Regulatory low dose limits: from science to political correctness?

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Abstract: The setting of regulatory low dose limits has become a topic of central importance for further radiation uses because of its close relationship to:

- the public acceptance of nuclear power as a safe, inexpensive, reliable, ecologically beneficial, and climatically neutral source of electricity
- the use of various highly beneficial medical, industrial and research applications
- the exploding costs for remediation and decommissioning of sites and facilities, waste management, storage and transport of radioactive materials, *etc*.

Unfortunately, the initially quite reasonable ICRP Recommendations have degenerated over the decades into the applications of the LNT/Collective Dose dogma. With the accumulation of new radiobiological and epidemiological results during the last two decades, the scientific basis of LNT became increasingly questionable. At the same time, non-scientific political and ideological pressures on the limit-setting international and national authorities increased. In this paper, some trends leading to the low-dose recommendations in the ICRP 2005 draft, as well as likely problems in their implementation, are briefly discussed.

Keywords: low dose effects; cost-benefit assessment; radiation protection regulations; risk analysis.

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1 Introduction

This paper is dedicated to the memory of John R. Cameron, 1922-2005, who contributed so much to the optimised medical uses of radiation, the measurement of small doses, to radiation education, and during his last years in particular to the objective assessment and possible medical use of low doses.

In reflecting on almost half a century of involvement in measuring small radiation doses ('small' being defined as no demonstrable health effects level below 100–200 mSv), in regulating exposure limits, and in assessing the risk associated with human exposures in this dose range, many relevant quotations come to mind. For example, Aristoteles already remarked that it is impossible to prove the total absence of any risk. The fundamental statement by Theophrast Bombast von Hohenheim (known as Paracelsus) is that the dose, which makes a poison, is reasonably well known. And Balthasar Gracian remarked 350 years ago: "Things are not perceived as what they really are, but what they appear to be." By now, risk perception is a science (*e.g.*, Sandquist, 2004).

The setting of legal/administrative low dose limits became a topic of central importance for all peaceful uses of ionising radiation due to the interaction with, and intense influence on, among many other issues:

- the public acceptance of nuclear power as a safe, inexpensive, reliable, ecologically beneficial, and climatically neutral source of electricity
- the increasing use of highly beneficial medical, industrial, agricultural, and research applications of radiation sources
- the assessment of the consequences of nuclear accidents, *e.g.*, Chernobyl (Becker, 1996)
- possible restrictions of the flying time for long-distance air crews
- the exploding costs for remediation and decommissioning of nuclear sites and facilities, waste management (with, for example, a recent increase of the time horizon for high-level repositories from 10 000 to a 1 million years in Germany), storage and transport of radioactive materials, *etc*.

Such developments raise serious concerns about the cost/benefit ratio, and various ethical implications of the currently dominating radiation protection policies. Just to mention the damage to patients who refuse essential diagnostic and therapeutic radiation procedures, effects of indoor-radon-radiophobia on the real estate market, or as an example from Germany, the costs for the decommissioning of the small pilot reprocessing plant (WAK) will exceed the construction costs by at least a factor of 50, and billions of $US are being spent for reducing natural outdoor radon levels in former U mining areas in southeastern Germany.

Unfortunately, the initially quite reasonable ICRP Recommendations degenerated over the decades into a universal application of the LNT/Collective Dose dogma. LNT was introduced by Bill Russell in Oak Ridge 50 years ago for the evaluation of radiation-induced mutations in the mouse germ cell line (Kathren, 1996). Over the years, it became a useful administrative tool. As then-ICRP-Chairman Dan Beninson summarised its advantages: "It simplifies bookkeeping." However, with the accumulation of new radiobiological and epidemiological results during the last decades, the 'scientific

basis' of LNT became increasingly questionable. This has recently been described in many papers during this conference, and in a particularly detailed 62-page report with 306 references by the French Academy of Science, and the French National Academy of Medicine (Tubiana *et al*., 2005). Many other national groups and individual colleagues (*e.g.*, Becker, 2004a) expressed their doubts about the universal validity and cost/benefit ratio of the LNT/collective dose hypothesis in by now over 200 mostly critical comments on the ICRP 2005 Draft.

Non-scientific political and ideological pressures on the limit-setting international and national authorities increased. Currently, some effects, such as genetic instability, bystander effects, and a few cases of increased radiation sensitivity associated with very rare diseases, appear to remain as the last defence lines in support of LNT. In addition, there is the well-known trend to selective quoting of pro-LNT publications, neglecting more or less the rapidly increasing published evidence contradicting LNT in all the 'official' documents. In addition, the well-known universal administrative lethargy and 'practical' considerations, such as rewriting regulations and textbooks and additional staff training, remain as obstacles against serious changes in the current concepts.

2 How expensive is one avoided mSv of low-level population exposure?

Neglecting medical and natural radiation exposures, cost/benefit studies for radiation protection in the power generating sector, where only minor personal exposures are known to occur (Tubiana *et al.*, 2005), resulted in costs of up to over $US40 million for a 'statistical life saved' by adding small and very small doses on the basis of the 'official' LNT assumption. The average in the UK fluctuated around $US4 million, with a broad range between $US2 and $US10 million (Jackson *et al*., 2005).

Incidentally, according to an EU recommendation,[1] "there are strong theoretical and empirical grounds for believing that the value for preventing a fatality declines with age". For example, in a study in Ontario (Krupnick *et al*., 2000), 'Willingness to Pay' was reduced for those over 70 to a mean value of $US0.6 million, thus illustrating the diminishing value of senior citizens.

Obviously, years of lifetime reduction at high age, other parameters such as income level, or the 'social value' of a person, could perhaps provide better yardsticks for this type of slightly macabre calculations. Lawyers, insurance companies, *etc*., in different parts of the world would probably provide other figures. In any case, one should keep in mind that a few 'megabucks' may be relatively little for a successful Wall Street investment broker, but a lot for most of mankind: More than half of our planet's inhabitants live on less than $US2/day, or $US700/year. For them, $US4 million correspond to about 6000 annual incomes.

In reflecting on the risks and benefits of nuclear power, one should probably not only focus on electricity costs and climatic effects, but keep in mind the real numbers of accountable radiation fatalities. During the last half century, this number – including the Chernobyl accident and all criticality accidents, but not including some accidents with research reactors, medical, and orphan sources – amounts to around one hundred, that is two per year. According to the official recent data, the total number of casualties due to radiation effects related to the Chernobyl accident amounted to about 40–50 (IAEA,

WHO, UNDP, 2005). For comparison, in electricity produced in conventional fossil fuel plants, according to official data, in China alone in 2004, at least 6000 fatalities occurred in coal mining. Many more deaths are associated with the transport of fossil fuels, air pollution around plants, *etc*., in many parts of the world.

3 Residential radon in Germany: a recent case study

The new ICRP 2005 draft recommends an 'action level' for residential radon up to 600 Bq/m³, but the more restrictive EU-Commission decided on a 200 Bq/m³ goal for new buildings – keeping in mind the many areas with increased radon concentrations in Europe. For example, in Finland, the average radon level in all homes is about 100 Bq/m³. The German Radiation Protection Commission recommended in 1994 values up to 250 Bq/m³ to be considered as normal, values up to 1000 Bq/m³ as worth to consider some reduction measures, and above 1000 requiring remediation. In other European countries, the currently prescribed action levels are between 200 and 400 Bq/m³ (Switzerland, Finland). In Switzerland, with an average indoor radon concentration of 75 Bq/m³, 1%–2% of the population live in homes above 400, and ca. 0.2% above 1000 Bq/m³ with personnel exposures up to 100 mSv/y.[2] This would require the remediation of 5000 houses. So far, the world low record in restrictive recommendations is the US EPA action level of 150 Bq/m³.

However, according to a proposed new German 'Radon Protection Law', this level should be reduced to 100 Bq/m³. This is based on controversial epidemiological case-control studies (review, Becker, 2003), assuming about 3000 annual additional radon fatalities. The conclusions of similar studies in nearby France (Baysson *et al*., 2004) are different. Despite much higher radon levels above 400 Bq/m³ which have been studied there, no statistically relevant increase in lung cancers has been observed. Nevertheless, new reports in preparation by UNSCEAR and WHO will probably retain a LNT estimate for residential radon lung cancer risk around 10% for 100 Bq/m³, or a doubling at 1000 Bq/m³.

The radon discussion is not just a matter of academic controversy about data interpretation (especially regarding the high uncertainties in radon dosimetry and the overwhelming effect of smoking on lung cancer incidence, known to increase the radon effect by approximately a factor of 25), but also a matter of economics: As there are 1.5 million homes in Germany above the proposed 100 Bq/m³ limit, the total costs for mandatory measurements, remediation, administration, *etc*., has been estimated to exceed the $US10 billion level, with far-reaching economic and social consequences in the affected areas – including industrial investments, tourism, and the possible damage to the radon treatment facilities there.

Radon therapy of painful arthritic/rheumatic joint diseases is highly successful as an alternative to conventional analgesics, non-steroid anti-rheumatics, and other drugs providing only short-term relief and in many cases serious side effects, primarily on the gastrointestinal tract. Beneficial effects of radon have been known since ancient times by experience, but more carefully investigated and seriously clinically used by hundreds of thousands of patients in many countries since the discovery of radon (review Becker, 2004b). The therapeutic effects of radon by inhalation or bathing have recently been demonstrated in various randomised clinical double-blind studies. They are especially effective for people suffering from Morbus Bechterew, a painful permanent bending of

the spine (Deetjen *et al.*, 2005). Incidentally, low level part- or total-body irradiations also found widespread applications for stimulating the immune system, *etc*. in many other therapeutic applications (Falkenbach *et al*., 2005).

4 From science to ideology?

Just to mention a few items to illustrate the current situation, with a more detailed description far exceeding the scope of such a brief review:

- Discrepancy between the regulatory neglect of the by far dominating and widely varying natural exposures, and the extremely restrictive treatment of 'artificial' exposures down to release limits of 0.01 mSv/y (ca. 0.4% of the average natural exposure) for natural or artificial 'radioactive waste'.
- Multiplying extremely small hypothetical low-dose 'risks' with large population numbers naturally leads to frightening 'calculated' (or 'estimated') death rates, *e.g*., related to the Chernobyl accident.
- National authorities are free to further reduce, frequently just for political, publicity, and/or ideological reasons, the low limits recommended by ICRP even further (*e.g.*, in the residential radon action levels).

Many competent scientists and organisations such as the Health Physics Society and the French Academies say that no statistically significant radiation risks can be detected below about 100–200 mSv, and even ICRP reluctantly admits, in a recent SC 1 draft report on low-level radiation effects, that most data may not support the LNT/collective dose concept. Nevertheless, it is retained quasi as a symbol of political correctness. In some cases one may suspect that the setting of absurdly low limits by 'green', 'environmentally' and/or 'ethically' oriented political/administrative bodies has the main purpose of stimulating the already widespread and intensely media-supported public radiophobia in order to prevent any further use of nuclear electricity or other peaceful applications of ionising radiation.

Unfortunately, such trends are also reflected in the formerly highly respected ICRP recommendations. This is, for example, indicated in the first lines of Draft 2005 S2: "This aim (to provide an appropriate standard to man) cannot be achieved on the basis of scientific concepts alone." Later (paragraph 184) it states: "This was achieved by worldwide decisions by governments, courts, public inquiries…". Ill-defined and complex non-scientific concepts such as 'stakeholder values' entered the picture. Also (Chapter 11): "The Commission recognises that there is a need to explore further the risk that may apply to other species…".

Apparently the only species with a slightly lower LD 50 than humans are goats and pigs. All other animals and plants are much less radiation sensitive than humans. Some bacteria are essentially radiation resistant. Should we, therefore, really consider reducing the officially prescribed 1 mSv/y general public dose limit to 0.8 mSv/y for goats and pigs? Or should we search for some other not-yet-discovered species, which is more radiation sensitive than humans? In particular, in Scandinavia, 'biota' studies with various exotic species appear to become a lucrative new source of research and travel funding.

Another psychological hazard is the increasing sensitivity and precision of radioactivity and radiation measurements. If we now frequently express activities in mBq, and dose-rates in nano-Sv, the resulting frightening large numbers will confuse and worry less informed media consumers. Most journalists know little or nothing about radiation, but always look for sellable scaring new 'hazards' headlines. This suggests to the general public that whatever is detectable must also be dangerous.

The last ICRP Chairman Roger Clarke tried, unfortunately largely unsuccessfully, to soften the new ICRP Recommendations somewhat regarding the sensitive threshold/collective dose issue, the too high quality factor for alpha particles, *etc*. But as he pointed out on many occasions, he received many more letters from politicians and environmentalists complaining about ICRP limits being too liberal, than from scientists who pointed out with good arguments that they are too restrictive. And it is so easy to be complaisant… Should we try to change this situation, *e.g.*, by better education and information – not only of the public opinion makers and multipliers, but also of still insufficiently informed colleagues in the closely related fields of radiation research, application, and protection?

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Notes

1 European Union Recommended Interim Values for the Value of Preventing a Fatality, in DG Environment Cost Benefit Analysis (http://europa.eu.int/environment/enveco, 2001).

2 Jahresbericht 2004 der Abt. Strahlenschutz, Public, BAG VS 6.06, Switzerland, June 2005, e-mail: str@bag.admin.ch.