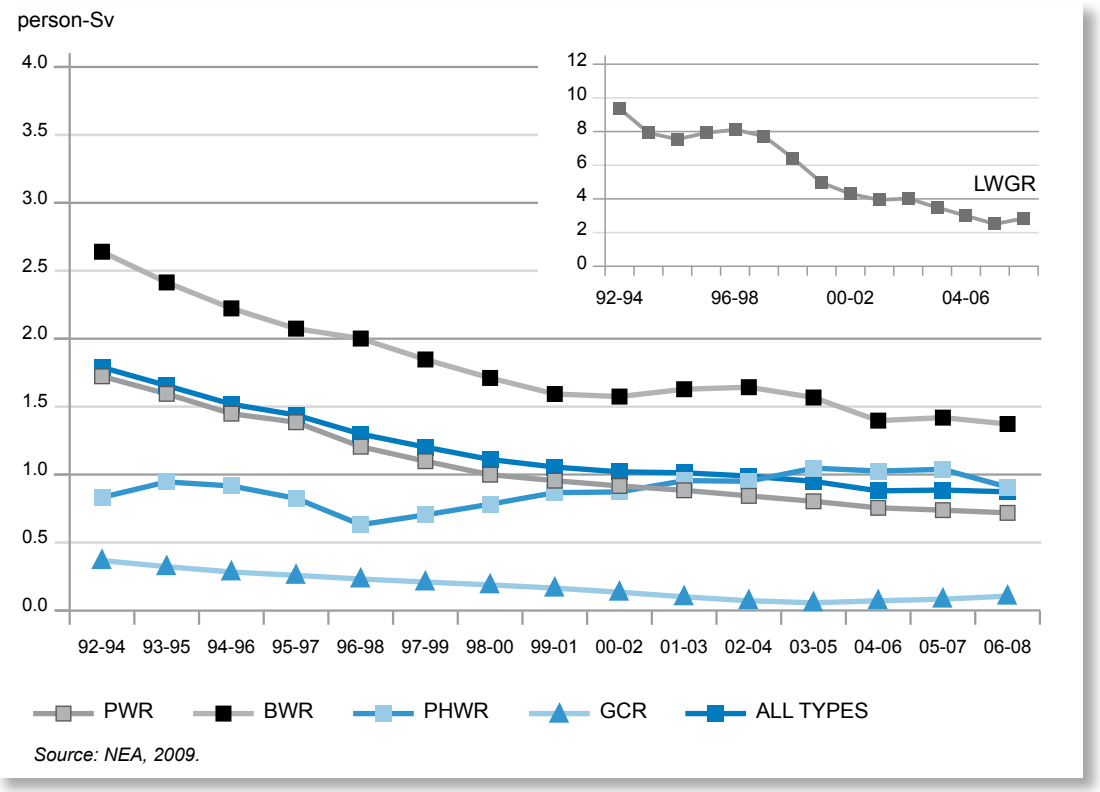
Work management to optimise occupational radiological protection

by B. Ahier*

Occupational exposures at nuclear power plants worldwide have steadily decreased since the early 1990s. Regulatory pressures, technological advances, improved plant designs and operational procedures, "as low as reasonably achievable" (ALARA) culture and information exchange have contributed to this downward trend (see Figure 1). However, with the continued ageing and possible life extensions of nuclear power plants, ongoing economic pressures, regulatory, social and political evolutions, and the potential of new nuclear build, the task of ensuring that occupational exposures are kept as low as reasonably achievable continues to present challenges to radiological protection professionals.

Since 1992, the Information System on Occupational Exposure (ISOE), jointly sponsored by the OECD Nuclear Energy Agency and the International Atomic Energy Agency, has provided a forum for

Figure 1: Annual collective dose per reactor, three-year rolling average,1992-2008



Source: NEA, 2009.

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radiological protection professionals from nuclear power utilities and national regulatory authorities worldwide to coordinate international co-operative undertakings for the radiological protection of workers at nuclear power plants. The ISOE objective is to improve occupational exposure management at nuclear power plants by exchanging relevant information, data and experience on methods to optimise occupational radiological protection.

Key to effective occupational exposure management has been the widespread understanding of the need for careful planning and execution of refuelling and maintenance outages. This approach, referred to *as work management,* stresses the importance of approaching jobs from a multi-disciplinary team perspective, and of following jobs completely through all stages from conception to post-job follow-up. Since the publication of the first ISOE work management report in 1997, this approach has been broadly implemented in the nuclear power industry, and for several years has shown itself to be useful in reducing worker doses and operational costs. However, economic and regulatory pressures have continued to confront the nuclear power industry, while many other changes have also arisen, including evolutions in the radiological protection system, technological advances, social, political and economic changes, and the prospect of new nuclear build. Of no less importance is the ongoing exchange of experience amongst radiological protection professionals.

Although work management is no longer a new concept, continued efforts are still needed to ensure that good performance, outcomes and trends are maintained in the face of current and future challenges. The ISOE programme thus created an Expert Group on Work Management in 2007 to develop an updated report reflecting the current state of knowledge, technology and experience in the occupational radiological protection of workers at nuclear power plants. Published in 2009, the new ISOE report on *Work Management to Optimise Occupational Radiological Protection in the Nuclear Power Industry* provides up-to-date practical guidance on the application of work management principles, thereby contributing to the optimisation of occupational radiological protection. The report presents the key aspects of work management that should be considered by nuclear power plant managers and workers to save time, dose and money, and is supported by recent practical examples from within the ISOE community.

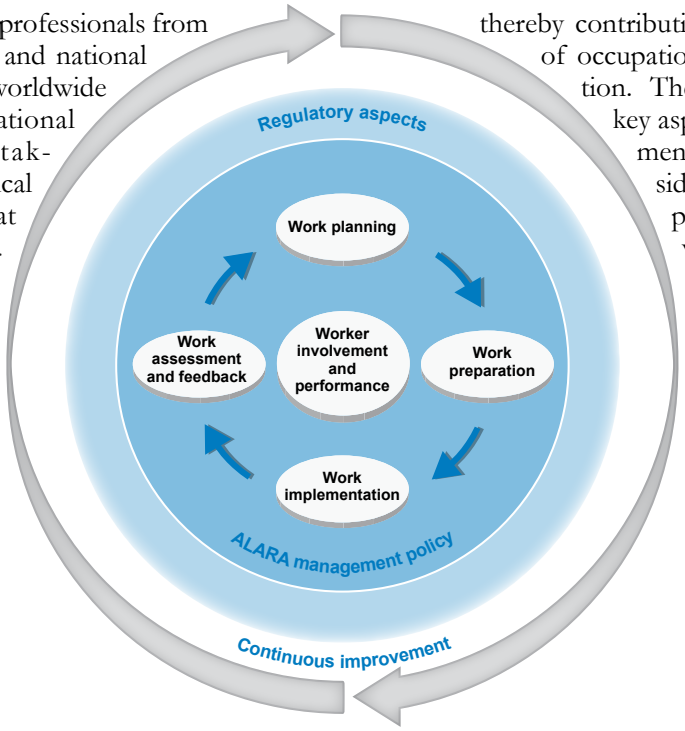

Figure 2: Work management elements and their iterative nature

Principles of work management

The operation and maintenance of nuclear power plants imply the occupational exposure of workers. Experience shows that the optimisation of occupational radiological protection necessitates a coherent and comprehensive work management approach. This approach stresses the importance of managing jobs completely from planning to follow-up in a multi-disciplinary manner which involves all relevant stakeholders. While dose reduction is only one component of this approach, radiological protection personnel are a key component within such teams, and must operate within this context to ensure that occupational exposures are kept ALARA.

Work management measures aim at optimising occupational radiological protection in the context of the economic viability of the installation. Important factors in this respect are measures and techniques influencing i) dose and dose rate, including source-term reduction; ii) exposure, including amount of time spent in controlled areas for operations; and iii) efficiency in short- and long-term planning, worker involvement, coordination and training. Equally important due to their broad, cross-cutting nature are the motivational and organisational arrangements adopted. The responsibility for these aspects may reside in various parts of an installation's organisational structure, and thus, a multi-disciplinary approach must be recognised, accounted for and well-integrated in any work.

Based on the operational experience within the ISOE programme, the following key areas of work management have been identified:

- regulatory aspects;
- ALARA management policy;
- worker involvement and performance;

- work planning and scheduling;
- work preparation;
- work implementation;
- work assessment and feedback;
- ensuring continuous improvement.

The details of each of these areas are elaborated and illustrated in the report through examples and case studies arising from ISOE experience. They are intended to provide all those involved in work management with relevant experience on good practice in the implementation of work management initiatives aimed at optimising occupational radiological protection in the nuclear power industry. The key points of each of these areas are briefly elaborated below.

Regulatory aspects

While it is the licensee's duty, in the first instance, to ensure that a particular operation is safe from the perspective of nuclear safety and radiological protection, this must be done within the applicable regulatory framework. Regulatory frameworks aim to ensure the protection of workers, public and environment from ionising radiation through regulations addressing radiological protection. Such regulation provides for an effective radiological protection infrastructure which includes a "safety culture" shared by those with protection responsibilities from workers through to management. The licensing framework provides one of the means of control available to a regulatory authority. Such frameworks can vary in their level of prescription and can therefore impact the options available to utilities within their approaches to work management. Within this regulatory framework, utilities should also develop and set their own internal radiological protection procedures and develop targets to manage individual and collective exposures.

ALARA management policy

The ALARA approach consists in always questioning whether all that is reasonable has been done to reduce doses in an optimal manner. To foster the practical implementation of this philosophy, it is necessary to create specific organisations for ALARA management, distribute individual and collective responsibilities and establish common rules to be applied. Plant management must put in place a management structure or organisation to ensure that radiological protection is appropriately considered in all jobs performed. In particular, plant management must be willing to support, in policy and budget, a multi-disciplinary team approach to plan, schedule, implement and follow up jobs. Although such structures vary from country to country and from utility to utility, many of the key points of these structures are common and can benefit from experience exchange amongst radiological protection professionals.

Worker involvement and performance

ALARA levels cannot be achieved without worker involvement. It is the worker who is exposed and it greatly depends on the worker himself to reduce the exposure. While certain types of work planning and implementation may be carried out without the feedback of workers, there are many features that can be supported or improved by worker involvement and which can contribute to worker performance. By engaging the worker in the task to be performed, from the planning to the post-job review, the worker is more likely to be motivated to perform the job to the best of his/her abilities. This will be reflected in lower job doses and higher job quality. To ensure the full involvement of workers, conditions should favour the creation and continuation of such involvement and ensure a mechanism for matching individuals and their skill levels with appropriate tasks.

Work planning and scheduling

Work activities must be carefully planned to ensure that radiological protection is optimised. The planning stage is an essential period within which to implement work management actions, incorporate radiological protection criteria and integrate feedback experience and benchmarking to ensure that effective approaches are implemented. Planning and scheduling must recognise not only the sequence of job steps, but also their relationship and their multi-disciplinary nature. Key issues in the selection and planning of work include the use of realistic assumptions when deciding upon the necessity for performing work, the selection of only those jobs which are "necessary" to the safe and efficient running of the plant and the implementation of a schedule that is tight but not rushed so as to reduce the risk of rework. Particular attention should be paid to the optimisation of outage duration. The scheduling of jobs in relation to each other, the identification of potential work interferences and hazards in the work zone, and the identification of dose-intensive jobs are critical to the optimal use of resources and job success. In terms of job planning, the effective incorporation of lessons learnt from previous jobs, or from similar jobs performed elsewhere in the nuclear industry, is essential. By concentrating on those jobs which are the most dose-intensive and by making effective use of available experience, work selection and planning activities will be focused and directed.

Work preparation

The success of work greatly depends on the quality of the preparation, which includes all activities performed before and during a job to prepare the site and the work crew. A large amount of preparatory work must be done prior to the outage and should properly reflect the multi-disciplinary nature of the work to be carried out. All efforts to prepare

and support the task and its working environment are essential if working conditions and radiological protection are to be optimised. It is crucial to optimise the work site from the perspective of the radiation source term, exposure reduction and work-efficiency improvement. It is essential to understand the radioactive source term in order to select appropriate dose rate reduction techniques such as decontamination and shielding. Tools and equipment to avoid exposure, such as robotics, as well as improvements of the working environment are also effective. Since these techniques constantly develop and improve, it is important to choose the best available at any time.

Work implementation

The work implementation phase refers to the actual performance of the work and to actions taken during this time which affect or facilitate the work. During work implementation, it is essential to ensure efficient control of radiological protection at the job location. There are several areas where work management can effectively contribute to lowering dose, time and cost. These include organisational aspects, such as the presence of radiological protection personnel, and specific procedures and technical aspects such as remote monitoring and access control systems. Efficient work process controls will help to assure that the objectives set during the work planning phase are met, that planned occupational radiological protection measures have been properly implemented and that any necessary corrective actions are identified and implemented. The reduction of unnecessary dose will be facilitated by providing workers with sufficient radiological, plant and job-specific information. Finally, the efficient collection of feedback information will assist in real-time work management and facilitate the preparation of future work.

Work assessment and feedback

The philosophy of work management can be seen as a continuous loop that consists of scheduling, planning, implementing, assessing, following up on lessons learnt and repeating the process for the next job to be undertaken, thus making the work cycle progressively optimised and in line with current technological developments. The job review and follow-up are among the most important parts of any task evolution. Normally, follow-up will lead directly into the implementation of the next operation under consideration. The lessons learnt, both good practices and areas for improvement, should be collected in a diligent manner, and exchanged not only with the work team but also with colleagues at the plant, industry and international levels. In a generic approach, two levels of information may be necessary to provide complete feedback on work implementation: the "internal" level, which consists of an analysis of in-plant performances, and the "external" level, which will provide national and/or international data favouring the exchange of new ideas and allowing the plant to assess its position with regard to other plants of the same type. Various information sources may be available for job dose assessment, such as the in-plant radiation exposure monitoring system database or corrective action programme, and corporate-wide, industry-wide and international databases of ALARA practices. Finally, work management implementation should be audited periodically to ensure that it is functioning properly.

Ensuring continuous improvement

While work management is an iterative process, it is also forward-looking, seeking continuous improvement to ensure and maintain a high level of radiological protection. Improvements therefore seek to incorporate, through information and experience exchange, lessons learnt and ongoing technological advances to inform not only future work activities, but also in the longer term, new design, new build and new operations to ensure that occupational radiological protection is optimised. In addition to experience exchange through programmes such as the ISOE, there is a range of technologies in various fields relevant to exposure reduction. These include technologies addressing source-term reduction, decontamination and mechanisation, automation and remote monitoring. Technologies for radiological protection and improvements in work efficiency have been broadly implemented in the nuclear industry. However, their ongoing development and further application should be considered in light of the radiological protection issues that will become important in the future, including exposure reduction in newly constructed or newly designed plants, large-scale modification works expected to be needed in association with ageing and lifetime extension of nuclear reactors, and reactor decommissioning.

This multi-disciplinary, practical experience in work management based on lessons drawn from many years of nuclear power plant operations, in addition to approaches that are still under development or that will be achieved in the future, are important elements in the optimisation of occupational radiological protection and for ensuring continuous improvement in the face of current and future challenges and opportunities.

Report availability

The ISOE report on *Work Management to Optimise Occupational Radiological Protection in the Nuclear Power Industry* can be downloaded, along with other ISOE reports, from the public section of the ISOE website, www.isoe-network.net (see ALARA Library/ISOE Reports). The report is currently available in English. Translations into other languages will also be posted on the ISOE website as these become available. ■