Introduction and History of DDREF

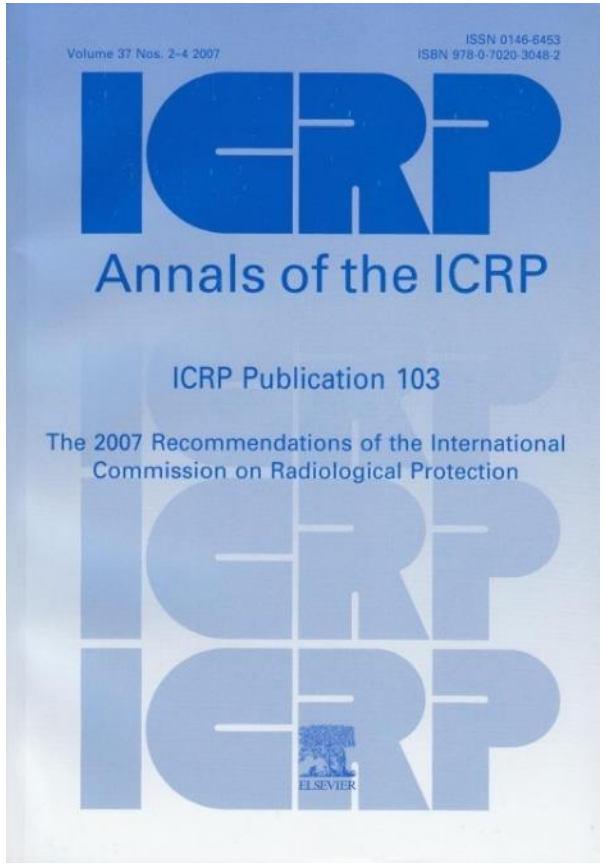
TG91 Workshop

Radiation Risk Inference at Low-Dose and Low-Dose-Rate Exposure for Radiological Protection Purposes

May 28, 2025

Werner Rühm
ICRP Chair
TG91 Chair
BfS, St-ZS

System Review: Time for Action!



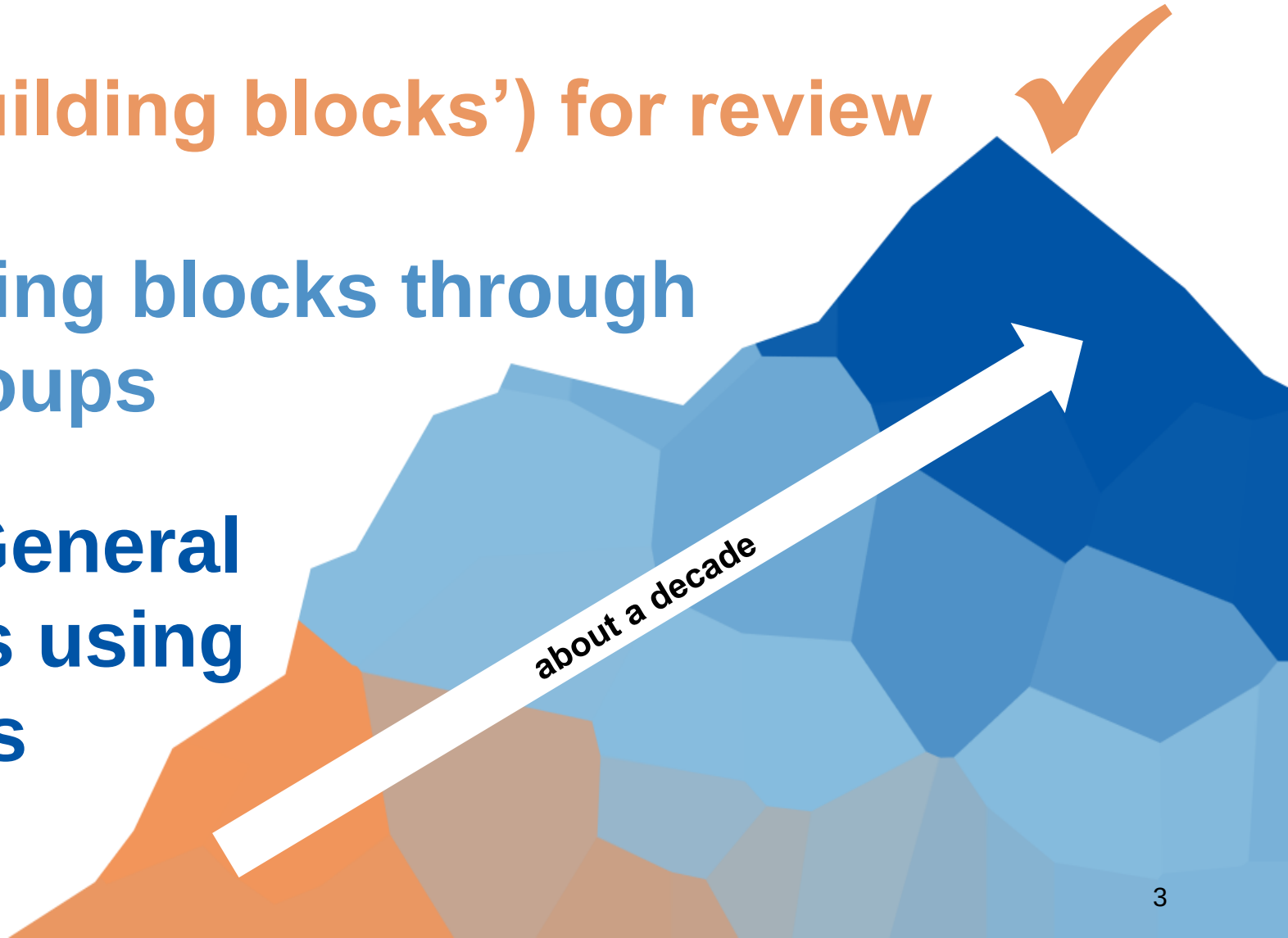
- ICRP Publication 103 forms the basis of radiological protection all over the world
- It is time now to review Publication 103 given scientific and societal progress made since 2007
- Identify **basic open questions** (“building blocks”): essential work required for the next general recommendation

Review & Revision of the System of RP

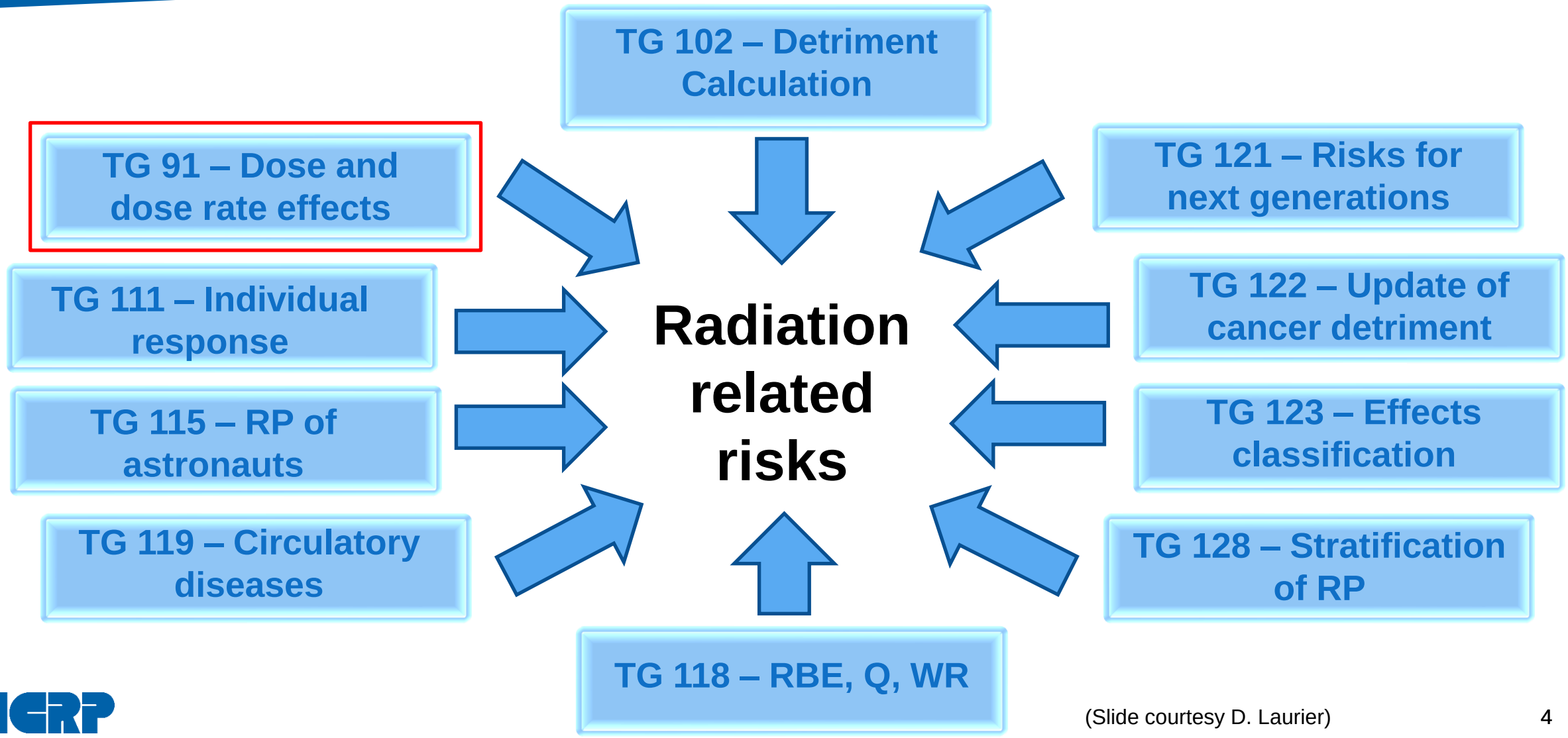
Identify topics ('building blocks') for review ✓

→ Develop building blocks through ICRP Task Groups

Prepare the next General Recommendations using the building blocks

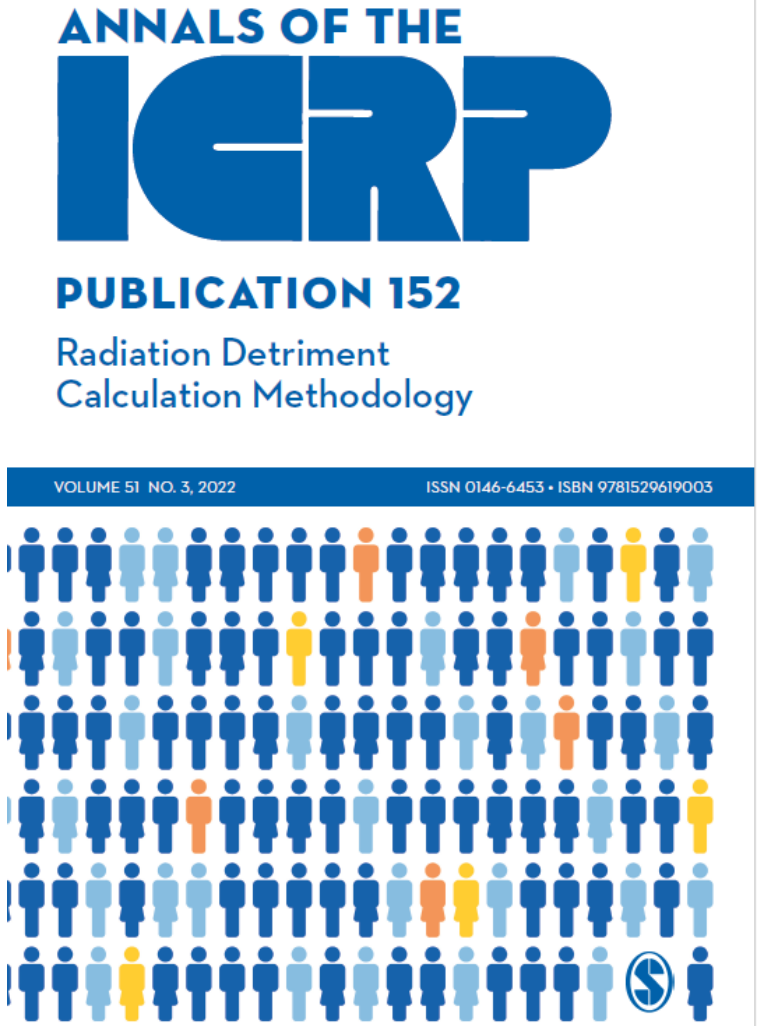


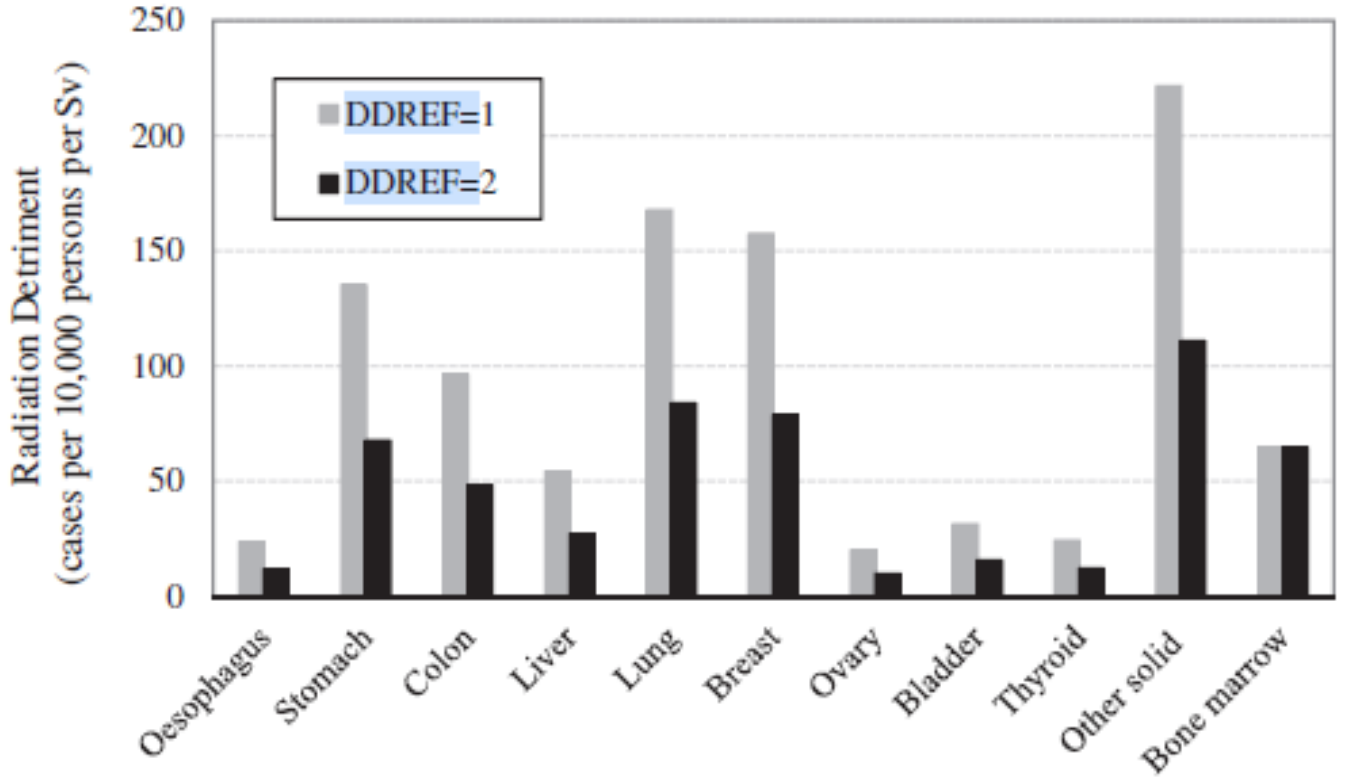
Integration of TGs under C1



(Slide courtesy D. Laurier)

Role of DDREF in detriment calculation





„At a glance, **changing DDREF from 2 to 1** appears to have a major effect, as it **doubles the detriment** for all solid cancers“ (ICRP Publ. 152, para 101)

Task Group TG91: “Radiation Risk Inference at Low-dose and Low-dose Rate Exposure for Radiological Protection Purposes: Use of Dose and Dose Rate Effectiveness Factors”

Werner Rühm **(Chair)**, Federal Office for Radiation Protection (BfS), Germany
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Kotaro Ozasa **(Member)**, Kyoto Prefectural University of Medicine, Japan
Kazuo Sakai **(Member)**, Tokyo Healthcare University, Japan
Roy E. Shore **(Member)**, New York University School of Medicine, USA
Quanfu Sun **(Member)**, National Institute for Radiological Protection, China
Linda Walsh **(Member)**, University of Zurich, Switzerland
Gayle Woloschak **(Member)**, Northwestern University, USA
Franklin Eze **(Technical Secretary)**, Mercy Radiology, New Zealand

Current Situation

- ICRP uses risk estimates from high dose rate study (atomic bomb survivors)
- Suggests a dose and dose rate effectiveness factor (DDREF) of 2 to apply those risk estimates to the occupational setting

>> TG91 to review the current scientific evidence with focus on LDEF (low dose effectiveness factor) and DREF (dose rate effectiveness factor)

- **Low dose: < 100 mGy**
- **Low dose rate: < 0.1 mGy / min averaged over 1 hour**

TG91 ICRP-Workshop on DDREF

TG91 Draft Report is online for public consultation

- Since 12 March 2025
- Report describes the **Scientific Evidence** Relevant to the Assessment of **Solid Cancer** Radiation Risk at Low Dose and Low Dose Rate.
- Report is available **until 13 June 2025**
- Workshop addresses **important points** of the report through presentations by Task Group members. Attendees will have an opportunity to participate through a **moderated Q&A session**

The draft report – content and major points

ICRP
DRAFT REPORT FOR CONSULTATION: DO NOT REFERENCE
ICRP ref: 4904-3744-8231

Annals of the ICRP

ICRP PUBLICATION XXX

Scientific Evidence Relevant to the Assessment of Solid Cancer Radiation Risk at Low Dose and Low Dose Rate

Editor-in-Chief
C.H. CLEMENT

Associate Editor
K. NAKAMURA

Authors on behalf of ICRP
xxx

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TG91 ICRP-Workshop on DDREF

Programme

Reflects the content of the report

12:00 UTC 
Introduction and History of DDREF
Werner Rühm (ICRP & BfS, Germany)

12:10 UTC 
Evidence from Cellular Studies
Simon Bouffler (ICRP & UKHSA, UK)

12:20 UTC 
Evidence from Experimental Animals
Gayle Woloschak (Northwestern University, USA)

12:30 UTC 

Evidence from Epidemiology & Dose Rate Meta Analyses
Linda Walsh (University of Zurich, Switzerland) & Roy Shore (New York University School of Medicine, USA)

12:40 UTC 

Evidence from Epidemiology & Dose Curvature Analyses
Mark Little (National Institutes of Health, USA) & Kotaro Ozasa (Kyoto Prefecture University of Medicine, Japan)

12:50 UTC 

Evidence from Mechanistic Modelling
Michiaki Kai (Nippon Bunri University, Japan) & Werner Rühm (ICRP & BfS, Germany)

13:00 UTC 
Conclusions of the Report
Werner Rühm (ICRP & BfS, Germany)

13:10 UTC
Q&A

A Bit of History

NCRP 1980

- Introduced the "dose-rate effectiveness factor (DREF)"
- For a variety of endpoints **in animal models values between 2 and 10 were observed**

UNSCEAR 1988

- "*… such a factor certainly **varies very widely with individual** (human) **tumour type** and with dose rate range. However, an appropriate range to be applied … should lie between 2 and 10*"

ICRP 1991

- Introduced the "Dose and Doserate Effectiveness Factor (DDREF)" **with a value of 2**
- Acknowledged that the chosen **value of 2 might be somewhat arbitrary**, and it was felt that **it may be conservative**

UNSCEAR 1993

- **Suggested a value of about 2 for DDREF**, based on radiobiological information, animal data, and human data from epidemiological studies
- **Substantial uncertainties with this value were acknowledged**

A Bit of History

UNSCEAR 2006 (approach confirmed recently in 2017)

- Fitted the LSS data using a dose-response curve that included a quadratic component
- In this way, an LDEF was implicitly taken into account
- *Values of DDREF of about 2 consistent with this approach*

BEIR VII, 2006 (US)

- Bayes analysis yielded a range of values: 1.1 – 2.3 with a point estimate of 1.5

WHO 2013 (Fukushima Report)

- Did not use a DDREF

SSK 2014 (Germany)

- Suggested a DDREF of 1

SENES Report 2017 (To be used in the US for compensation claims)

- Suggests 1.3 (50%) and a range of values of 0.47 – 3.46 (5% – 95%)

Review done ✓

In Rühm, W., Woloschak, G. E., Shore, et al. (2015) Dose and dose-rate effects of ionizing radiation: a discussion in the light of radiological protection. Radiat Environ Biophys 54: 379-401

TG 91 WORKSHOP

RADIATION RISK INFERENCE AT LOW-DOSE AND LOW-DOSE RATE EXPOSURE FOR RADIOLOGICAL PROTECTION PURPOSES

28 MAY 2025

THANK YOU!

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