THE BASIC SAFETY STANDARDS FOR RADIATION PROTECTION PRESENT AND FUTURE OUTLOOK

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THE SYSTEM OF DOSE LIMITATION

The Basic Safety Standards (BSS), Safety Series No.9 , 1982 edition, jointly sponsored by the International Atomic Energy Agency, the International Labour Organization, the Nuclear Energy Agency of the OECD and the World Health Organization, are based on the system of dose limitation recommended by the International Commission on Radiological Protection. This system incorporates the three basic requirements of justification of the practice; optimization of protection, which is synonymous with the principle of "doses to be kept as low as reasonably achievable, social and economic factors being taken into account" which is commonly known by its acronym ALARA; and individual dose limitation.

This paper is intended to contribute to the Congresses objectives by describing some of the main features of the BSS together with a discussion of some problems of implementation in practice and presenting the future outlook of optimization.

The implementation of the BSS policy requires that individual related requirements and source related requirements be carried out. The first requirement is a rather common feature to all norms for health protection, whereby the objective is to prevent relatively high exposures that could produce causal biological effects. However, the source related requirements are a device rarely used in other protection standards. Thus, although the individual related requirements provide safety to all individuals, the source related requirements require further decrease in the remaining collective detriment through the ALARA principle.

Individual related requirements: The dose limits in the BSS are not to be used for purposes of planning and design; thus it is not a priori permissible to approach the limits.

Secondary limits - related to the primary dose limits - have also been specified, e.g. in terms of limits of intake of radioactive material into the body. Annual limits on intake for members of the public have been recommended by the BSS; they are provisional values until appropriate ICRP recommendations become available.

As an individual may be exposed to several sources (present and foreseeable), the dose limits should not be used for limiting the maximum individual dose permitted to be received from a single source. The IAEA's Manual on Principles for Establishing Limits for the Release of Radioactive Materials into the Environment (IAEA Safety Series 45) recommends the use of "source upper-bounds" in order to ensure that the sum of all controllable exposures which may be received by a selected individual from various sources will not exceed the dose limits.

The fraction of the exposure due to natural sources not technologically enhanced is not considered in the summation of individual dose rates, which is to be compared to the limits. Individual exposures as patients, apart from research, are also excluded as individual benefit is assumed to override the risk. On the assumption of proportionality between radiation dose and probability of harm, the harm from natural background would be independent of any additional doses from artificial sources and also would not influence the harm from these sources and can be treated independently.

Source related requirements: These aim at keeping the stochastic health detriment ALARA; in other words optimizing protection.

OPTIMIZATION OF PROTECTION

Optimization applies to all situations where radiation exposures from a source can be controlled by protective measures, and could conceptually also be used for planning protective actions where a source may get out of control. The optimization requirement is intended for radiation protection only and can be applied independently of conventional protection requirements (e.g. a shield thickness is not related to any conventional protection parameter).

ACHIEVING OPTIMIZATION THROUGH COST BENEFIT ANALYSIS

Cost benefit analysis is shown in the BSS to be a simple quantification technique for the purpose of optimization of protection by minimizing the sum of actual protection cost and the cost assigned to the radiation detriment. However, it should be emphasized as ICRP did in its report No.37 on "cost benefit analysis in the optimization of radiation protection", that cost benefit analysis is only one method for optimization and other methods are not ruled out as long as the ALARA principle is respected.

Based on the ICRP recommendations, the BSS assumes that the stochastic component of radiation detriment (cancer and hereditary harm) is proportional to the collective effective dose equivalent (referred to in this document as collective dose). The concepts of risk, detriment, collective dose and its committment has been defined in the BSS. Only a general outline of some of the practical problems encountered will be briefly mentioned here.

SOME PRACTICAL ISSUES

Direct proportionality between dose and response. The validity of this assumption in the BSS has been challenged due to the absence of human data at very low doses. However, the fact is that doses to which people are currently being exposed to are not negligible. The United Nations Scientific Committee on the Effects of Atomic Radiation shows that such exposures are in the range of some milli sievert per annum. Therefore, the marginal relatively small increase in dose rate due to nuclear installation would fall within the range of the average dose rate incurred by the world population and as given in UNSCEAR 1982 and it is in this range of doses that linearity must be judged. Furthermore, as reported during the IAEA Symposium in Venice, "... the amount of harm in any tissue should in large parts be simply proportional to the number of particle tracks within that tissue; and the dose effect relationship should then be linear at the small incremented dose rates with which we are mainly concerned in non-medical radiation exposures".

Truncation of dose rate integral: The question is, is it possible to disregard negligible rates and therefore arrive at the "de minimus" dose concept? The BSS do not provide any justification for neglecting individual dose rates - however small - in the collective dose rate assessment; but the standards do not preclude ignoring negligible individual doses provided that they result in a negligible collective dose.

Integration of collective dose rates over infinity: Some practices may involve long-lived radionuclides which can cause exposures over thousands or even millions of years. The marginal collective dose is the relevant quantity in the optimization process. If available, protection systems can prevent the release of radioactive material during different time periods; then, the marginal collective dose will become the finite time integrals of the collective dose rates over the difference in the lifetime of the systems provided that the relevant functions are not changed.

Assigning values to parameters involved in cost benefit analysis: Based on direct proportionality between dose and effect for the objective health detriment, the proportionality constant alpha is then the monetary value assigned to the unit collective dose. This valuation of life expectancy applies to unknown statistical individuals and not identified ones and its magnitude determines the attainable level of radiation protection. It has nothing to do with a valuation of human life but is a rational device for conserving lives.

Optimization of protection against releases of radioactive materials causing transboundary exposure: The IAEA in co-operation with WHO are in the process of recommending policies for such optimization. These recommendations include a minimum value of alpha to be applied to the part of the collective dose that causes exposures beyond the frontier of the country that controls the source. The recommended value is US $3000 (man sievert)$^{-1}$ adjusted to 1981 prices.

Distributional problems: In the BSS there are no discriminations in the assignment of value to different spacial and temperal components of a detriment. The IAEA Safety Series No.45 indicates that careful judgement by regulatory authorities must be exercised in deciding whether it is reasonable to attach less weight to doses far in the future. A group of experts convened by the Holy See's Pontifical Academy of Sciences recommend that future doses that can be avoided by protective measures should always be given the same weight as present doses.

Other components of the detriment: In the BSS the cost assigned to the non objective detriment components can be taken to be proportional, with a proportionality factor called "beta", to the number of individuals receiving high dose equivalents, and to a function of the individual dose equivalents which could depend on risk aversion attitudes and national regulations.

FUTURE OUTLOOK

Strictly speaking, the BSS system of dose limitation applies ony to controllable exposures. It could also be applied to exposures arising from incidents for which emergency arrangements for limiting exposures were planned in advance. However, human beings may also incur doses from sources having the potential, but low probability, to get out of control. Such potential, low probability exposures may occur from both unexpected situations as well as from foreseen accidents for which sufficient emergency arrangements were not planned. Examples of these are large accidents in nuclear installations or disruptive events in radioactive waste depositories. In many of these cases, the eventual exposure is of probabilistic nature in the sense that a probability can be defined to quantify the chance of the exposure occurrence. This probability need not necessarily be objectively determined from experimental data; conceptually, it can be subjectively assumed as a 'degree of belief' and substantiated by logical and technical arguments of deterministic nature.

It is tempting to associate the idea of limiting the probabilities of occurrence of accidents, and their subsequent exposures, with the two relevant and interrelated requirements of the BSS dose limitation system, i.e. limiting the probability of individual harm, and keeping the mathematical expectation of collective harm to a level as low as reasonably achievable. It can be realistically assumed that this idea will be worked out in the near future and that substantial conceptual developments on the basic criteria will be carried out.

CONCLUSIONS

The BSS system of dose limitation is expected to have a substantial impact on radiation protection regulations all over the world. Many of the practical problems are solved but new issues appeared. It is felt that the current status of both the system and the optimization of protection can be seen from a positive perspective.

Current issues such as nuclear safety goals or criteria for radioactive waste disposal could be more rationally treated. The IAEA is looking into this problem with particular attention and closely follows scientific developments on the subject. In other forums the matter is also under consideration. The future outlook for the principles of the BSS system of dose limitation is highly promising.