

Implementation of ALARA culture in German NPPs



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Introduction

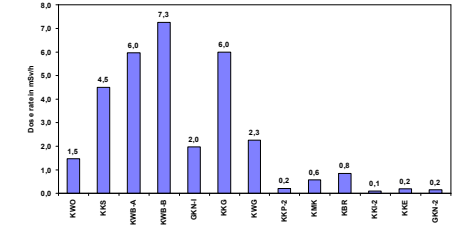
Experience has shown that occupational exposure in nuclear power plants basically is driven by the detailed design of the plant which defines the general basic radiological conditions. This puts main influence on the degree and quality of implementation of radiological protection planning and measures (operational radiation protection), what is true for operation as well as for outages of the plant. Both factors influence and control the exposure under the given radiological conditions related to the tasks and the workload prevailing and will be part of ALARA implementation.

Influence of design

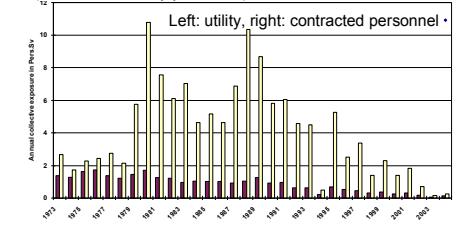
Regarding the first factor addressed, on the basis of experience feedback from the early time of the operation of NPPs in Germany, the design of the plants was significantly improved with time in joint co-operation efforts of operators, designers, authorities and technical consultant organisations. Special guidance was developed and published in Germany not only to assure safety of the NPPs but also to foster good design in radiation protection. Important issues addressed in this field (and laid down in the guideline IWRS I) were dedicated material selection (to avoid material producing long-lived gamma-emitting activation products as e.g. cobalt), recommending working conditions and equipment supporting, shortening of

working times in high-radiation areas, separation of systems and components to reduce background radiation from adjacent systems, and installation of fixed and temporary shielding to reduce the radiation levels in workplaces, corridors and waiting areas. As an outcome, the most recent NPPs can be operated with extremely low collective doses. As a selected example the basic radiological conditions at the primary circuit of the cold leg of the main coolant loops of German PWR are presented in the graph. The influence of replacing cobalt and antimony in the early years of operation of an older plant on the dose rate can be identified from the dose rate data of GKN-I. These activities, however, may afford ALARA-considerations.

Mean value of dose rate at the cold leg of main coolant loop in mSv/h. Data are averaged in time and over all available measured values for each PWR



Collective exposure of staff in KKS (PWR-type), KKS contributed significantly to the evaluation of the increase of collective exposure in the early years of operation

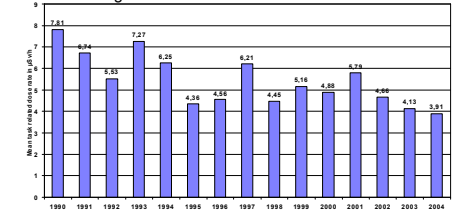


Operational radiation protection

Regarding operational radiation protection, the reduction of exposure could be improved dramatically due to experiences in the early years, starting from quite high collective and individual doses after the first years of operation. The trend of collective exposures is presented in the graph for KKS as one of the early PWR in Germany. The figure shows the development of the increase of the exposure levels in the first years due to the increase of the activation products and of work load. Certainly, due to differing work loads for the NPP the trend in the collective exposure presented is not a definite proof of the improve-

ment of radiological working conditions with time, as outages and back fitting activities in different years may increase the collective dose of the staff significantly. As an additional indicator, the mean task-related dose rate may be applied and is shown for the German BWR KKP-1. These data to some extent can be used as a measure of the overall mean radiological working conditions in the plant. In this case the collective exposure is normalized by the working time invested into the workload.

Mean task-related dose rate in KKP-1; in spite of fluctuations, the decreasing trend of the data is obvious



Technical organisational and regulatory influences

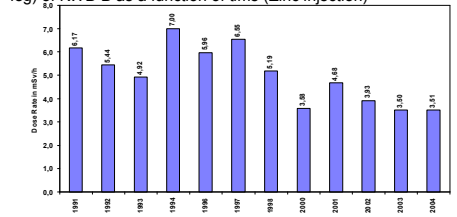
The example on task related dose rates shows that the overall radiological working conditions in general could be improved with time. Issues as e.g. improved radiation protection commitment, feedback including task-related personnel dosimetry, and improved planning and implementation of optimised protective measures such as shielding contributed in this field to dose reductions with ongoing efforts without bigger changes in the radiation levels.

In practice, issues that were later considered to be a part of work management already contributed to reduce exposure in the early years of operation of NPPs in Germany. Early guidelines such as the IWRS II significantly supported RP, as this guideline - which was published already in 1978 - introduced the need of qualified radiation protection planning for dose-intensive tasks with collective doses higher than 50 Pers.mSv or individual exposures exceeding 10 mSv. This guideline was reviewed recently and re-published with reduced dose limits.

The guideline also requested that independent experts review the implementation and results of radiation protection planning on behalf of the authorities. In addition, a status of implementation has to be performed by the utility and be reported to the competent authorities to allow feedback of experiences from the tasks performed.

Considering governmental input to radiation protection and ALARA considerations, dose limits to some extent contributed to the trend of reduction of personnel exposure. In this case the driving force was not really the fixed individual annual limit, but rather more the discussion and implementation of the lifetime dose of 400 mSv in Germany in the late eighties, which supported the introduction of some mean dose levels as a kind of constraint, followed by the broad discussion of the new 20 mSv limit of the EU Basic Safety Standards and discussion and implementation of this new limit in the German Radiation Protection Ordinance. The decreasing trend of high individual doses for an early plant can be taken from the last graph.

Mean dose rate in mSv/h at main coolant loops (cold and hot leg) of KWB-B as a function of time (Zinc injection)



Conclusions

With time, improved planning, re-evaluation as well as exchange of experiences and the stimulus of national and international discussion of ALARA implementation and work management further reduced exposure levels in German NPPs, making RP planning more and more an integral part of work planning. The re-issue of IWRS II laid down reduced dose limits and fostered an early integration of RP specialists (SSB) into work planning.

"IWRS I": Richtlinie für den Strahlenschutz des Personals bei der Durchführung von Instandhaltungsarbeiten in Kernkraftwerken mit Leichtwasserreaktor: Teil 1: Die während der Planung der Anlage zu treffende Vorsorge - IWRS I vom 10.7.1978 (GMBI 1978, S. 418), under review

"IWRS II (old)": Richtlinie für den Strahlenschutz des Personals bei der Durchführung von Instandhaltungsarbeiten in Kernkraftwerken mit Leichtwasserreaktor - Teil 2: Die Strahlenschutzmaßnahmen während der Inbetriebsetzung und des Betriebs der Anlage vom 23. Juni 1981 (GMBI 1981, Nr. 26 S. 363)

"IWRS II": Richtlinie für den Strahlenschutz des Personals bei Tätigkeiten der Instandhaltung, Änderung, Entsorgung und des Abbaus in kerntechnischen Anlagen und Einrichtungen: Teil 2: Die Strahlenschutzmaßnahmen während des Betriebs und der Stilllegung einer Anlage oder Einrichtung - IWRS II vom 17. Januar 2005 (GMBI 2005, Nr. 13)

Distribution of individual doses of utility personnel in KKS. Percent of persons in each dose interval (Doses below 5 mSv not shown)

