CONFERENCE ON THE HUMAN RIGHT TO A SAFE AND HEALTHFUL ENVIRONMENT AND THE RESPONSIBILITIES UNDER INTERNATIONAL LAW OF OPERATORS OF NUCLEAR FACILITIES

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Summary of Long-Term Risks Created by Prolonged Contact with Low-Level Radioactivity

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Summary

The International Commission on Radiological Protection ICRP has developed risk estimates about health detriments in populations exposed by low doses of ionizing radiation. They were derived from findings in the Japanase A-bomb survivors and are specified to three kinds of effects: 1) hereditary diseases in the descendants, 2) Cancer mortality, 3) Developmental defects by in utero exposure. Numerous findings in contaminated regions show that the effects are underestimated by the ICRP risk factors by several orders of magnitude in cases of chronical low dose exposure to incorporated radioactivity. Alternatively, the risk estimates of the European Committee on Radiation Risk ECRR are presented.

The most serious radiation effects by radioactivity – hereditary defects in the descendants of exposed parents – had been already detected in the twenties of the last century by the later nobel prize winner Herman Joseph Muller. He concluded from his investigations in drosophila that also low dose exposures and thus also the natural background radiation are mutagenous. In the thirties already, the idea arose that cancer is initiated by a single cell transformation, a "somatic" mutation. Therefore Muller concluded that there is also no harmless dose range for cancer induction (1).

Later on, the International Commission on Radiological Protection ICRP developed the term of the "stochastic" radiation effect from this. If a great collective is exposed by a small dose, one cannot predict which individual person will suffer from a radiation damage, only a propability is derivable. The amount of diseases increases with the accumulated dose, but after halving the dose there remains still an elevated effect. Therefore, no "threshold" exists i.e. a dose range without risk.

A third group of radiation effects which has to be considered in the low dose region was also known already at the time of Muller. These are teratogenis effects i.e. damages which are caused by exposure in utero. They may manifest as cancer in childhood or as malformations and other developmental distortions, also as fetal loss, stillbirths, and infant deaths. Kind and frequency of the damage for a given exposure depend on the stage of development. In the former days of radiation research the fetus was thought to be the most radiosensitive system.

The Chernobyl accident, at the latest, has shown that several other serious diseases occur after chronical low dose irradiation. Distortions of the central nervous system are observed, especially mental illnesses (2), as well as malfunctions of other organs. It is often supposed that distortions of the immune system are the cause of the observed diseases because deviations in the corresponding parameters were measurable. It was further confirmed that radiation-induced lens opacities (cataracts) have to be counted among the stochastic effects.

The geneticist Muller warned after the second world war of deteriorating the genetic pool of mankind by environmental radioactivity. He was therefore uninvited as speaker at the Atomic Conference of Geneva in 1955 where the large-scale so-called peaceful use of nuclear energy was initiated. Since then, those scientists were prefered and selected as experts by the authorities who declared the handling of man-made hudge amounts of radioactivity to be practicable and safe. The anti-nuclear movement was initiated by scientists whose conclusion was that the ruling opinions about the effects of radioactivity were wrong and dangerous, as e.g. was expressed by John Gofman and Arthur Tamplin (3), former advisers of the U.S. Atomic Energy Commission AEC which had been established for the promotion of nuclear energy application.

The normative board for the evaluation of radiation risks und the proposal of dose limits is the ICRP. Although the commission derives only recommendations these are applied by all Western and Eastern industrial nations. It followed a committee which had been founded in 1928 by radiological societies of several countries for the purpose of developing standards for radiation protection in the medical field. Therefore, it is traditionally obliged to the interests of the users. Since 1950, in the period of the Cold War and the development of nuclear energy consumption, it grew up to great importance. Technically, its recruitment remained the task of the radiological societies, de facto it recruits itself (4).

Critics of the official radiation protection criteria have therefore always questioned the arguments and results of the ICRP which completely contradict many established findings, especially in regions contaminated by radioactivity. The reference population which is used by the ICRP to play down the effects are the Japanese A-bomb survivors of Hiroshima and Nagasaki. The research programs in these are dominated by American scientists.

The problems of such comparison are not only lying in several peculiarities which reduce the general validity of the Japanese data. It lies also in the dosimetry system which was created by the ICRP to make all exposure conditions comparable. The Japanese survivors were irradiated by extremely high-energetic penetrating gamma rays, the radioactive fallout is neglected in the dose estimation. The dose in Sv is defined as an absorbed energy per tissue mass (dimension Joule/kg) multiplied with a so-called weighting factor depending on the kind of radiation: gamma/beta or alpha radiation. For estimating the dose in cases of radionuclide incorporation it is necessary to know the amount of substance deposited in the specific tissue and the course of retention from there. The ICRP has developed dose factors in Sv per inhaled or ingested Bq of the radionuclide which are intended to meet all individual conditions. The uncertainties of these dose factors may amount to several orders of magnitude (5, 6). Nevertheless are they used – to the disadvantage of the affected persons – quite similarly as natural constants and prescribed in the official rules of radiation protection e.g. to decide whether the dose limits near nuclear installations are kept.

In order to overcome an endless discussion about the parameters used in the ICRP models Busby chose another method to derive realistic estimates. He was followed by an European Committee on Radiation Risk (ECRR) founded in 1998 which sees itself as an alternative of the ICRP (7). Its risk estimates are based on observed evidence in the low-dose region for those effects where the basic mechanisms of induction are known.

The risk estimates of the ICRP about health effects after low-dose exposure are shown in Table 1 (8, 9) and compared to the evaluation of the ECRR.

Table 1 Health effects by chronical low-dose irradiation of a population

	Hereditary diseases	Cancer mortality	Teratogenic effects (in utero exposure)	Morbidity except from tumours
ICRP Risk estimate	130 cases per 10^4Sv	500 deaths per 10^4Sv (5 % per Sv)	No effect below 100 mSv	No effect
Evaluation by the ECRR	Underestimated by factor 100-2000	Underestimated by factor 100-2000	Cancer Malformations Mental retardation Mental disorders Down´s syndrome Childhood morbidity Stillbirths Infant deaths Spontaneous abortions Low birth weight	Manifold

The value 10^4Sv in columns 2 and 3 expresses a unity of the collective dose which is the sum of all individual doses in a collective. The risk estimate by the ICRP in column 2 means, that 130 additional cases of hereditary diseases are expected if a population of 10.000 persons is exposed by 1 Sv or a population of 10 million people by 1 mSv. Such relation can also be considered as an indivual risk. 500 deaths per 10^4Sv corresponds to a probability of 5 % for suffering from cancer death after exposure by 1 Sv.

For dose comparison it may be useful to remember that the dose limit – after recommendation of the ICRP - for a population exposed by emissions from nuclear facilities is 1 mSv per year.

It is shown in the ECRR report that the ICRP either simply ignores numerous results in the scientific literature about low level effects or neglects them for doubtful reasons. A most grotesque attidue is shown by their evaluation of teratogenic effects. The mainstream science has accepted in the meantime – after resistance for decades – that the cancer risk is real for children who were prenatally exposed to diagnostic x-rays and thus to very low doses. This damage has to be attributed therefore to the stochastic effects without threshold dose. The ICRP also adopts this not without distaste, in contrast, however, to this formal acceptance they postulate their threshold dose of 100 mSv which is not even proved in the A-bomb survivors, their prefered reference collective.

Numerous studies after diagnostic x-raying and in regions contaminated by radioactivity – especially by the Chernobyl accident – have shown a variety of teratogenic effects which are listed in column 4 of table 1 (10).

Regarding genetic diseases not only the ICRP but also other international and national committees of radiation protection refer exclusively to the A-bomb survivors where no significant effects were observed in the first generation of descendants. The ICRP interpretes their risk estimate (Table 1, column 1) therefore as an estimate on the safe side which would probably not occur in reality. The many results about genetically induced cancer diseases which were initiated by the debate about the leukemias near the British reprocessing plant Sellafield are declared to be not plausible in view of the knowledge of Hiroshima and Nagasaki.

Table 2 is taken from the ECRR report (7) and contains informations about European nuclear facilities which are showing elevated cancer rates after 1983 when the Sellafield leukemias had been detected. In these contaminated regions one has to consider as well as for numerous

findings after Chernobyl that there will be a cumulative induction in both exposed parents as well as by prenatal and postnatal irradiation of the children.

Table 2 Studies establishing excess leukaemia and cancer risk in children living near nuclear sites, data from ECRR-Report 2003 (7)

Nuclear Site	Year	Notes	Reference
[a]Sellafield/Windscale, UK	1983	Well studied by [f]COMARE: high level of discharge to atmosphere and sea	(11)
[a]Dounreay, UK	1986	Well studied by [f]COMARE: high level of discharge to atmosphere and sea	(12)
[a]La Hague, France	1993	Particle discharge to atmosphere and sea: ecological and case control studies	(13)
[c]Aldermaston/Burghfield, UK	1987	Well studied by [f]COMARE: particle discharge to atmosphere and rivers	(14,15)
[b]Hinkley Point, UK	1988	Discharges to offshore and bank	(16)
[d]Harwell, UK	1997	Discharges to atmosphere and river	(17)
[e]Birkenfeld, Germany	1990	Discharges to atmosphere and drinking water	(18, 19)
[b,d]Geesthacht, Germany	1992	Discharges to atmosphere and Elbe river	(20-22)
[d]Jülich, Germany	1996	Discharges to atmosphere and river	(23)
[b]Barsebaeck, Sweden	1998	Discharges to atmosphere and sea	(24)

[a]Reprocessing plants discharging to sea;[b]Nuclear power station discharge to sea or river; [c]Atomic weapon and nuclear material fabrication plants; [d]Atomic research with discharges to local rivers, [e]Uranium waste, [f]Committee on Medical Aspects of Radiation in the Environment, U.K.

Results about radiation-induced cancers in children which were only preconceptionally exposed are compiled in Table 3. The dose estimates were derived by the authors or reckoned by the writer. From these and the relative risks the doubling dose was derived (the dose which elevates the rate of diseases by the same amount as is given by the spontaneous rate).

This compilation shows that the interpretation of the Sellafield leukaemias by Martin Gardner (25) as genetically induced was not at all new and unexpectable as was claimed by ICRP and other committees. Rather, such connection had been found by a variety of researchers before.

Studies in children of parents which were exposed by Chernobyl radioactivity have shown that not only cancer is genetically induced in the next generation by low level exposure but also malformations, metabolic diseases, mental disorders, and Down´s syndrome (35).

Table 3 Radiation-induced hereditary effects/Cancer in childhood after preconceptional low-dose exposure

Exposed collective	Disease	Gonadal Dose mSv	Relative Risk	Doubling dose mSv
Seascale fathers 1990 (25)				
all stages of spermatogenesis	Leukaemia +	200	7	29
6 months before conception	lymphoma	10	7	1.4
Sellafield workers 2002 (26)	"		1.9	
Occupational exposure W.Cumbria 1991 (27)	"		3.2	
Preconceptional X-ray diagnostics				
Fathers 1966 (28)	Leukaemia	5*	1.3	3.8
Fathers 1988 (29)	Leukaemia	3-30	1.4-3.9	
Fathers 1994 (30)	Leukaemia		3.8	
Mothers 1958 (31)	Leukaemia	5*	1.7	2.9
Mothers 1966 (28)	Leukaemia	5*	1.7	2.9
Mothers 1973 (32)	Leukaemia	5*	1.4	3.6
Mothers 1980 (33)	Cancer	3*	2.6	1.2
Occupational exposure 1984 (34)	Cancer		2.7	

* Dose values reckoned by writer

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