



**Fachverband für  
Strahlenschutz e.V.**

Für Deutschland und die Schweiz  
Mitgliedsgesellschaft der IRPA  
International Radiation Protection Association

## **German-Swiss Association for Radiation Protection:**

### **Comment on the ICRP draft on “Detriment Calculation Methodology”**

Adopted on April 28, 2020 by the FS-Board of Directors

## Comment on the ICRP draft on “Detriment Calculation Methodology”

The draft on „Radiation Detriment Calculation Methodology” gives a very much needed explanation of one of ICRP’s basic concepts to quantify radiation risk. Since the concept of detriment is difficult to explain to non-specialists, it is very welcome. The historical reflection is particularly interesting and helps to understand the development of our knowledge about radiation risk.

However, the draft does little to make the concept more understandable. This depends on some formal aspects which are listed below.

### Formal aspects

The definitions of the quantity detriment are not given in a clear way. In the draft, the ICRP 60 detriment is defined in a footnote of Table 2.3, in ICRP 103 the detriment is defined in a footnote in Table 3.6, and in the draft the detriment according to ICRP 103 is again defined in a footnote in Table 3.6. There are equations in the draft which have a prominent place, i.e. a line for them, but not the equations defining the main topic of the draft. The detriment definitions should be given at prominent places and explained in more detail.

Moreover, the definitions in ICRP 103 and the draft use different notations without giving a reason for them.

**ICRP 103:** The detriment D is based on incidence, modified for mortality, quality of life, life lost

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

R the nominal risk coefficient

q lethality

$(1 - q_{min}) q + q_{min}$  weight given to non-fatal cancers

$q_{min}$  the minimum weight for non-fatal cancers

**ICRP draft:** The detriment D is based on incidence, modified for mortality, quality of life, life lost

$$D = \left[ (R \times k) + (R \times (1 - k) \times q) \right] \times l \text{ with } q = k + q_{min} \times (1 - k)$$

R Nominal risk coefficient

k Lethality fraction

$q_{min}$  Min weight for non-fatal cancers

q Non-fatal case weight

l Relative cancer free life lost

These differences confuse the reader und should be avoided, if there are not well explained reasons for changing the notations.

The different notations between ICRP 60 and ICRP 103 are meaningful since ICRP 60 is based on mortality and modified for life lost, while ICRP 103 is based on incidence rather on mortality. But, also this difference must be made clearer.

The large difference seen for total fatal cancer in ICRP 26/ICRP 45, on the one hand, and ICRP 60, on the other, should be discussed. The change from additive risk to multiplicative risk model must be mentioned and discussed.

### **Fundamental critics**

The concept of detriment tries to quantify the radiation risk as detailed as possible. Detriment is one of several existing approaches to such quantification. The question, however, which remains open, is whether or not there is enough reliable information for a detailed modelling.

ICRP 60: Total detriment for a whole population  $D = 725,3 \times 10^{-4} \text{ Sv}^{-1}$ .

ICRP 103: Total detriment for a whole population  $D = 574 \times 10^{-4} \text{ Sv}^{-1}$ .

The difference is to a great deal due to the lower estimate for hereditary diseases in ICRP 103 and reveals a change of knowledge between ICRP 60 and ICRP 103. But also other contributions to the detriment have changed significantly.

The two detriment estimates demonstrate the relative stability of our knowledge, in spite of the fact that many of the quantities involved change with time, such as e.g. the mortality as a consequence of improving health care and the incidence as a consequence of aging populations.

But, if one compares the detriment data according to ICRP 60 and ICRP 103 in detail, there are significant differences in the data. These differences, going up to a factor of two, should be explained and discussed.

The question whether or not the two estimates differ depends on the uncertainties associated with the estimates. However, the uncertainties associated with the estimates cannot be quantified. They are only investigated using a sensitivity analysis.

It is highly appreciated that the draft presents a sensitivity analysis for the calculation of the detriment in chapter 4. The sensitivity analysis reveals several sources of uncertainty, the DDREF being the dominant source. Also the "arbitrary" choices of the risk models (ERR or AER) have large impact on the results. Given the large uncertainties revealed by the sensitivity analysis, the methodology of detriment calculation appears to be a scientific overkill.

What should be done? The draft discussed the potential evolution. It proposes more detailed modelling of the detriment while it is highly questionable, given the large uncertainties, that more detailed modelling will solve the basic problems.

The concepts of detriment, of the effective dose, and of the DDREF are closely related. They have to be re-evaluated together, on the long term.

A frequent re-evaluation has severe consequences for the definition of the effective dose because e.g. of the changes in the tissue weighting factors. Stability is of great relevance for radiological protection. Changes of the basic quantities should only be made if there is good reason for them and the changes should do more good than harm for the system.

The problems related to the basic concepts of radiological protection should be made clearer and a discussion should be initiated how the problems can be overcome.