Views regarding upcoming changes in Dose and Dose-Rate Effectiveness Factor (DDREF) at low dose

WNA – ICRP Webinar

Enabling Sustainable Development through the System of Protection

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Chair of Committee 1

INTERNATIONAL COMMISSION ON RADIOLOGICAL PROTECTION

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Dose and Dose Rate Effectiveness Factor: Current situation and objectives

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
- Last update in *ICRP Pub 60* (1991)

Objectives of TG91: "Radiation Risk Inference at Low-dose and Low-dose Rate Exposure for Radiological Protection Purposes: Use of Dose and Dose Rate Effectiveness Factors"

- To provide update on the Low Dose and Dose-Rate Effectiveness Factor (DDREF)
- To review the current knowledge on the effects of low doses and low dose rates at the molecular, cellular, animal and human levels
- To estimate potential values for Low Dose Effectiveness (LDEF) and Low Dose Rate Effectiveness (DREF)

Definition of low dose and dose rate (UNSCEAR 2015)

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

TG91: Membership

Werner Rühm (Chair), Federal Office for Radiation Protection (BfS), Germany
Tamara Azizova (Member), Southern Urals Biophysics Institute, Russian Federation
Simon Bouffler (Member), UK Health Security Agency, United Kingdom
Michiaki Kai (Member), Nippon Bunri University (NBU), Japan
Mark P. Little (Member), National Institutes of Health, USA
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

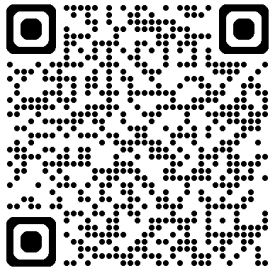
TG91: Work performed

Work done

- Historical development
- Cellular radiobiological studies
- Animal studies
- Epidemiological studies – low dose rate effects
- Epidemiological studies – low dose effects

Publications

- 15 articles published in the scientific literature



Draft report: “Scientific Evidence Relevant to the Assessment of Solid Cancer Radiation Risk at Low-Dose and Low-Dose-Rate”

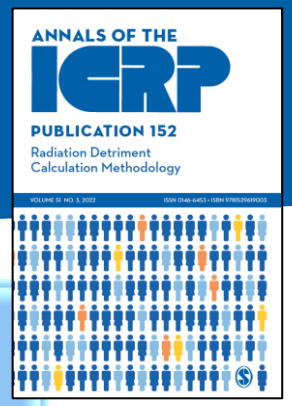
- Pre-consultation phase (July-Sept 2024): IAEA, IARC, MELODI, NCRP, OECD-NEA, UNSCEAR, WHO, WNA
- Public consultation scheduled for T1 2025
- Publication expected in 2025-26

TG91: Main points

(from the pre-consultation draft report – May change)

- This report evaluates the **current scientific evidence on low-dose and low-dose-rate biological effects of ionising radiation**, in terms of the low dose effectiveness factor (LDEF) and the dose rate effectiveness factor (DREF). The combined concept of DDREF, which basically represents an approach to be applied for radiological protection purposes, is not the focus of this report.
- For somatic **cell mutation, cell transformation and cytogenetic endpoints**, numerical evaluations of both DREF and LDEF provide values of around 4 and below.
- Recent pooled analyses of data from **experimental animals** mostly suggest LDEF and DREF values between 1 and 2 for life-shortening and for all solid cancers combined, with considerable variation depending on tumour type.
- Recent **meta-analyses of epidemiological data** for all solid cancers point toward DREF values between about 1 and 3, taking account of the uncertainties involved in these estimates.
- **Analyses on curvature** in the incidence and mortality data from the Japanese atomic bomb survivors find consistent evidence of curvature, so that evaluated population risks per Gy for all solid cancer mortality evaluated at 1 Gy are about twice those evaluated at 0.01 Gy. They tend to support a sex-averaged LDEF value of between 1 and 2 for all solid cancers combined, with some indication of variation between different cancer sites.
- **The overall conclusion of this report is that LDEF and DREF values much larger than 3 or less than 1 are unlikely**. These ranges appear largely consistent for the various sources of data reviewed in this report and are narrower than earlier ranges but have residual uncertainties.

Integration with other C1 TGs



TG 102 – Detriment Calculation

TG 91 – Dose and dose rate effects

TG 121 – Risks for next generations

TG 111 – Individual response

TG 122 – Update of cancer detriment

TG 115 – RP of astronauts

TG 123 – Effects classification

TG 119 – Circulatory diseases

TG 128 – Stratification of RP

Radiation related risks

TG 118 – RBE, Q, WR

Some challenges for the assessment of health risks at low doses and low dose rates

- **Shape of the dose-risk relationship**
  - DREF and LDEF
  - LNT
  - Variations with sex, age, region
  - Differences between cancer sites
- **Severity of cancers**
  - Lethality, quality of life, loss of life
- **Non-cancer diseases**
  - Hereditary effects
  - Long-term non-cancer effects (Diseases of the circulatory system, lens opacities)
- **Interpretation of risks at low-doses**
  - Clarification of the Detriment
  - Improvement of risk communication

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