Comment of the German-Swiss Radiation Protection Society

Regarding the IRPA letter to the Associated Societies from September 25th, 2015

How should we present the uncertainty in risk estimates at low doses?

Recommendation: Radiation risk appreciation has to be based in comparison to natural radiation doses and risks of our daily life. For the later it has to be distinguishing between risks taken deliberately and others imposed by society, technology and environment. Uncertainty in risk estimation has to be explained as incomplete information on the exact value of a risk with a confidence interval and not as a lack of information.

In a recent report UNSCEAR has made a concise description of the situation regarding the effects of ionising radiation. UNSCEAR states that there is proven evidence for deterministic (tissue) effects and a clear attributability of these effects to an exposed individual. The protection principle for those threshold effects is also clear: to define limits which are with some safety margin below the threshold. This is part of the RP regulations worldwide. Nevertheless, a number of accidents happened throughout the world, resulting in severe deterministic effects including death victims. The RP community reacted to alleviate this situation. The D-concept was developed and the protection of high active sealed sources was improved. In Europe, in 2003 the HASS Directive was issued and subsequently corresponding national regulations. Thus, for deterministic effects the situation is rather clear: there is an attributability of risk and there is a protection concept, which now even includes an enhanced protection and preparedness against accidental exposures.

Regarding stochastic effects the situation is different in the sense that the probability, i.e. the risk, for stochastic effects like cancer or hereditary diseases *(and not the severity as for deterministic effects)* is increasing with radiation dose. There is no attributability of stochastic effects such as cancer to radiation in the low dose region below 100 mSv, as in general, cancer rarely can be attributed to a specific risk taken by the concerned individual. Although there is proven evidence in the higher dose range due to the evaluations of the atom bomb survivors from Hiroshima and Nagasaki, the dose response in the low dose range is based on assumptions only. We should clearly say that there is no prove for any (positive or negative) effect at low doses. Most if not all epidemiological studies in the low dose range suffer from poor statistics and from the difficulty to include correctly background radiation and doses from other (i.e. medical) exposures. However, UNSCEAR states in the above mentioned report that it is the sum of all exposures which has to be taken into account.

The current legislation is based on the precautionary principle including the LNT model. This is an assumption stating that the dose response curve goes linear down to dose zero, sometimes the linearity is questioned and other models like a linear-quadratic ones are suggested. But all these discussions are based on simple assumptions with no biological evidence. So, finally the LNT model, as it is recommended by ICRP *(as a probably conservative assumption)* is the only practicable one until better and scientifically proven alternatives are available.

RP regulations and legislation are partially based on scientific evidence and partially on assumptions and, especially, on precautionary principles. Whilst high radiation doses present a real and proven impact on human health, low doses increase “only” the risk of stochastic effects. So, the question from what levels on radiation doses are dangerous depends on the individual perception of a danger, being strongly depending on societal evolution and risk awareness. The only meaningful appreciation of radiation risk has to be based on a comparison with natural radiation and the risks we are exposed to in our daily live.

Risk evaluation and appreciation

A correct risk evaluation is only possible comparing them to risk of our daily live. If an additional risk is significantly lower than any other daily risk of our civilian and professional life, it should be considered as acceptable and any further measure to reduce it should be regarded as not justified. Risk appreciation should be based on a holistic view, concerning all risks of our daily life.

Risk optimization

Risk optimizing does not mean to eliminate any risks, but to reduce it to an acceptable or at least tolerable level maintaining effort and benefit in a reasonable balance. Radiation risk should always be seen in comparison to all other risks of our daily life. Risk optimization means, identifying the most important risks and focus one these in term of risk reduction.

Risk communication

Risk communication to the public in an understandable language is not an easy task. Risk perception is always subjective. In particular risks we are taking deliberately because we expect a direct benefit thereof will be more easily accepted than risks imposed on us by others without our consent. We accept more easily risks from, for example, smoking, car driving and mountain climbing because of their direct benefit than a motorway, an environment polluting factory or a nuclear power station constructed next to our home where our own and immediate benefit is not readily apparent. Risk communication has to be improved by involving specialist in this domain and by comparing radiation risks to other risks from our daily life.

Confusion and definitions
Terms like probability, risk and uncertainty are often misunderstood or misinterpreted und need therefore a careful communication since they are not identical to everyman's definition of risk.[1] The common sense meaning of these terms is somewhat different from the scientific definition. Uncertainty does not mean a lack of security but it means unknown or incomplete information. So, for example, we can only give a confidence interval for the expected value of a quantity. This means, that the correct value could be, but only with a low probability, outside the given interval.

Perception of the society
Our society is characterized by a sometimes hysteric and exaggerated risk-awareness and people forget that our life in contrast to our perception is much surer than that of our grandparents. In the same time we lost some faculty for a reasonable risk assessment and risk appreciation. In particular in the fields of radiation protection and nuclear energy opinions and preconceived ideas are extremely charged with emotions making any objective discussion difficult.

Improve communication
In radiation protection and in particular for communication with the population we need more help from specialists in risk estimation, risk appreciation and risk communication. We need further professionals able to inform the population in an understandable language. The implication of scientific journalists for translating scientific information into a media-ready and easy understandable language would be extremely helpful.

Should we give a more prominent context to natural background exposure?

<u>Recommendation</u>: Natural radiation and its variability should be taken as reference value in the evaluation of radiation doses from all anthropogenic sources. It has to be emphasized that the same number of mSv, independently whether they are of natural or man-made origin represent the same radiological risk.

In some regions of the earth people are exposed to 200 and more mSv/a by natural radiation. Actually there is only little knowledge on the health impact of these natural radiation sources, despite several studies tried to investigate this.

Radioactivity and ionizing radiation are natural and part of our daily life. Man and environment have always been exposed to it and nature has learned to live with it. Using ICRP risk factors and LNT it comes out that (without radon in dwellings) approximately one percent of the spontaneous cancer incidence is due to natural radioactivity. Life of a biological organism is based on a continuous interaction with its environment and its survival is linked to a beneficial relationship with its surroundings and its ability to defend itself against harmful influences from the outside. Radiation can be a threat for life; very high doses are lethal. Unfortunately radiation cannot be perceived by human senses, which explains the fear of radiation amongst many members of the population, but also the need for clear regulation and legislation in this field based on precautionary principles.

[1] Covello: Risk is a threat of loss, real or perceived, to that which we value. And: Ortwin Renn: Das Risikoparadox – Warum wir uns vor dem Falschen fürchten. (ISBN 978-3-596-19811-5)

On the other side radiation has some justification in regard to the origin and the evolution of species. It contributes to the evolution of life by producing mutations. By natural selection processes those genetic configurations are selected that are best adapted to a given situation or a given environment. Although radiation could stimulate and train the natural immune defence mechanism and the ability to repair damages in the genetic code produced by radiation or other harmful agents, the number of mutations and chromosome damages produced by natural radiation is, however, much smaller than those occurring spontaneously.

UNSCEAR has announced to evaluate studies about the effects of background radiation. At present, they try to find a consensus about the criteria to evaluate such studies. This process might endure some time. It is time to discuss about background radiation within the RP community and start to go new ways in RP instead of time and again repeating the old assumptions and considerations without having new facts or evidence.

It is remarkable to learn that NRC these days has launched a consultation process about a petition to change from the LNT to the hormesis in evaluation of the effects of ionizing radiation. But as long as we don't have any scientific evidence Hormesis should be considered as a hypothesis that needs further investigation prior to be applied seriously in radiation protection.

Whilst accepting the principle of dose limitation, should we have more flexibility in how this is emphasized and presented? If so, how?

<u>Recommendation</u>: We need more flexibility in emergency situations for which ad-hoc-limits would be useful. They should be adapted constantly as the situation returns to normal. We need also more flexibility for long-term existing situations where mitigation is difficult and expensive, for example for contaminated areas by human activities or regions with high natural radioactivity or high radon levels.

The limitation principle was and is one of the pillars of the ICRP system of protection since 1977 when ICRP 26 was issued, together with the two other equally important principles: Justification and Optimisation. Limits were meant as the borderline between tolerable and not tolerable exposure, not as the borderline between dangerous and not dangerous. Subsequently exceeding the limits is an offence and will be punished. The system has been improved by the following publications of ICRP, in particular ICRP60 and ICRP107. It seems, however, that this refinement of the system of radiation protection by the newer ICRP publications became a challenge in order to be understood correctly by most of the practitioners, in particular also because some of the translations were not enough accurate and led to misinterpretations.

Dose limits are often misinterpreted and this applies even more for the term *dose constraints*. The public perception is: *above limit* = dangerous, *below limit* = safe. The correct interpretation should be: *above limit* = risk unacceptable compared to daily life risks, *below limit* = risk is insignificant and acceptable. Some flexibility in fixing dose limits seems useful; for example for natural radiation and for radon, i.e. for very long time existing situations were reduction measures could only be implemented with disproportionate effort. The second case where more flexibility is needed are emergency situations for with ad-hoc-limits would be useful. They should be adapted constantly as the situation returns to normal.

For a practitioner dose constraints may seem superfluous. However, in some situations they are useful. ICPR explained them as follows: "*Dose constraints by definition should be used at the planning stage in radiation protection. They can be used at the design and planning stage of a new facility where the size and nature of the specific sources are taken into account. In these cases these are sometimes referred to as source-related or design dose constraints and are used to determine levels of shielding material required in order that calculated doses to workers should not exceed the annual dose constraint value. They can also be used when planning a specific task, rather than a facility, to take account of the actual working procedures that will be used - in such instances they are often referred to as task-related or operational dose constraints."*

The «de Minimis»-concept should be maintained in risk estimation and risk management. In particular in the low risk domain a threshold should be defined below them no further optimization or any other risk reduction action or dose reduction measures are required, in particular if they need disproportionate measures..

Should we make ALARA even more central in our control hierarchy? If so, how do we ensure proportionality of effort?

Recommendation: The correct communication of ALARA as a precautionary principle for optimisation is crucial: i.e. what it means what it is for, in particular where optimization is necessary, where it could be useful and where it is unnecessary or even counterproductive.

Optimization or ALARA is already a central part of RP. If one looks at the development of exposures over time worldwide there is a clear tendency towards lower doses in any areas of application. This is partially due to the ALARA principle. To greater extend, this due to an increased, but not always justified and sometimes even disproportionate risk awareness of our society.

The correct interpretation of ALARA is therefore crucial, since it can be interpreted in very different ways putting the emphasis on “as low as” or on “reasonable” or on “achievable”. It seems that our Society puts too much emphasis on “as low as” and too little on “reasonable”. It should be our job, to keep this in balance, by better information of the public. Cost-benefit-analysis as it was suggested in ICRP publication 26 seems obsolete today as a RP measures are based more on political or societal considerations and the acceptances question has become increasingly important.

Optimization by a continuous improvement of safety culture is the way RP has to go. But Optimization also needs to have a lower endpoint. If the ALARA concept will be maintained the second part of the sentence, that is often forgotten, should be more emphasized in particular *«as low as **reasonably** achievable, **social** and **economic** factors being taken into account»*. So, the practical implementation of ALARA has to be adapted continuously to the evolution of our society and its perception and awareness of risks.

Should we make more effort to present radiation risk in the wider context of public health? Which ways would you propose?

Recommendation: Health effects and risks from radiation should be considered in the context of public health and everyday risks, as for example food safety, environmental pollutants, risks form energy production and exploitation of natural resources, NIR, transport and mobility, risk at work place, etc.

Our society has developed - despite the fact our life is much safer than that of our grandparents - a sometimes exaggerated and disproportionate awareness of risk and safety: Food, pollution, additives in daily life products, non-ionizing and ionizing radiation, energy sources and production, pharmaceutical products, etc. A huge amount of digested and undigested information is available, in particular on internet. Citizens need help from specialist to interpret correctly this huge flow of sometimes contradictory information. A holistic view of all risks of our daily life is needed in order to avoid an overestimation of a particular risk. Without this, a balanced risk optimisation is not possible. Risk optimisation should primarily identify the greatest risks so that risk optimisation can focus on these first. This should include risks we take deliberately and those imposed to us by society, technology and environment.