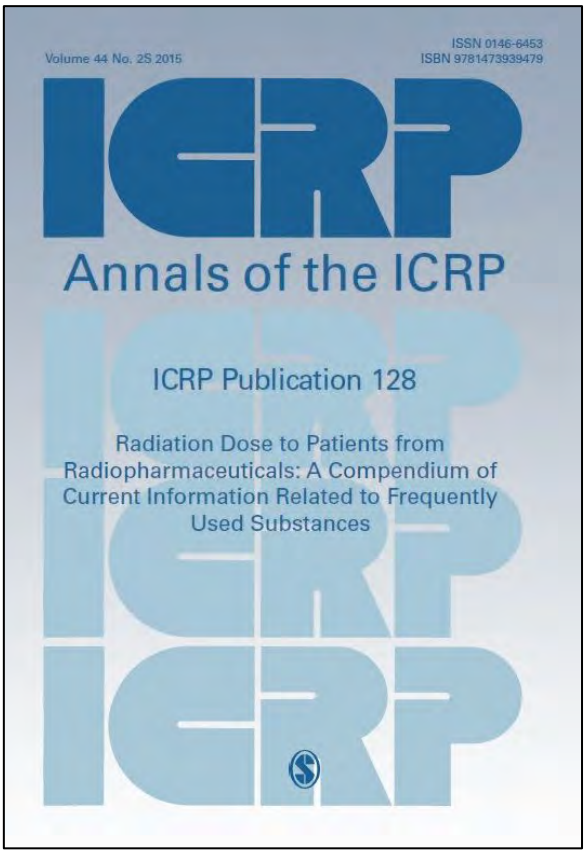
Radiological protection of medical staff at ion beam radiotherapy facilities requires special attention. Appropriate management and control are required for the therapeutic equipment and the air in the treatment room that can be activated by the particle beam and its secondaries. Radiological protection and safety management should always conform with regulatory requirements. The current regulations for occupational exposures in photon radiotherapy are applicable to ion beam radiotherapy with protons or carbon ions. However, ion beam radiotherapy requires a more complex treatment system than conventional radiotherapy, and appropriate training of staff and suitable quality assurance programmes are recommended to avoid possible accidental exposure of patients, to minimise unnecessary doses to normal tissue, and to minimise radiation exposure of staff.



Publication 128 Radiation Dose to Patients from Radiopharmaceuticals: A Compendium of Current Information Related to Frequently Used Substances

S. Mattsson, L. Johansson, S. Leide Svegborn, J. Liniecki, D. Noßke, K. Å. Riklund, M. Stabin, D. Taylor, W. Bolch, S. Carlsson, K. Eckerman, A. Giussani, L. Söderberg, S. Valind

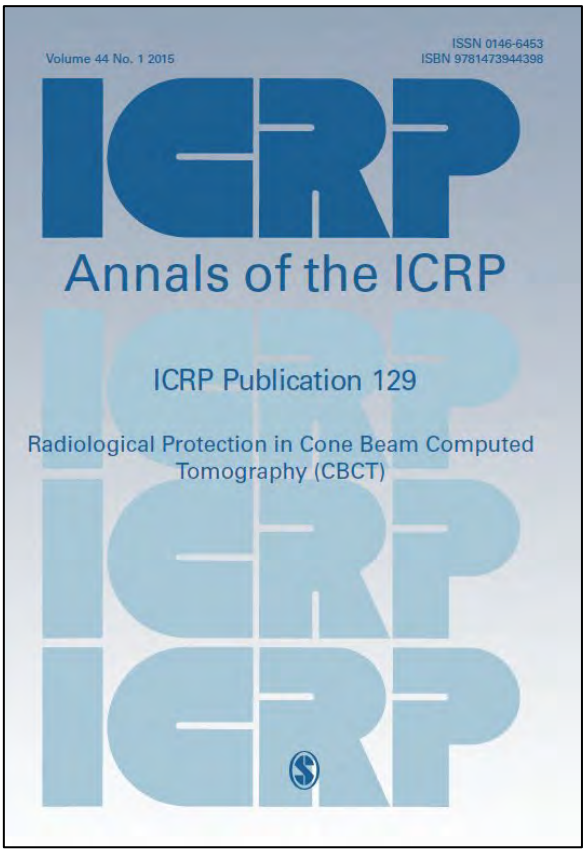
This report provides a compendium of current information relating to radiation dose to patients, including biokinetic models, biokinetic data, dose coefficients for organ and tissue absorbed doses, and effective dose for major radiopharmaceuticals based on the radiation protection guidance given in *Publication 60*. These data were mainly compiled from *Publications 53*, *80*, and *106*, and related amendments and corrections. This report also includes new information for 82 Rb-chloride, iodide (^{123}I, ^{124}I, ^{125}I, and ^{131}I) and 123 I labelled 2.-carbomethoxy 3.-(4-iodophenyl)-N-(3-fluoropropyl) nortropane (FPCIT). The coefficients tabulated in this publication will be superseded in due course by values calculated using new International Commission on Radiation Units and Measurements / International Commission on Radiological Protection adult and paediatric reference phantoms and *Publication 103* methodology. The data presented in this report are intended for diagnostic nuclear medicine and not for therapeutic applications.



Publication 129 Radiological Protection in Cone Beam Computed Tomography (CBCT)

M.M. Rehani, R. Gupta, S. Bartling, G.C. Sharp, R. Pauwels, T. Berris, J.M. Boone

The objective of this publication is to provide guidance on radiological protection in the new technology of cone beam computed tomography (CBCT). *Publications 87* and *102* dealt with patient dose management in computed tomography (CT) and multi-detector CT. The new applications of CBCT and the associated radiological protection issues are substantially different from those of conventional CT. The perception that CBCT involves lower doses was only true in initial applications. CBCT is now used widely by specialists who have little or no training in radiological protection. This publication provides recommendations on radiation dose management directed at different stakeholders, and covers principles of radiological protection, training, and quality assurance aspects. Advice on appropriate use of CBCT needs to be made widely available. Advice on optimisation of protection when using CBCT equipment needs to be strengthened, particularly with respect to the use of newer features of the equipment. Manufacturers should standardise radiation dose displays on CBCT equipment to assist users in optimisation of protection and comparisons of performance. Additional challenges to radiological protection are introduced when CBCT-capable equipment is used for both fluoroscopy and tomography during the same procedure. Standardised methods need to be established for tracking and reporting of patient radiation doses from these procedures.

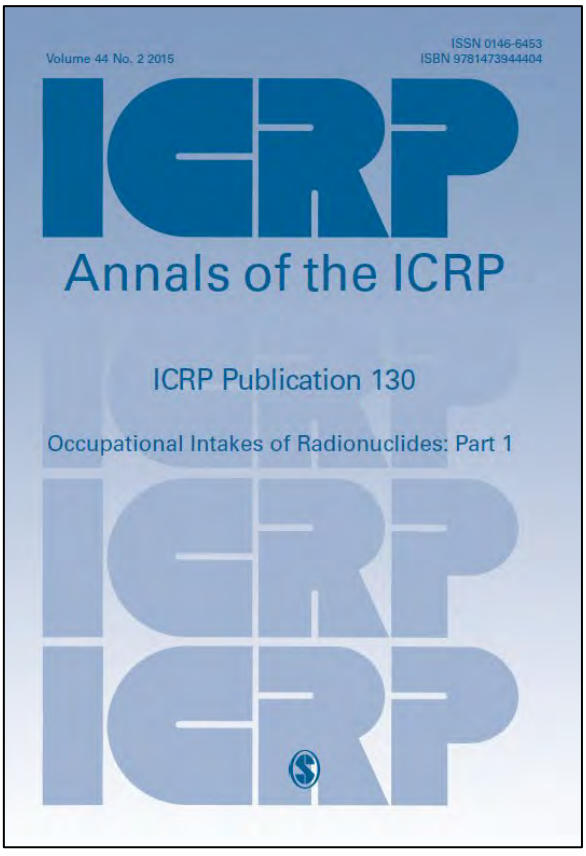


The recommendations provided in this publication may evolve in the future as CBCT equipment and applications evolve. As with previous ICRP publications, the Commission hopes that imaging professionals, medical physicists, and manufacturers will use the guidelines and recommendations provided in this publication for implementation of the Commission's principle of optimisation of protection of patients and medical workers, with the objective of keeping exposures as low as reasonably achievable, taking into account economic and societal factors, and consistent with achieving the necessary medical outcomes.

Publication 130 Occupational Intakes of Radionuclides: Part 1

F. Paquet, G. Etherington, M.R. Bailey, R.W. Leggett, J. Lipsztein, W. Bolch, K.F. Eckerman, J.D. Harrison

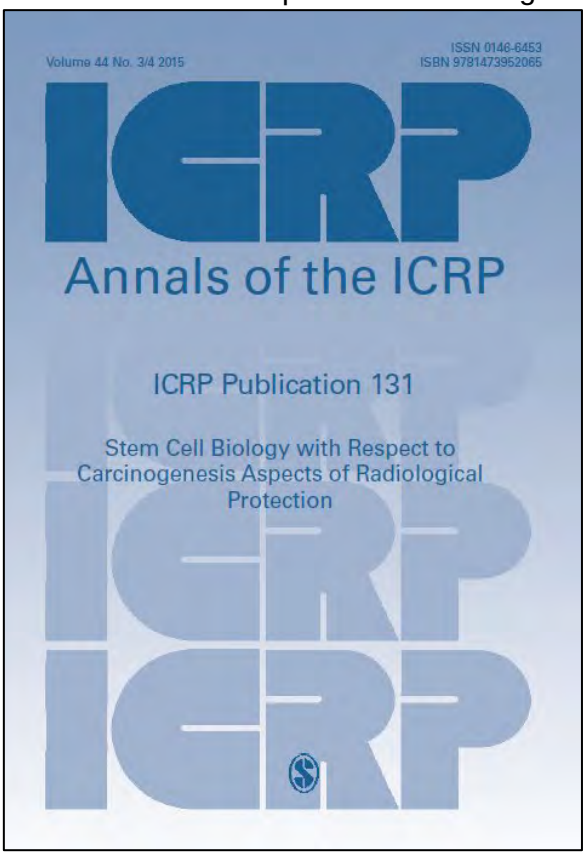
This report is the first in a series of reports replacing *Publications 30* and *68* to provide revised dose coefficients for occupational intakes of radionuclides by inhalation and ingestion. The revised dose coefficients have been calculated using the Human Alimentary Tract Model (*Publication 100*) and a revision of the Human Respiratory Tract Model (*Publication 66*) that takes account of more recent data. In addition, information is provided on absorption into blood following inhalation and ingestion of different chemical forms of elements and their radioisotopes. In selected cases, it is judged that the data are sufficient to make material-specific recommendations. Revisions have been made to many of the models that describe the systemic biokinetics of radionuclides absorbed into blood, making them more physiologically realistic representations of uptake and retention in organs and tissues, and excretion. The reports in this series provide data for the interpretation of bioassay measurements as well as dose coefficients, replacing *Publications 54* and *78*. In assessing bioassay data such as measurements of whole-body or organ content, or urinary excretion, assumptions have to be made about the exposure scenario, including the pattern and mode of radionuclide intake, physical and chemical characteristics of the material involved, and the elapsed time between the exposure(s) and measurement. This report provides some guidance on monitoring programmes and data interpretation.



Publication 131 Stem Cell Biology with Respect to Carcinogenesis Aspects of Radiological Protection

O. Niwa, M.H. Barcellos-Hoff, R.K. Globus, J.D. Harrison, J.H. Hendry, P. Jacob, M.T. Martin, T.M. Seed, J.W. Shay, M.D. Story, K. Suzuki, S. Yamashita

This report provides a review of stem cells/progenitor cells and their responses to ionising radiation in relation to issues relevant to stochastic effects of radiation that form a major part of the International Commission on Radiological Protection's system of radiological protection. Current information on stem cell characteristics, maintenance and renewal, evolution with age, location in stem cell 'niches', and radiosensitivity to acute and protracted exposures is presented in a series of substantial reviews as annexes concerning haematopoietic tissue, mammary gland, thyroid, digestive tract, lung, skin, and bone. This foundation of knowledge of stem cells is used in the main text of the report to provide a biological insight into issues such as the linear-no-threshold (LNT) model, cancer risk among tissues, dose rate effects, and changes in the risk of radiation carcinogenesis by age at exposure and attained age. Knowledge of the biology and associated radiation biology of stem cells and progenitor cells is more developed in tissues that renew fairly rapidly, such as haematopoietic tissue, intestinal mucosa, and epidermis, although all the tissues considered here possess stem cell populations. Important features of stem cell maintenance, renewal, and response are the micro-environmental signals operating in the niche residence, for which a well-defined spatial location has been identified in some tissues. The identity of the target cell for carcinogenesis continues to point to the more primitive stem cell population that is mostly quiescent, and hence able to accumulate the protracted sequence of mutations necessary to result in malignancy. In addition, there is some potential for daughter progenitor cells to be target cells in particular cases, such as in haematopoietic tissue and in skin. Several biological processes could contribute to protecting stem cells from mutation accumulation: (a) accurate DNA repair; (b) rapidly induced death of injured stem cells; (c) retention of the DNA parental template strand during divisions in some tissue systems, so that mutations are passed to the daughter differentiating cells and not retained in the parental cell; and (d) stem cell competition, whereby undamaged stem cells outcompete damaged stem cells for residence in the niche. DNA repair mainly occurs within a few days of irradiation, while stem cell competition requires weeks or many months depending on the tissue type. The aforementioned processes may contribute to the differences in carcinogenic radiation risk values between tissues, and may help to explain why a rapidly replicating tissue such as small intestine is less prone to such risk. The processes also provide a mechanistic insight relevant to the LNT model, and the relative and absolute risk models. The radiobiological knowledge also provides a scientific insight into discussions of the dose and dose-rate effectiveness factor currently used in radiological protection guidelines. In addition, the biological information contributes potential reasons for the age-dependent sensitivity to radiation carcinogenesis, including the effects of in-utero exposure.



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ITEM	2015	2014	2013	2012	2011
Incoming Resources					
Contributions Received	799 343	529 949	482 334	533 025	650,955
Royalties	151 846	126 527	103 772	199 059	70,071
Interest and Other Income	0	8	30	1 331	78
Total Incoming Resources	951 189	656 484	586 146	733 414	721 104
Resources Expended					
Promotion of Radiological Protection	378 187	240 069	303 917	401 855	627 326
Governance Costs	377 611	392 753	380 943	269 846	288 646
Other Resources Expended	1 896	36 642	23 037	13 034	21 873
Total Resources Expended	757 694	669 464	707 897	684 735	937 845
Net Movement in Resources	193 495	(12 980)	(121 750)	48 679	(216 741)
Total Funds Carried Forward	**280 843**	**87 348**	**100 328**	**222 078**	**173 399**
Tangible Fixed Assets	2 415	0	0	1 032	2 680
Current Assets	155 734	22 574	95 683	107 572	236 567
Debtors	192 683	149 186	194 986	242 167	38 498
Creditors	(69 989)	(84 412)	(190 341)	(128 693)	(104 346)
Net Assets	**280 843**	**87 348**	**100 328**	**222 078**	**173 399**

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.

Although this table focuses on finances, the majority of ICRP support is received in kind. For example, members' institutions make members' time available without charge and, in many cases, cover their costs of attending ICRP meetings.

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- French National Radioactive Waste Management Agency (Agence nationale pour la gestion des déchets radioactifs, ANDRA)
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- Norwegian Radiation Protection Authority (Statens strålevern)
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- US Environmental Protection Agency
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- US Nuclear Regulatory Commission

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Dr William F. Morgan

1952 – 2015

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