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● *Special Report*

POSSIBILITIES AND LIMITS FOR APPLYING THE CONCEPT OF COLLECTIVE DOSE

A Recommendation of the Commission for Radiological Protection of the Federal Republic of Germany

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BESIDES the protection of individuals, radiation protection is concerned with the detection and reduction of the radiation exposure of groups of occupationally exposed persons and groups of the general public. The resulting task is the definition, for supervisory and optimization purposes, of the appropriate characteristics of the radiation

exposure of such a group of persons. This definition should consider not only the doses to individuals but also the number of exposed persons.

From a statistical point of view, either (a) the statement of the distribution of the number of persons to the various classes of doses (with an appropriate selection of class boundaries) or (b) already a greatly simplified concept—the statement of the number of persons and of the mean dose could be used; and (c) as an even more simplified measure of total exposure, the "collective dose" offers itself, which is defined as the product of the number of persons exposed and the arithmetic mean of all doses which occur.

In a recommendation published in detail elsewhere (Ka86), the Commission for Radiological Protection of the Federal Republic of Germany investigated the problem whether, and if so, under what conditions the "collective dose" characteristic is a meaningful measure of the radiation exposure of an exposed group of persons. In particular, the investigation was to determine whether the collective dose is suitable as (i) a measure of the radiation-related "detriment" and (ii) a tool for the optimization of radiation protection and for the comparison of safeguards, and thus proves to be a meaningful measure of exposure. This investigation was carried out considering both the scientific state of the art and the prevailing legal situation in the Federal Republic of Germany.

Furthermore, the aim was to determine whether other methods are available for a meaningful characterization of the radiation exposure of groups of the population.

On the basis of a comprehensive analysis, the Commission obtained the following results:

(1) The collective dose is suitable to serve as an absolute measure of the collective detriment only if there is a sufficient knowledge of the risk coefficients required for the calculation of detriment in the dose range to be studied. For the relevant dose ranges in practical radiation protection, it has to be emphasized that the risk coefficients are derived from epidemiological data at relatively high doses. Their extrapolation to low doses is based on the assumption of a linear dose-risk relationship without a threshold.

(2) Under certain conditions, the collective dose can be used to estimate the relative ratio of detriments from different sources or practices. This is particularly valid if the doses from these sources are small compared with the natural radiation dose and if the latter has similar values for persons exposed to the different sources or practices. Under these conditions the ratio of detriments is nearly equal to the corresponding ratio of the collective doses from different sources or practices, independent of the shape of the dose-risk relationship.

(3) With respect to radiation workers, particularly in nuclear facilities, the German Radiation Protection Commission considers the collective dose to be a suitable quantity for the optimization of the occupational radiation protection. It can be used to compare the efficiency of different working procedures and protective measures and for the selection of such procedures and measures which lead to a minimization of the collective dose on the basis of the ALARA (as low as reasonably achievable) principle.

(4) In accordance with the present state of the art, the International Commission on Radiological Protection (ICRP) proposal of an optimization on the basis of a cost-benefit analysis cannot be a subject of legal regulations, because of an insufficient knowledge of monetary values for the radiation-induced detriment. The minimization procedure already developed in the past, i.e., for the improvement of effluent-reducing techniques as well as the establishment of authorized individual dose limits and effluent limits, have proved their worth in the radiation protection of the population.

(5) If statistical characteristics for the radiation exposure of the population are required, it seems more appropriate to estimate the size of population groups in different dose cohorts. However, the size of the group of the population that is exposed to less than 3 μSv per year should not be considered a meaningful parameter for the purposes of optimization and decision-making. This value is far below the range of variation of natural radiation exposure and amounts to 1% of the authorized dose limit of 0.3 mSv per year that is valid in the Federal Republic of Germany for the exposure of members of the public to artificial sources, except medical exposure.

The group of the population receiving an effective dose equivalent above 3 μSv per year is considered to be the group which should primarily be regarded for accounting and comparative purposes concerning radiation protection measures. Thus, it is a meaningful approach to state the size of this group and possibly the arithmetic mean of the effective dose in this group. In special cases, it may be appropriate to introduce further class boundaries.

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Ka86 Kaul A., Aurand K., Bonka H., Gumprecht D., Harder D., Hardt H. J., Jacobi W., Kellerer A. M., Landfermann H.-H., Oberhausen E., and Streffer C., 1986, "*Possibilities of and Limitations to the Application of the Collective Dose—A Recommendation of the Commission for Radiological Protection of the Federal Republic of Germany* (proc. of an Int. Symp. on the Optimization of Radiation Protection, IAEA-SM-285/31 (Vienna, Austria: International Atomic Energy Agency).