

“ALARA and Occupational Exposure: Experience and Challenges”

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Stochastic effects of radiological consequences started to be recognized from the 1940s.

In the 1950s, it was considered that radiation exposure should be reduced to the lowest possible level. After that, it was a turning point in the history of reducing exposure to radiation when not only reducing exposure was pursued but also the economic and social effects and uncertainties began to be taken into consideration, and the balance between reduction and cost benefits was considered. Radiation exposure should have been reduced “readily,” but in ICRP Publication 22 (1973), “readily” was replaced by “reasonably.” After 1977, ALARA has not been changed largely. At the beginning of the 1980s, social values were calculated and introduced.

In ICRP Publication 55 (1988), practical means for reducing exposure drew attention.

From the 1990s, equity issue, the tolerability of risk model, and the dose constraint concept were introduced. For details of the tolerability of risk model, refer to the figure in Slide 9. In ICRP Publication 101 (2005), new factors were included and integrated. For example, exposure reduction is also important for exposure equity, and there is an idea of involving stakeholders and making them participate in communication for successful ALARA to further reduce exposure.

ICRP Publication 60, practical basic recommendation, described three principles (limitation, justification, and optimization) as the basis of radiation protection. To be able to address not only exposure in normal operations of nuclear facilities but also other exposure conditions such as public protection against radon or in emergencies, “intervention” to reduce radiation exposure by removing radiation sources, changing exposure pathways, reducing the number of exposed persons, and taking other actions was established.

In ICRP Publication 103, a new basic recommendation, “action” and “intervention,” which had been described in the former recommendation, were changed to “exposure situations,” and planned, emergency, and existing exposure situations were introduced. The three principles (dose limit, justification, and optimization) were kept. Dose constraint was considered as a so-called dose-related limit value.

A band was set up for dose constraint. Dose constraint is a tool for optimization and is used for ALARA. It is a useful tool to improve the quality of radiation protection. Based on exposure equity and past experience, it applies empirical values and reflects them in optimization. Although an image that strong limitations are imposed on dose constraint seems to exist, ICRP named it as dose constraint because it has the meaning of restricting practicable options when they are selected in an optimization process. Dose constraint can be considered as good practice. When the exposure reduction of part-time and itinerant workers is considered, for example, the concept of dose constraint can be used as a tool for protecting them.

When the number of occupationally exposed persons is examined in the UNSCEAR 2008 report, radiation exposure from the natural world is seen to increase; this is due to an increase in the number of subjects monitored. Exposure associated with industrial use has increased. Medical exposure has also increased; the increase in medical exposure is the main issue. The report describes how, as a result of ALARA, the number of persons in the nuclear industry who are exposed to relatively high doses is smaller than that in other industries such as the medical industry.

Detriment that had been $5.6\% \times 10^{-2}$ in ICRP Publication 60 decreased to $4.2\% \times 10^{-2}$ in ICRP Publication 103. This is due to the change of load coefficient and the decrease of the contributing part of the genetic effect. If a worker continuously worked at a level of 20 mSv/year for 25 years, though a worker who is exposed to such a level could hardly be imagined practically, his lifetime risk of developing a cancer would increase by 2%. For reference, the risk of dying in a car accident is 1% in France.

It is mostly in the fields of maintenance and operation that ALARA has been addressed so far. Although the number of cases where plants are decommissioned will increase in future, ALARA culture is missing in the field of dismantling operations. Issues about dismantling operations include the lack of information such as the history of facilities and the lack of commitment, unlike in the case of nuclear power plants. ISOE has prepared a pink book and green book for operation and maintenance so far; some pieces of advice and a similar book, though its color is uncertain, will be required for ALARA in dismantling operations in future. It takes time now (a few weeks) to confirm the state of exposure of itinerant workers. To address the issue of reducing exposure of itinerant workers, it is important to further ensure transparency, and data will need to be shared.

