Emergencies, Ethics, and Evolution

Nordic Nuclear and Radiation Risk Estimates – Advances and Uncertainties

Joint NKS-R & NKS-B Seminar

Stockholm, 15th January 2019

Dr Claire Cousins

Chair, ICRP

2nd International Congress of Radiology (Stockholm)

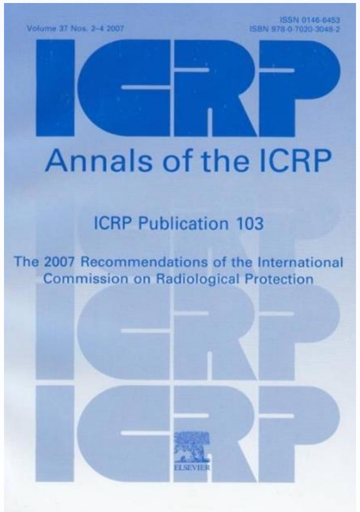
27 July 1928: International X-Ray and Radium Protection Committee is formed

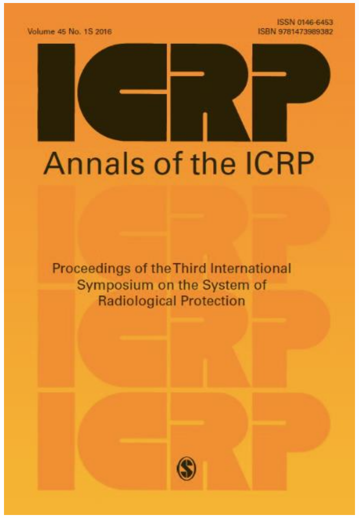
1950: Renamed **International Commission on Radiological Protection (ICRP)**

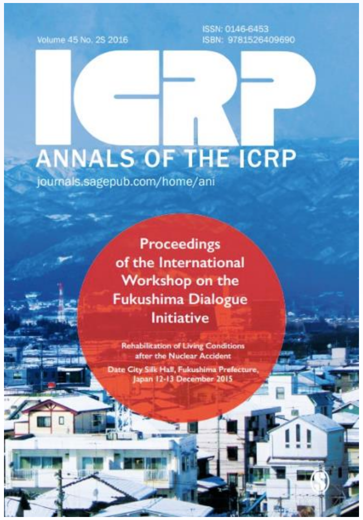
Dr. Rolf Sievert, Stockholm, Chairman,
Dr. G. W. C. Kaye, London, } Hon. Secr.
Dr. Stanley Melville, London, } Hon. Secr.
Prof. Giulio Ceresole, Venezia,
Dr. G. Grossmann, Berlin,
Dr. I. Solomon, Paris,
Dr. L. S. Taylor, Washington.

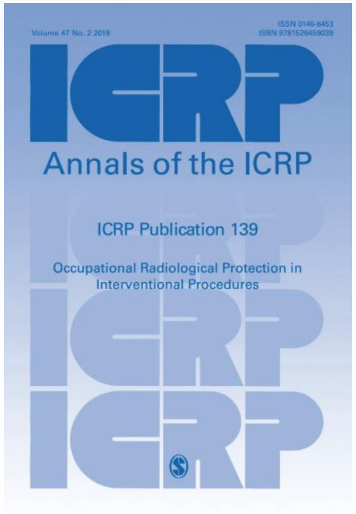
ICRP Mission

Advance for the public benefit the science of radiological protection, in particular by providing recommendations and guidance on all aspects of protection against ionising radiation









Structure ICRP

Main Commission

Scientific Secretariat

Committee 1
Effects

Committee 2
Doses

Committee 3
Medicine

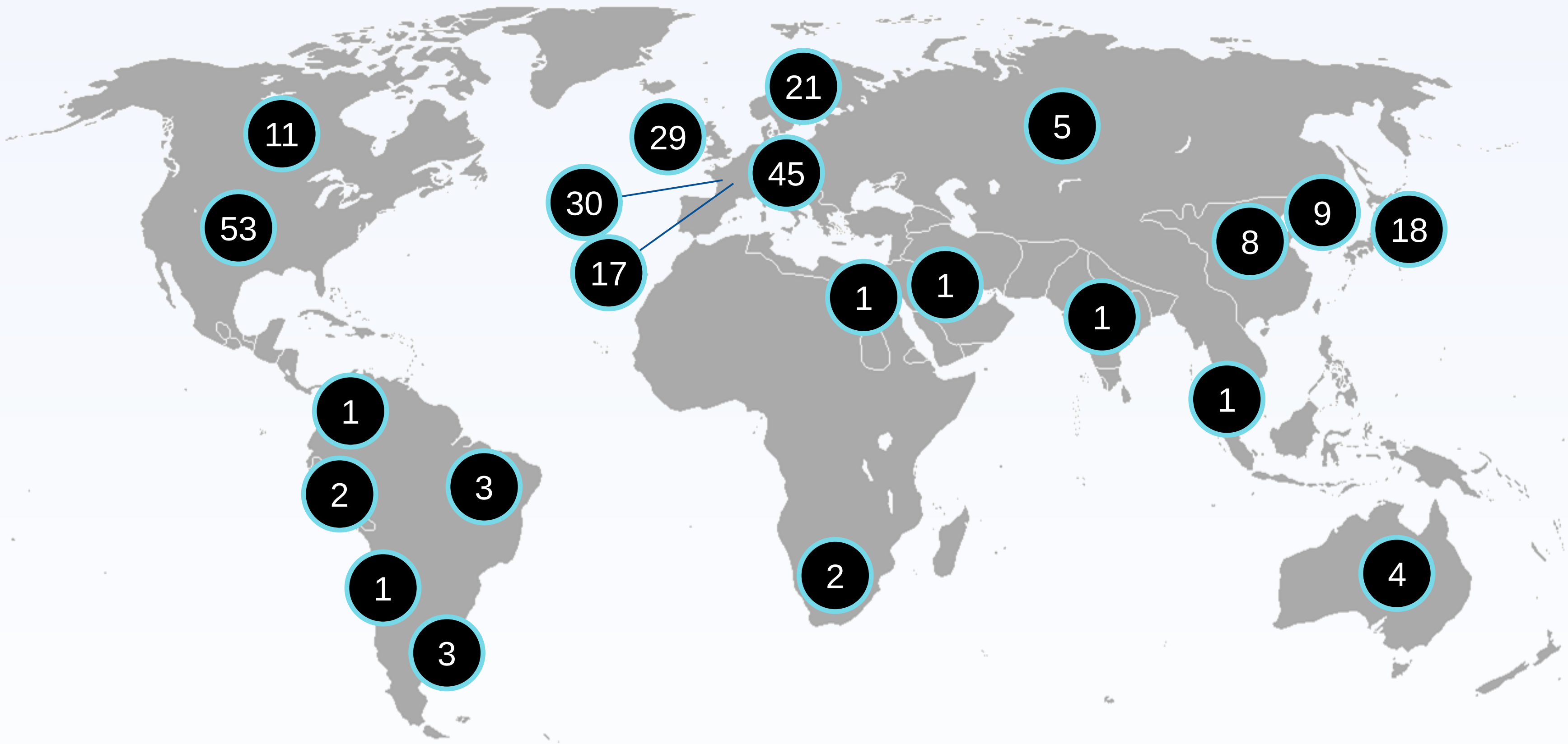
Committee 4
Application

TASK GROUPS

Main Commission Stockholm 2018

Absent: Carl-Magnus Larsson

Membership



266 members from 38 countries

as of 2018 September 12, including liaison organization primary contacts

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Receiving regular voluntary support from organisations with an interest in radiological protection

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IAEA International Atomic Energy Agency

FANR الهيئة الاتحادية للرقابة النووية Federal Authority for Nuclear Regulation

U.S.NRC United States Nuclear Regulatory Commission *Protecting People and the Environment*

United States Environmental Protection Agency

Innovative Solutions for Energy and Environment JANUS JAPAN NUS CO., LTD.

CNSC CCSN

Health Canada Santé Canada

IRSN INSTITUT DE RADIOPROTECTION ET DE SÛRETÉ NUCLÉAIRE

Department of Energy United States of America

Strål säkerhets myndigheten Swedish Radiation Safety Authority

Chinese Society of Radiation Protection (CSRP)

ANDRA French national radioactive waste management agency

Australian Government Australian Radiation Protection and Nuclear Safety Agency

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Schweizerische Eidgenossenschaft Confédération suisse Confederazione Svizzera Confederaziun svizra Swiss Confederation
Eidgenössisches Nuklearsicherheitsinspektorat ENSI Inspection fédérale de la sécurité nucléaire IFSN Ispettorato federale della sicurezza nucleare IFSN Swiss Federal Nuclear Safety Inspectorate ENSI

Statens strålevern

CSN CONSEJO DE SEGURIDAD NUCLEAR

NEI NUCLEAR ENERGY INSTITUTE

Southern Urals Biophysics Institute (SUBI)

NEA Nuclear Energy Agency

ILO International Labour Organization

ISR The International Society of Radiology

IRPA

GEISLAVARNIR RÍKISINS

STUK

Danish Protection Authority (SIS)

eDF

Cameco

JRIA

ICRP INTERNATIONAL COMMISSION ON RADIOLOGICAL PROTECTION

24 Active Task Groups

TG36 Radiopharmaceutical Doses

TG64 Cancer Risk from Alpha Emitters

TG72 RBE and Reference Animals and Plants

TG76 NORM

TG79 Use of Effective Dose

TG89 Occupational RP in Brachytherapy

TG90 Age-dependent Dose Conversion Coefficients for External Exposures

TG91 Low-dose and Low-dose Rate Exposure

TG93 Update of ICRP *Publications 109* and *111*

TG95 Internal Dose Coefficients

TG96 Computational Phantoms and Radiation Transport

TG97 Surface and Near Surface Disposal

TG98 Contaminated Sites

TG 99 Reference Animals and Plants Monographs

TG101 Radiopharmaceutical Therapy

TG102 Detriment Calculation Methodology

TG103 Mesh-type Computational Phantoms

TG104 Integration of Protection of People and the Environment

TG105 The Environment in the System of RP

TG106 Mobile High Activity Sources

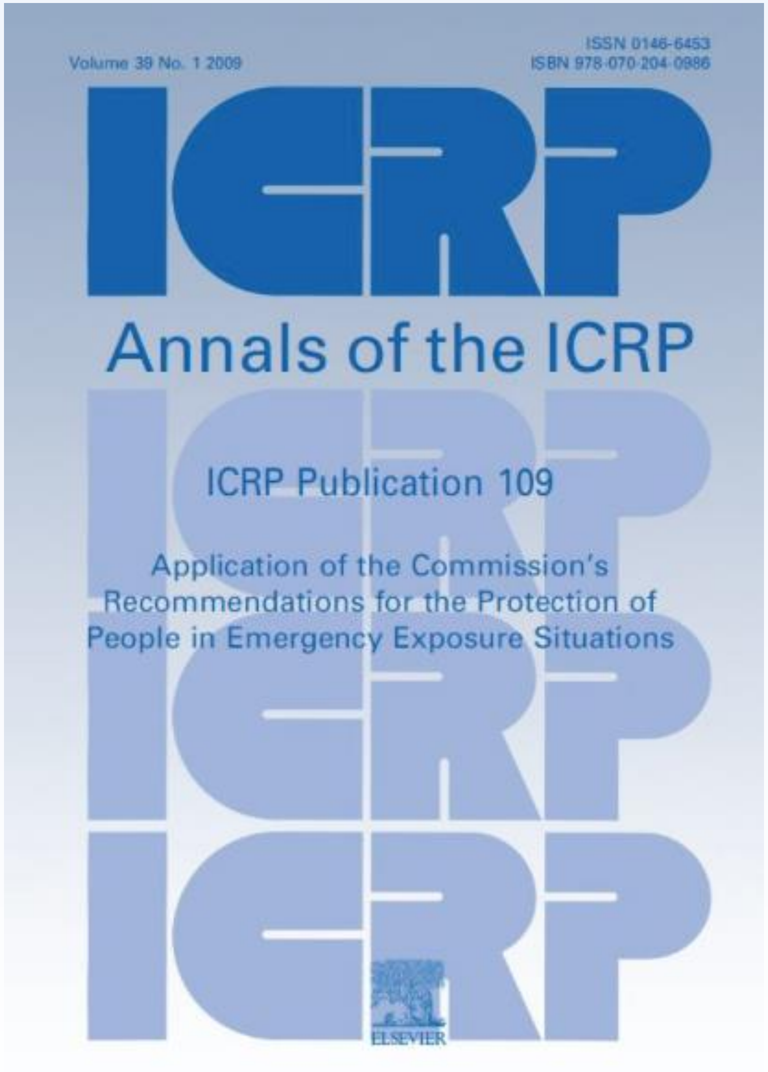
TG108 Optimisation of Protection in Digital Radiography, Fluoroscopy, and CT

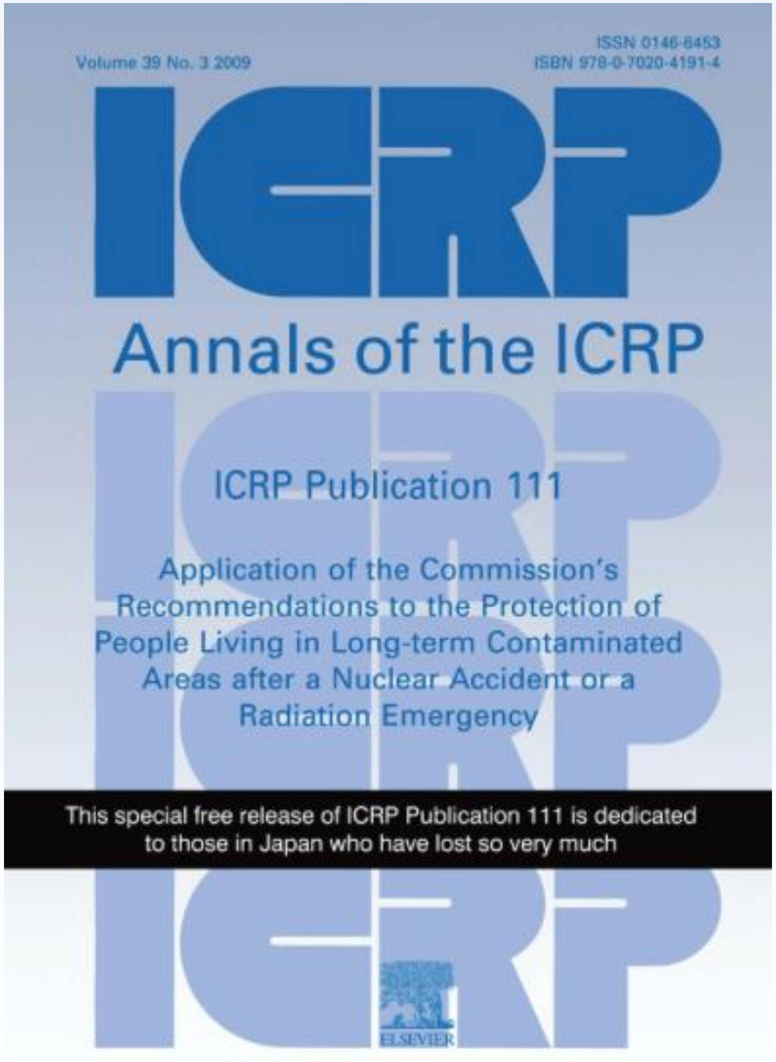
TG109 Ethics in RP in Medicine

TG110 Veterinary Practice

TG111 Individual Response to Radiation

Publications 109 and 111





Task Group 93 Draft Report

Application of the Commission's Recommendations for the protection of people and the environment in the event of a large nuclear accident

- Update of Publications 109 and 111 -

Timeline of an Accident

Preparedness	Emergency Response		Recovery
	Early phase	Intermediate phase	Long-term phase

Emergency exposure situation — Existing exposure situation

Early phase:	**Various protective actions need to be taken promptly**
Intermediate phase:	**The source of the release has been stabilised** **Focuses on characterising the radiological situation on-site and off-site**
Long-term phase	**On site when the source is considered secured enough and the exposure situation sufficiently stabilised** **Off site when the radiological conditions in the affected areas are sufficiently characterised to support decisions by the authorities**

Consequences of Large Nuclear Accidents

- Large nuclear accidents are complex situations
- All dimensions of individual and social life affected
- Situations cannot be managed with radiological protection considerations alone
- Other considerations:
  - Psychological
  - Health
  - Economic
  - Educational
  - Ethical
  - Environmental
  - Cultural

Emergency Response 1

Protection strategy for the early phase

- **Immediate use of pre-planned strategy necessary**
- **Essential all relevant stakeholders involved in plan**
- **Decisions to modify emergency plan should only be taken if planned response proves inappropriate**
- **Those affected should be informed fully, quickly and continuously with regard to:**
  - **What is known**
  - **What is unknown**
  - **Reasons for recommended actions**

Emergency Response 2

Protection strategy for the intermediate phase

- **Active participation of stakeholders brings relevant local knowledge and experience to decision making**
- **Protection strategies more likely to be understood and supported**
- **Key issues should be addressed to characterise exposure situation**
- **Characterisation enables informed planning and implementation of longer terms actions**
  - **Detailed environmental monitoring**
  - **Long-term health surveillance**

Emergency Response 3

Monitoring of individuals during the emergency

- **Thyroid monitoring at early stage important for children and pregnant women**
- **Chernobyl and Fukushima accidents demonstrated value of putting individual exposure in context of other exposures**
- **Benchmarking individual exposure in a relevant context helps with understanding self-help**

Emergency Response 4

Termination of emergency protective actions

- **Decision to terminate individual protective measures needs to reflect prevailing circumstances of the emergency exposure situation**
- **Termination decisions should be transparent, have due regard for the appropriate reference level and for stakeholder concerns whenever possible**

Protection of Emergency Responders

Table 3.1. Reference levels for emergency responders

	Emergency exposure situation	
	Early phase	Intermediate phase
On-site		
Dedicated teams (for radiological intervention) **Emergency teams (fire, police, rescue, medical)** **Plant and outside workers**	100 mSv or below Exceptional circumstances	100 mSv/y or below May evolve with circumstances
Off-site		
Emergency teams	100 mSv or below Exceptional circumstances	n/a
Skilled workers **Other responders**		20 mSv/y or below May evolve with circumstances

Recovery 1

- Management of an existing exposure situation following a nuclear accident relies on the implementation of an integrated and complex rehabilitation programme
- Relevant radiological protection characterised by strategies that include:
  - actions implemented by authorities locally & nationally
  - self-help actions taken by affected population
- For managing long-term contamination, essential system of radiation monitoring and data dissemination are developed to select and implement appropriate protective actions

Recovery 2

In the recovery phase:

- Individual life-styles become key factor to control radiation exposure of those living and working in affected area
- Individual measurements with suitable devices critical to ensure development of practical radiological protection culture
- Establishing process of co-expertise facilitates emergence of such culture in local communities
- Practical RP culture is composed of information, practical knowledge and skills enabling people to judge for themselves the most appropriate approaches

Recovery 3

Health surveillance

- **Main goal of a health surveillance programme to improve health and living conditions of potentially affected populations**

- **Development of health surveys and databases requires communication strategies and RP culture with empowerment of affected population**

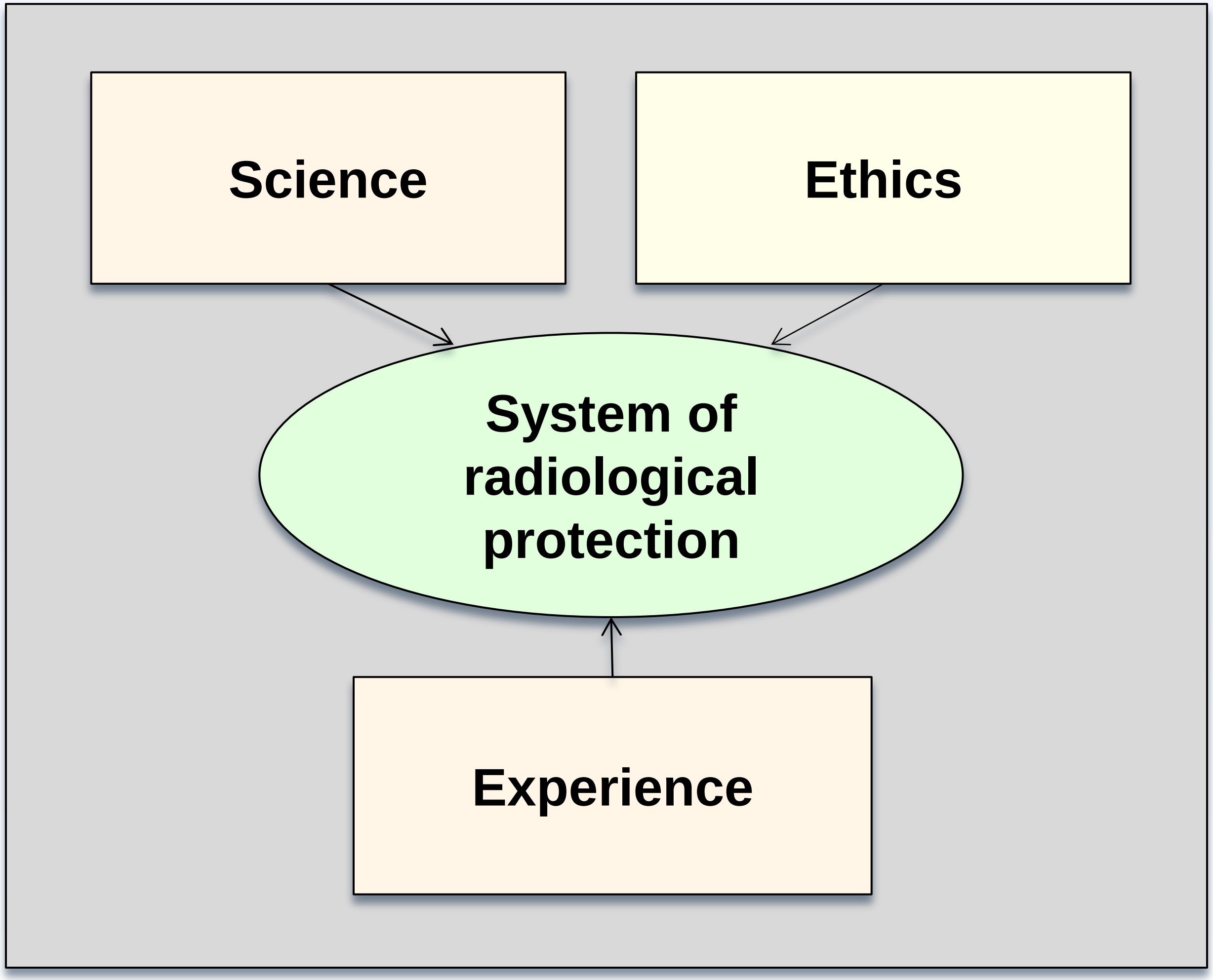
- **Establish links with socio-economic support and dedicated education and training programme for health professionals**

Reference levels for optimising protection in case of nuclear accidents

	Emergency exposure situation	Existing exposure situation
Public	100 mSv or lower [a]	10 mSv/y or lower [a,b] The long term goal is to reduce exposures to the range of 1mSv/y
Responders	100 mSv or lower [a] Could be exceeded in exceptional circumstances [c]	20 mSv/y or lower [a]

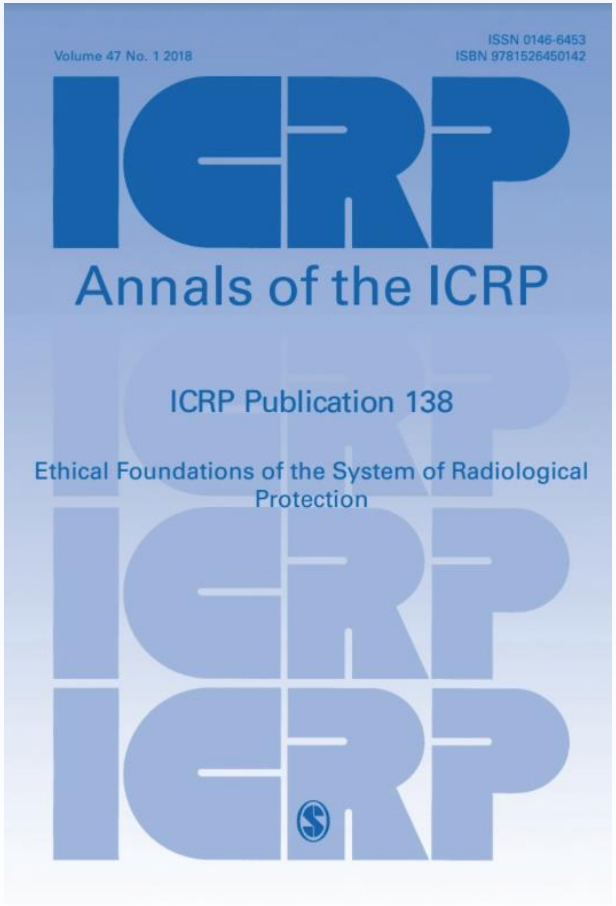
a) Previously the Commission recommended selection of reference levels in the band of 1-20 and 20-100 mSv or mSv/y. The current recommendation recognises that under some circumstances lower reference levels than 20 for emergency and 1 for existing may be appropriate. The optimisation of the thyroid dose from radioiodine should be differently applied. See 2.3.3.3.
b) This clarifies the previous recommendation of the Commission to select reference levels for the optimisation of protection of people living in contaminated areas in the lower part of the 1-20 mSv/y band. See 2.3.3.3.
c) The Commission continues to recommend to take all practicable actions to not exceed 1000 mSv to avoid severe deterministic effects for responders involved in exceptional circumstances during the emergency phase (Ref. ICRP Pub.118)

Three pillars of the system of radiological protection



ICRP and Ethics

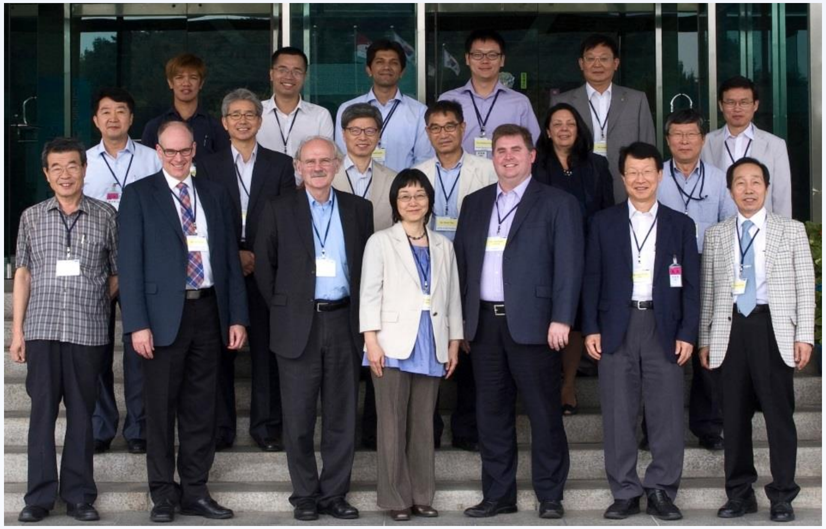
- **ICRP Publication 138 issued in February 2018**
- **First publication dealing explicitly with the ethical dimensions underlying the system of radiological protection**
- **Daily implementation of the system of radiological protection is a matter of what philosophy used to call ‘practical wisdom’**



Development of ICRP Publication 138

- **Task Group of Committee 4 established 2013**
- **Exemplary process of stakeholder involvement organised in collaboration with IRPA**
  - **Series of 8 workshops held worldwide and discussions at both IRPA regional and international congresses and ICRP 2015 Symposium**
  - **Active contribution of more than 150 specialists of ethics and radiological protection professionals**

The workshops on the ethical dimensions of the radiological protection system (1)



Daejeon, Korea, August 2013

Milan, Italy, December 2013

London, UK, June 2014

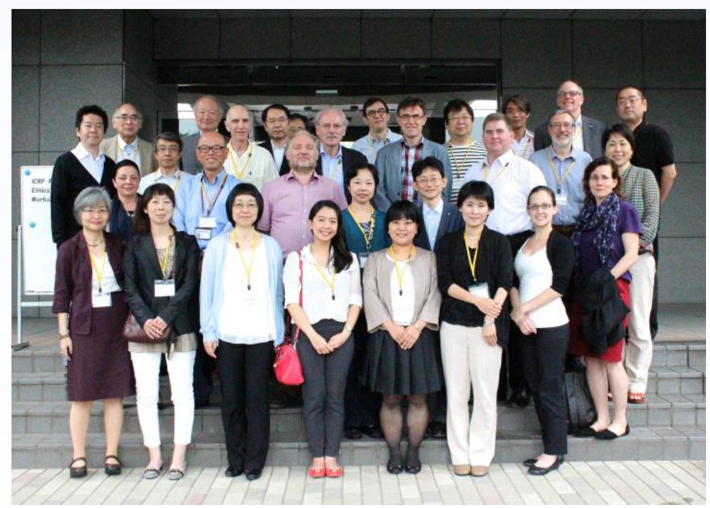
Baltimore, USA, July 2014

The workshops on the
ethical dimensions of the radiological protection system (2)

Budweiz, Czech Republic, June 2014

Madrid, Spain, February 2015

Cambridge, USA, March 2015



Fukushima, Japan, June 2015

Ethical values underpinning the system of radiological protection

Core values

- **Beneficence/non-maleficence**: doing good and avoiding harm
- **Prudence**: if facing uncertainty, avoid unwarranted risks
- **Justice**: fair sharing of benefits and risks
- **Dignity**: respect of individual autonomy

Procedural values

- **Accountability**: to be responsible for one's own action
- **Transparency**: to share available information
- **Inclusiveness**: stakeholder participation

Overall ethical goal is to contribute to the well-being of individuals and the quality of living together

Relationship between core ethical values and fundamental principles

- **Justification**: any decision that alters a radiation exposure situation should do more good than harm – **Beneficence/non-maleficence**

- **Optimisation**: all exposures should be kept as low as reasonably achievable (ALARA) with restriction on individual exposures (Reference levels) to limit inequity and the need to account for views and concerns of stakeholders – **Prudence, justice, dignity**

- **Limitation**: any individual dose should not exceed the level of exposure considered tolerable for workers and the public in planned exposure situations – **Prudence, justice, dignity**

The Optimisation Principle

- Optimisation principle said to be the cornerstone of the system of radiological protection since it governs decisions concerning protective actions taking account of:
  - Particularities of the exposure situation under consideration (economic and societal factors)
  - Views and concerns of stakeholders – inclusiveness
  - Most appropriate human, technical and financial means
  - Ethical values that govern radiological protection
- It is the process in which science, ethics and experience converge in order to choose wisely the best protective actions given the particular circumstances

The Optimisation Process
(ICRP Publication 101b - 2006)

Evaluation of exposure situations to identify the need for actions

↓

Identification of protective actions

↓

Selection of the best action under the prevailing circumstances

↓

Implementation of the protective actions

The Optimisation Process in Practice

This process requires:

- **To master the scientific basis of radiological protection**
- **To adhere to the general purposes of ethics**
- **To listen carefully to stakeholders**
- **To perceive what is required in a particular situation**
- **To share information**
- **To deliberate and choose well**
- **To act effectively, equitably and prudently**
- **To respect the dignity of people**
- **To be responsible for one's own actions**

The above skills are those that characterise what philosophy calls 'practical wisdom'

Ethics Summary

- By eliciting the ethical values that underpin the system of radiological protection, ICRP hopes professionals will gain a clearer view of the societal implications of their decisions
- In the long run, this should help improve dialogue with stakeholders
- Consideration of ethical aspects in practice should enrich the skills of radiological protection professionals
- Will require major effort to disseminate the content of Pub 138 as well as educational and training actions

What next?

- Publication 138 considered by Commission a founding document
- Task Group 109 ‘Ethics in medical diagnosis and treatment of patients’ established April 2018
- Henceforth, all publications will seek to explicitly address the ethical dimensions of radiological protection where possible
- Other Task Groups concerning ethics of radiological protection may be considered in future for particular exposure situations if deemed necessary

TG102 Detriment Calculation Methodology

- **Task Group of Committee 1 established in 2016**

Mandate:

- **Trace the history of detriment in ICRP**
- **Detail the calculation procedure and reproduce the calculations in Publication 103**
- **Assess the sensitivity of detriment to calculation parameters**
- **Identify potential improvements in the detriment calculation procedure**

Solid basis for future recommendations

ICRP and the History of Detriment

- **ICRP *Publication 26 (1977)***

‘*The Commission has introduced the concept of detriment to identify, and where possible to quantify, all these deleterious effects. In general, the detriment in a population is defined as the mathematical “expectation” of the harm incurred from an exposure to radiation, taking into account not only the probability of each type of deleterious effect, but also the severity of the effect*’

- **ICRP *Publication 45 (1985)* revised index of harm**
- **ICRP *Publication 60 (1991)* estimates of fatal cancer with allowances for lethality and morbidity**
- **ICRP *Publication 103 (2007)* cancer incidence rather than mortality data**

Detriment calculation

	① Nominal risks	② Detriment
Steps	1. **C**alculation of lifetime attributable risk 2. **T**ransfer of risk estimates across population 3. **A**pplication of a dose and dose-rate effectiveness factor (DDREF) 4. **S**ex-averaging 5. **I**ntegration of heritable effects	6. **A**djustment for lethality 7. **A**djustment for quality of life 8. **A**djustment for years of life lost
Inputs	✓ Baseline rates ✓ Survival function ✓ Cancer risk models ✓ Age distribution of the population	✓ Lethality fractions ✓ Quality of life factor ✓ Relative duration of life lost
	Step related to radiation	**Step not related to radiation**

Detriment calculation

① Nominal risks ② Detriment

Nominal risk and detriment for the general population (cases per 10 000 per Sv)

(from Tables A.4.1 and A.4.5, ICRP Publication 103, 2007)

Tissue	**Nominal risk coefficient**	Lethality fraction	Min weight for non-fatal cancers	Non-fatal case weight	Relative cancer free life lost	**Detriment**	Relative detriment
	R	k	q_{min}	q	l	D	
Oesophagus	**15**	0.93	0.1	0.935	0.87	**13.1**	0.023
Stomach	**79**	0.83	0.1	0.846	0.88	**67.7**	0.118
Colon	**65**	0.48	0.1	0.530	0.97	**47.9**	0.083
Liver	**30**	0.95	0.1	0.959	0.88	**26.6**	0.046
Lung	**114**	0.89	0.1	0.901	0.80	**90.3**	0.157
Bone	**7**	0.45	0.1	0.505	1.00	**5.1**	0.009
Skin	**1000**	0.002	0.0	0.002	1.00	**4.0**	0.007
Breast	**112**	0.29	0.1	0.365	1.29	**79.8**	0.139
Ovary	**11**	0.57	0.1	0.609	1.12	**9.9**	0.017
Bladder	**43**	0.29	0.1	0.357	0.71	**16.7**	0.029
Thyroid	**33**	0.07	0.2	0.253	1.29	**12.7**	0.022
Bone marrow	**42**	0.67	0.1	0.702	1.63	**61.5**	0.107
Other solid cancers	**144**	0.49	0.1	0.541	1.03	**113.5**	0.198
Gonads (heritable)	**20**	0.80	0.1	0.820	1.32	**25.4**	0.044
Total	**1715**					**574.2**	1

$$D = [(R \times k) + (R \times (1 - k) \times q)] \times l$$

$$q = (1 - q_{min}) \times k + q_{min}$$

Detriment calculation

Reproducing the detriment calculation procedure of the ICRP Publication 103

- **Allowed to resolve ambiguities in the calculation procedure (lifetime risk calculation method, lag time, lifetime age, transfer weighting…)**
- **Identified needs for updates (baseline rates, risk models, lethality fractions…)**
- **Identified lack of internal consistency (WT for cancers of the brain and of salivary glands without risk calculation…)**
- **Highlighted difficulties in understanding the meaning of detriment**

Sensitivity Analyses

Sensitivity analyses showed:

- **Limited sensitivity of detriment to latency, lifetime age, lifetime risk calculation method or quality of life**
- **Noticeable sensitivity to gender and population for certain cancer types**
- **Large sensitivity of detriment with DDREF, age-at-exposure, transfer model (100% ERR or 100% EAR model) and lethality**

Detriment Summary

Calculation of radiation detriment

- Concept first introduced in ICRP Publication 26 (ICRP, 1977) Methodology and scope has been evolving over time to consider new scientific knowledge about health effects of radiation exposure at low doses
- Calculation process consists of two main parts:
  - 1. based on the modelling of cancer radiation-induced risks
  - 2. based on the health consequences of cancer
- Complex calculation process implying a certain number of input data, parameters, calculation steps, and underlying hypotheses, which need to be clearly and fully documented
- Detriment is an integrated health risk indicator, calculated as a sex, age and population weighted mean and the severity-adjusted lifetime risk attributable to radiation exposure

Detriment Summary

Suggestions for potential future improvement

- To evolve depending on progress in scientific understanding of radiation health effects and the evolution of cancer consequences
  - To update and improve reference population data and cancer severity parameters
  - To consider new cancer risk models (LSS and other epidemiological studies, risk models for bone, skin, brain, salivary glands cancers)
  - To consider and justify whether or not to include non-cancer effects in radiation detriment
- To calculate detriment for both sexes and selected ages, and to average only at the last step
- To consider low dose exposure scenarios
- To ensure transparency and traceability of detriment calculation, and to improve understanding by non-specialists

ICRP Evolution

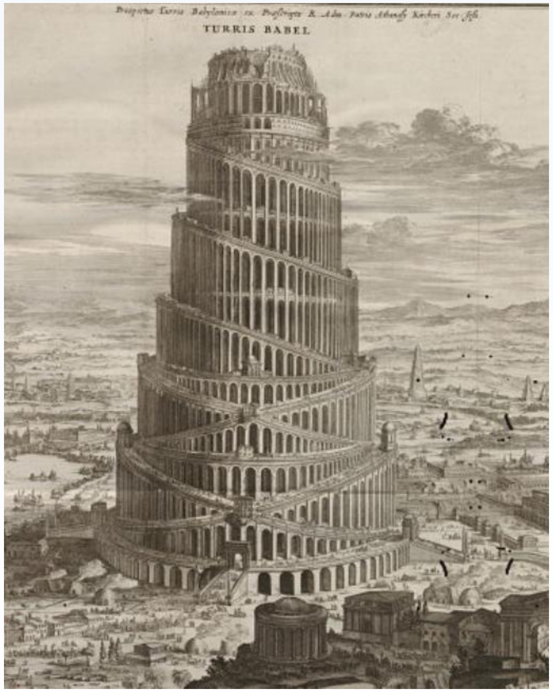
From 1928…

Missing Giulio Ceresole

…To 2018

ICRP 2009

- **Mainly elderly males**
  ('Old Boys' Club')
- **Lack of transparency**
  ('The ivory tower')



ICRP Evolution

- Established biennial symposia
- Established Special Liaison Organisations
- Written Strategic Plans
- Held open nominations for Committee members (25% change each term)
- Change of publisher from 2013

Relations with other Organisations

EUROPEAN ALARA NETWORK

IAEA
International Atomic Energy Agency

NCRP
National Council on Radiation Protection and Measurements

International Organization for Medical Physics
IOMP

World Health Organization

EUROPEAN RADIOECOLOGY ALLIANCE

NEA
Nuclear Energy Agency

FORO

UNSCEAR

MELODI

ISR
The International Society of Radiology

IRPA

ILO
International Labour Organization

European Commission

ENISS

industriall
global union

IEC
IEC Nuclear Instrumentation (IEC/TC45)

IEC
IEC Electrical Equipment in Medical Practice (IEC/TC62)

ICRU

EURADOS

Conference of Radiation Control Program Directors, Inc.
CRCPD
Est. 1968

ISOE
Information System on Occupational Exposure

WORLD NUCLEAR ASSOCIATION

HERCA
HEADS OF THE EUROPEAN RADIOLOGICAL PROTECTION COMPETENT AUTHORITIES

NERIS

EURAMED
European Alliance for Medical Radiation Protection Research

ICRP Evolution

- Developed ICRP Code of Ethics
- Strengthened Secretariat
- Changed Constitution
- Organisational restructure with four Committees instead of five
- Updated website

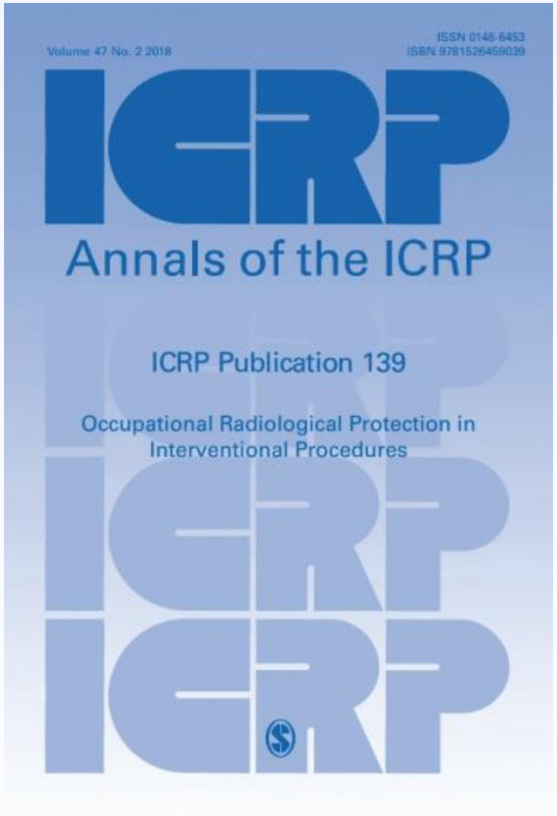
Protection of the Environment

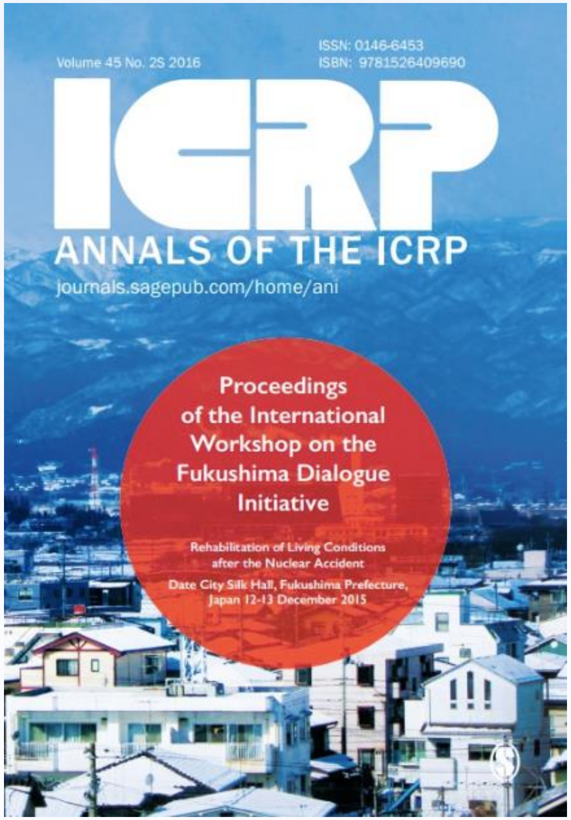
- Several publications trace development from initial framework to information for implementation
- Protection of the environment will now be fully integrated into the one system of radiological protection

90^{th} Anniversary Drive to Free the Annals

- **Currently: First 60 years Publications (1928-1988) and last general recommendations *Publication 103* free of charge**
- **Goal: make all ICRP publications freely available (except most recent rolling two years)**
- **Needed: €500,000**

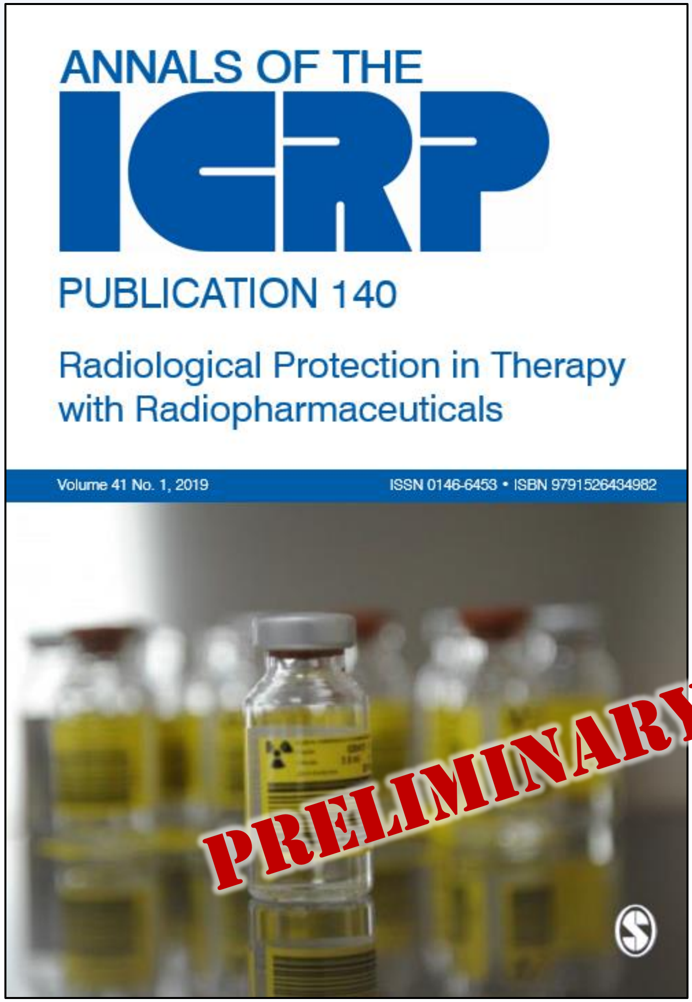
New Look Annals





"Don't judge a book by its cover"

Coming Soon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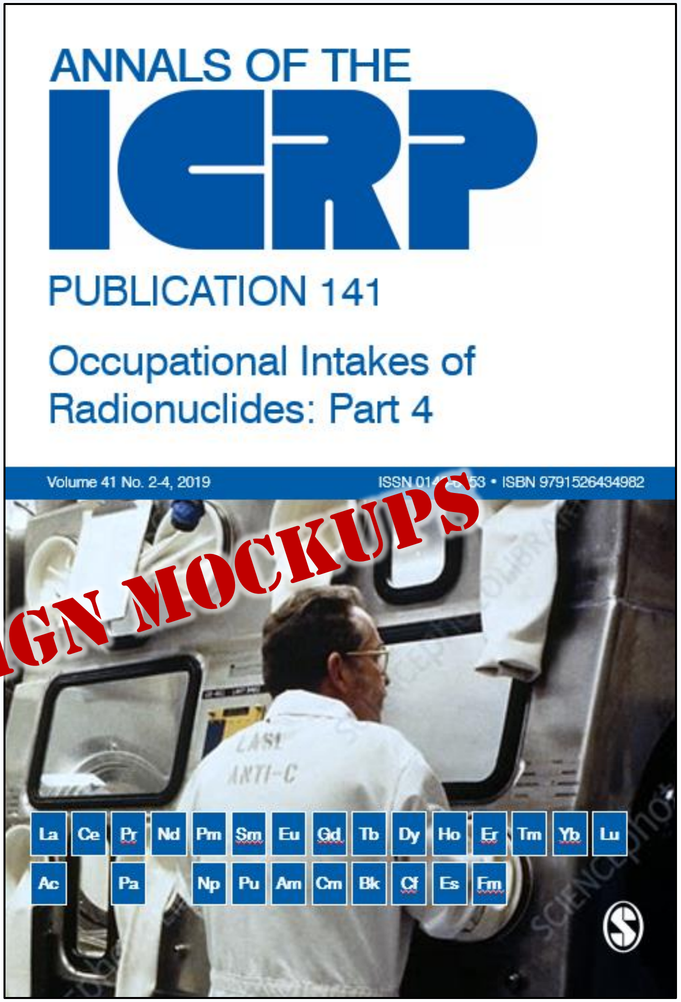
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Ac Pa Np Pu Am Cm Bk Cf Es Fm
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ICRP2019

5TH INTERNATIONAL SYMPOSIUM ON THE SYSTEM OF RADIOLOGICAL PROTECTION

19-21 NOVEMBER 2019 · ADELAIDE, SOUTH AUSTRALIA

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Australian Government

Australian Radiation Protection and Nuclear Safety Agency


2nd International Congress of Radiology
Hasselbacken, Stockholm • 23 July 1928

Celebrating 90 Years of ICRP 1928-2018

Hasselbacken, Stockholm • 16 October 2018

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Main Commission Members:

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