Towards Comprehensive Radiological Protection for Public using Background-Cancer-Risk Based Approach

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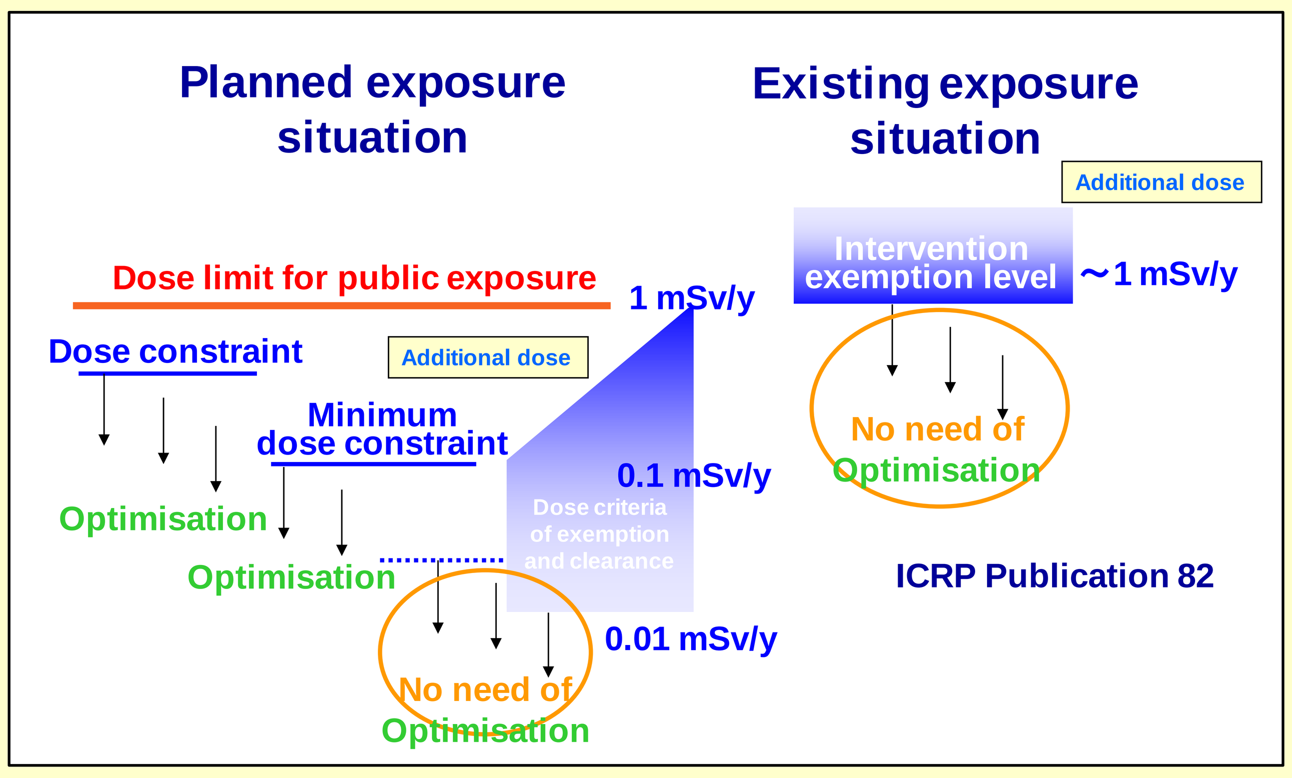
Introduction

- The International Commission on Radiological Protection (ICRP) has NOT stated in Pub. 103 the lower bound of optimization where radiation dose does not have to be reduced, since the use of a linear non-threshold (LNT) model is considered to be the best practical approach to managing risk from radiation exposure.
- This induces much public concern against extremely low level radiation exposure post Fukushima nuclear accident.
- Public has a significant confusion on a meaning of 1 mSv y^{-1} between planned and existing exposure situations.
- The meaning of 1 mSv y^{-1} in the planned exposure situation is a dose limit for public, but in the existing exposure situation is intervention exemption level.

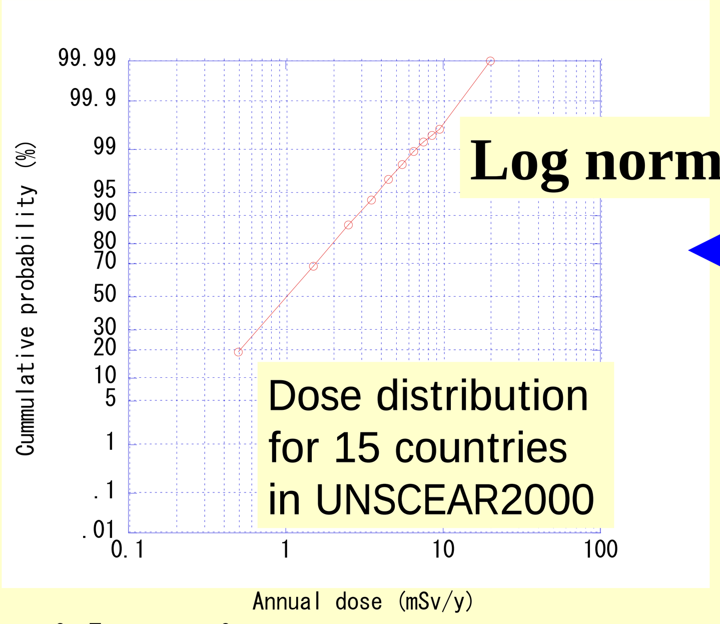


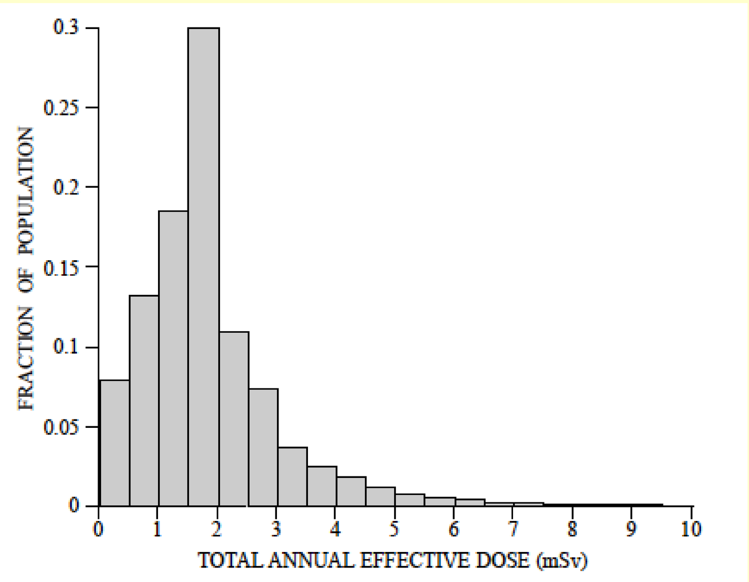
Background-Cancer-Risk-Based Approach

Ref. T. Hattori, Understanding of minute assumed risk due to radiation from man-made radioactive nuclides taking into consideration quantitative comparison with detriments based on background cancer mortality in Japan, Jpn. J. Health Phys., Vol 45, No. 2, pp172-176 (2010).

1. Dose Distribution due to Natural Background Radiation

- UNSCEAR 2000
- Worldwide average exposure to natural BG radiation = 2.4mSv/y
- The example of the dose distributions in the 15 countries





Nearly equals

Arithmetic mean : 2.5mSv/y

Log normal distribution is assumed with 2.0mSv/y for geometric mean (GM) & 2.0 for geometric standard deviation (GSD)

2. Dose Distribution due to Manmade Nuclides

- Dose distribution of radiation due to a manmade source that members of the public may be exposed to was assumed to be lognormal referring UNSCEAR 1993.
- Lognormal distributions are determined by GM and GSD.
- Because both natural and manmade nuclides are distributed in the environment in the same way, the dose distributions of radiations due to natural and manmade nuclides would be similar to each other.
- For this reason, the GSD of a dose distribution of radiation due to manmade nuclides was assumed to be 2.0.
- The assumption of an appropriate GM is closely related to the requirement for compliance with dose constraint using the concept of a representative person in ICRP Publication 101.
- When using the concept of the ICRP, it can be proven theoretically using the following equation that the 95th percentile of the dose distribution for the representative person is always lower than the dose constraint.

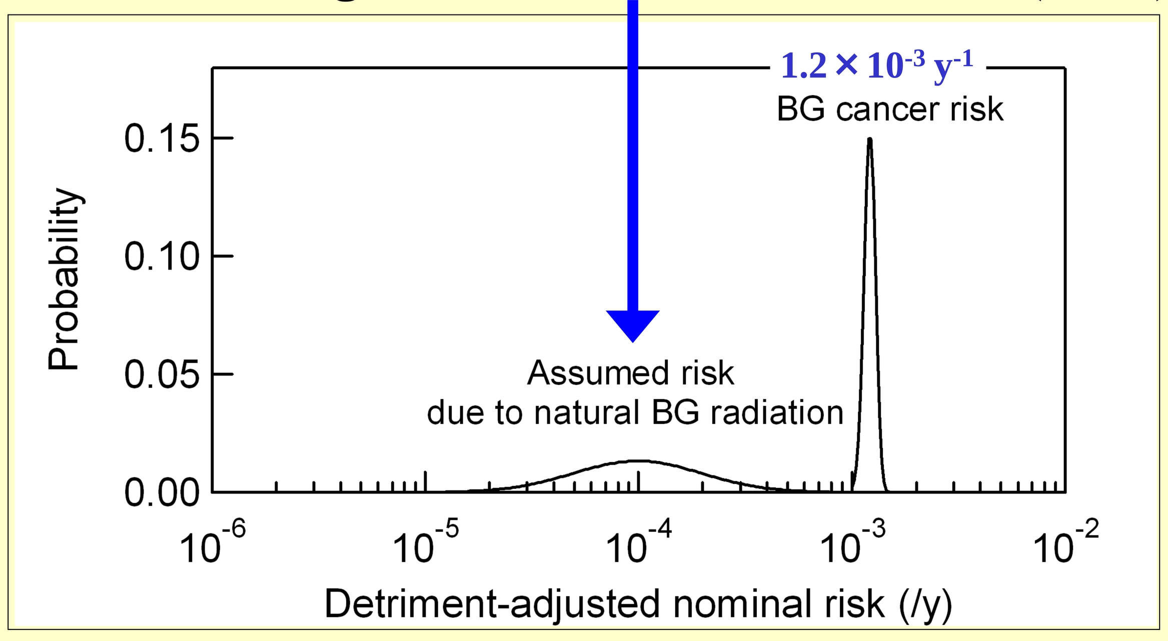
  DC > 95th percentile, (1)

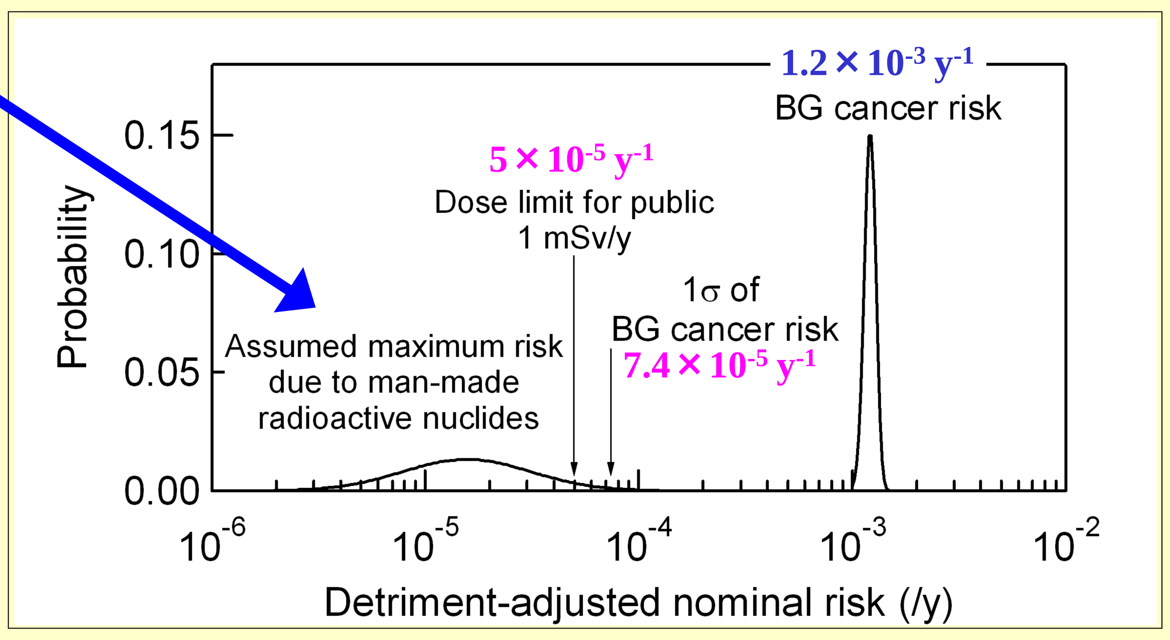
- where DC is the dose constraint (mSv/y) and 95th percentile is that of the dose distribution for the representative person (mSv/y). In the case of a log normal distribution, the 95th percentile can be obtained from the GM and GSD as

  95th percentile = GM x $GSD^{1.645}$. (2)

- If a value of 2.0 is given to the GSD, then equation (2) can be expressed as

  DC > GM x 3.13. (3)

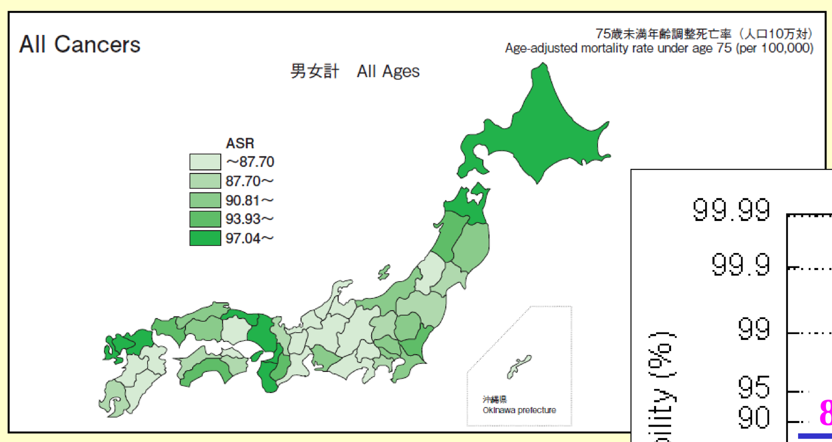


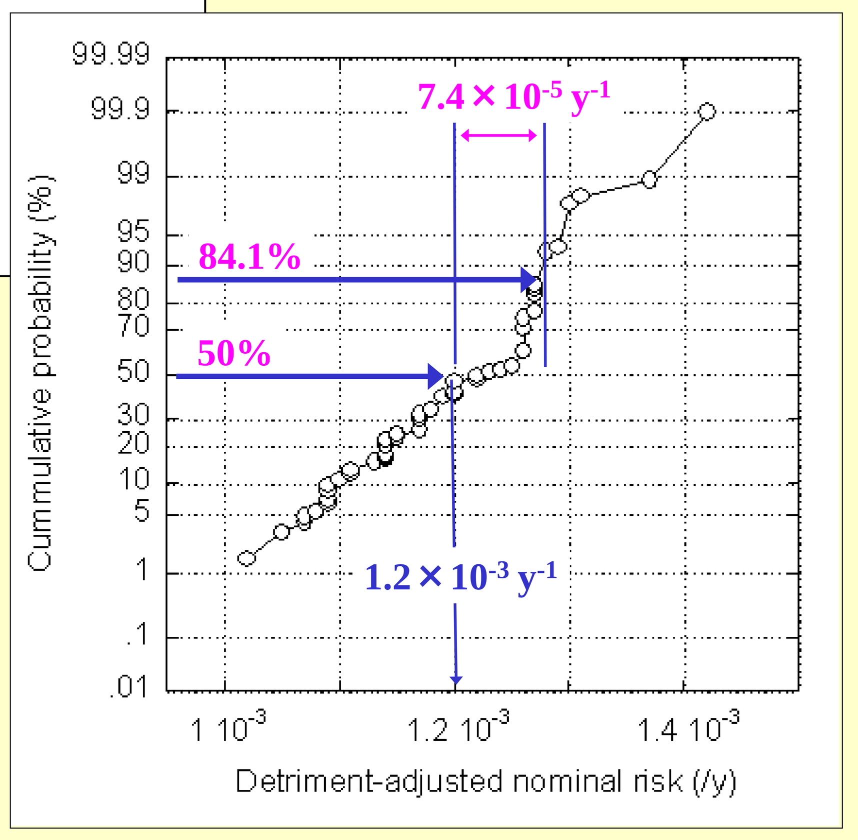


- ICRP considers it appropriate to use the overall fatal risk coefficient of 5% Sv^{-1} as provided in Pub. 103.
- Therefore, using this risk coefficient, the dose limit for the public (1 mSv y^{-1}) is equivalent to a risk of approximately 5×10^{-5} y^{-1}.

3. Probability distribution of detriment-adjusted risk determined on the basis of background cancer mortality

- The background cancer risk can be derived from detriment-adjusted risk estimated using spontaneously occurring cancer incidence data in place of the Life Span Study (LSS) data (*a long-term cohort study on health effects in the Japanese atomic bomb survivors in Hiroshima and Nagasaki*) in which ICRP used cancer incidence data.
- The background cancer risk was derived using detriment-adjusted risks for 47 prefectures that were weighted by the population of each prefecture to obtain the probability distribution (frequency distribution) of detriment-adjusted risk.
- The standard deviation of the background cancer risk corresponding to 1 σ is 3.8 $\times10^{-4}$ y^{-1}.
- This risk level is equivalent to 1.5 mSv y^{-1} if an overall fatal risk coefficient of 5%Sv^{-1} is used for conversion between risk and dose, although radiation exposure in such a low-dose region of 1 mSv y^{-1} or lower may not produce any actual additional risk.
- It should be noted that the background risk due to spontaneously occurring cancers includes all the risks associated with a possible cancer risk that might arise from ingesting carcinogens and medical exposure.





Discussions & Conclusions

- It is a reality that people normally would like to avoid any additional risk.
- However, they are not aware of the local difference in cancer mortality in their country at all.
- The risk communication using the local difference in background cancer mortality was actually an effective way to reduce their too much concern against low level radiation exposure in Fukushima residents (Fukushima-shi, Koriyama-shi and Minami-soma-shi).
- It would be a time to set 1 mSv y^{-1} as a lower bound of optimization toward comprehensive radiological protection for public.