A MULTI-STAGE PROCESS

TRAINING IN THE DECOMMISSIONING OF NUCLEAR INSTALLATIONS

BY ENRIC PLA

Within the nuclear industry, the term "decommissioning" refers to a series of actions to allow the removal of some or all of the regulatory controls from a nuclear facility. The ultimate goal is the removal or confinement of all radioactive materials and the unrestricted release or use of the site.

Hundreds of nuclear installations worldwide are approaching stages of decommissioning. They include nuclear power plants, research reactors, and nuclear installations that have exceeded 30 years of service life. Many of these facilities are already shut down. As these facilities undergo the effects of ageing, such as embrittlement and other debilitating processes, they will need to be decontaminated and dismantled.

Until recently, attention was focused on decommissioning nuclear power and research reactors. Some countries, however, are now devoting greater attention to the decommissioning of nuclear installations that do not reactors, with implementation of these decommissioning programmes being seen as a high priority.

Decommissioning has been included in the IAEA's programmes since the early 1970s. The IAEA has a suite of guidance documents to address the safety and technological aspects of decommissioning of nuclear facilities. The documents also cover technical cooperation projects, research programmes and training workshops on the safe decontamination, dismantling and demolition of nuclear installations.

Although countries with nuclear power programmes already have plans and infrastructures in place, other countries face new challenges for decommissioning reactors and other facilities, such as medical laboratories. The IAEA's support is tailored toward assisting these countries in establishing capabilities to carry out decommissioning activities safely and effectively. This article focuses on the major aspects related to training in the field of decommissioning, including the preservation of knowledge between old and new generations of experts.

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The decommissioning of a nuclear facility should be considered in the design and operation phases. The potential radiological impact on workers and the environment, due to activated or contaminated materials to be handled during the dismantling activities, are most effectively taken into account at the design stage. Also, all modifications implemented during operation should be performed considering the difficulty that arises when clean materials become contaminated. However, many nuclear installations have been operating for years and their decommissioning may not have been considered at the design or operations stages.

Some countries, where the construction of new nuclear power plants is stagnant, have established projects of life extension for those in operation. The engineers responsible for these projects should be trained in dismantling techniques in order to facilitate the eventual decommissioning in the future.

Design features which should be considered to facilitate the decommissioning of radiological areas include remote maintenance and monitoring capabilities; compartmentalization of process functions; protective coverings and hot cell liners; ready access to process equipment, structures, systems and components, and their ease of removal; built-in decontamination mechanisms; and modular construction to facilitate dismantling of structures, systems equipment and components that are difficult to decontaminate.

Decommissioning encompasses a wide variety of activities ranging from the elaboration of the

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decommissioning plan to demolition of installations. Expertise is required to perform tasks having components of both routine and non-routine activities. Routine activities may involve the radiological characterization and decontamination tasks, somewhat similar to those in the operating phase. Likewise, demolition activities are comparable to those in the construction industry. However, decommissioning activities pose unique challenges due to hazardous and radioactive work environments, as well as unknown factors and unexpected situations that are commonly encountered.

The actual number of difficulties arising as a result of unexpected events is significant, and the solutions need the conceptualization and implementation of innovative approaches. The ability to deal with such difficulties requires a broad understanding of relevant concepts and principles that will have to be used to achieve solutions.

ROLE OF TRAINING PROGRAMMES

An appropriate level of adequate personnel training and qualification should be maintained throughout the life of nuclear facilities. In the decommissioning stage, training programmes are beneficial for several reasons.

- They foster efforts to increase safety levels for workers, the public, and the environment. They demonstrate the commitment to public health and environmental safety after a nuclear facility is shut down.
- They reduce or optimize expenses. The funds required to carry out the decontamination and dismantling are significant. The timely development of a broad training programme covering all concepts, techniques and procedures during a decommissioning project can help to optimize the use of available resources.
- Development and maintainence of a competent work force. The operators of the facility should be trained for the dismantling phase and be kept during the decommissioning due to their intransferable experience. The detailed review of the operating period will require in-depth analysis of some incidents, review of theoretical calculations and even reproduction of manual actions that can lead to difficulties during dismantling. Additionally, nuclear material must be inventoried, and training will be required to retrieve any recovered material.
- Training extends to a variety of workers and facility staff, and sessions should be oriented towards the review of established procedures. Many times a training session finds some difficulties in the execution of a task, which then leads to a modification of the relevant procedure. For example, the use of hydraulic shears for cutting pipes is a routine activity for a mechanic. Yet when this activity has to be performed with special clothes and in a limited time due to the radiological environment, the worker will require and benefit from specialized training.

TRAINING NEEDS & SUPPORT

The IAEA organizes regional training courses on general and technical aspects of decommissioning. The courses draw upon published safety guides and technical documents, and invite the instructional participation of experts worldwide.

The decommissioning of research reactors and other small facilities is a particular case where the IAEA plays an important role in assisting Member States. There are many countries with little experience in decommissioning management where research or education reactors were built some decades ago.

As a specialized activity, dismantling and decontamination require phased training approaches. Each associated task has some specific characteristics, and personnel need to be trained for each one. For some activities, the use of mock-ups and models can improve efficiency and safety. An effective specialized training programme depends upon a clear definition of each required job's functions, responsibilities, and governing standards.

Environmental Monitoring. One essential task in the implementation of a decommissioning project is systematic environmental monitoring. This includes field measurements of alpha emitters and of airborne contamination. Proficiency in sampling and evaluation techniques and the use of different types of equipment is necessary.

Control of Radiation Exposures. The control of radiation exposure to workers is of particular importance during dismantling and decontamination activities. For training of health physicists, courses should begin with the evaluation of the historical records and data of the facility in order to elaborate and analyse the radiological map of workplaces during operation, and to become knowledgeable about the radiation levels of hazardous areas. Equally important is overall knowledge of the decommissioning project, since the radiological risks will change as the dismantling activities are going on.

Other subjects that should be covered in courses include the use of adequate clothing and protective equipment for each particular activity, and dose-reduction strategies. In addition, health physicists should be aware of the variety of work environments depending on the kind of activity. The radiological procedures need to be very different in dismantling a reactor, decommissioning an old container system for transport of radioactive material, dealing with a uranium mill tailings pile, or decontaminating plutonium production facilities. General training courses may not deal in detail with all the different work environments, but they can address the criteria to be used to evaluate the workplace.

Waste Management. Many nuclear installations have radioactive waste that requires conditioning. Consequently, the process of dismantling may result in significant additional amounts of radioactive waste to be disposed of or stored. Cleaning up old waste may often involve waste relocation when other decommissioning procedures are not adequate. The need to confine such wastes and halt any migration into the air, water, or land requires additional training in decontamination, environmental transport, and waste stabilization and engineering techniques. Knowledge of waste control engineering and procedures that prevent the loss of radioactive materials or the migration of radionuclides are necessary to condition the radioactive waste of any facility being decontaminated and dismantled.

Radiological Survey Report. On completion of decommissioning, a final radiological survey report will have to be submitted to the regulatory authority. The data to be assembled should be commensurate with the complexity of the installation being decommissioned and associated hazard potential.

Sample and data management are essential to produce the final radiological survey. Without them, a dismantled installation cannot be certified free of contamination and released for other uses. Additional training in sample collection and laboratory analysis and in data management can prepare health physicists to carry out validation and recording functions in a systematic and retrievable mode.

The need for training concerns each intervening step of a decommissioning project. These steps include "administrative actions" that are crucial to the ultimate decision on the removal of regulatory controls from a nuclear facility. Therefore, a regulatory authority also will be interested in training their inspectors on decommissioning techniques, environmental impacts, and radiation topics.

STAFF OF OPERATING ORGANIZATIONS

Personnel involved in decommissioning activities should be made familiar with the facility and the operating procedures for the effective conduct of their duties. A team composed of decommissioning specialists and appropriate site personnel should be formed to manage the decommissioning project. Although new competencies may be required for the decommissioning phase and the safe enclosure period if any, the presence and contribution of former personnel who are familiar with the installation during its operational phase are useful. These former employees can be cross-trained to allow them to perform the required tasks in a more efficient manner.

The IAEA's training materials and publications make special mention of the advantage of keeping the operator staff during the dismantling phase. This, however, should not prevent new training or refresher courses for operators.

The staff of the operating organization should be trained or retrained in such areas as radiation protection; decontamination; robotics and remote handling; engineering support dismantling and demolition; quality assurance and quality control; waste management; and industrial safety.

In some cases, contractors or personnel from similar installations may be used to carry out all or some aspects of the decommissioning. The operating organization should ensure that adequate levels of control, supervision and training specific to the installation are provided.

Specialized training may be needed in certain areas of the work. Care should be taken to utilize sound working practices and to maintain good working conditions. Prior to work in high contaminated areas, personnel should be trained in a clean one.

In dismantling tasks or in radioactive waste handling where robots are used, the operators of these tools need to be trained with clean material before undertaking the real activity. A mistake with or poor knowledge of the use of a robot can cause important radiological impact and economical damages.

TRANSFER OF KNOWLEDGE

The nuclear industry has demonstrated the feasibility of decommissioning nuclear installations. Many facilities have been decommissioned from nuclear power plants to small research laboratories. The nuclear technology is well mastered in all fields of application, from design to dismantling and disposal of radioactive waste. The know-how will be ensured if stakeholders are aware of the importance of training and retraining of new generations.

The best trainers are existing nuclear professionals with acquired experience working in a nuclear facility. In the field of decommissioning of nuclear installations, there is a growing concern in some IAEA Member States that their national capabilities in education and training are diminishing as the national nuclear industry stagnates or declines. Combined with the ageing of the first generations of specialists in the industry, this could lead to a rapid decrease in the expertise needed for decommissioning.

The need for qualified professionals to direct and manage decommissioning is increasing more rapidly than new qualified personnel are becoming available. Professionals in the industry became qualified primarily through on-the-job training, which to date has continued to be the primary method of preparing and developing new personnel to work in this field. This mode of preparing workers can no longer keep pace with the demand for personnel because many of these professionals are approaching the end of their careers, and the demand for qualified workers is expected to increase with the ageing of the nuclear complex.

It is clear that expertise in the nuclear field has to be maintained. Countries with operating nuclear power plants or other nuclear facilities will need to decommission them in the future.

Many engineers and scientists in the environmental and nuclear industries have educational backgrounds and experience relevant to some areas of decommissioning. But few individuals have the background and experience necessary to effectively contribute to decommissioning projects without some form of re-education. It, therefore, has become apparent that these deficiencies were not individual shortcomings but rather an indication that the educational needs in this emerging industry were not being met by traditional academic curricula. Although a number of short courses focusing on decommissioning procedures have emerged in the past few years, a programme designed to provide an educational background in key academic disciplines relevant to decommissioning did not exist.

In some countries where nuclear activities are diminishing and there are fewer students in nuclear technology, it is questioned whether specific nuclear engineering courses should be maintained at the university, or whether it would be sufficient to have mechanical engineering, chemical engineering and other engineering courses. If the latter decision is taken, a generalist engineer will need to receive sound instruction to develop and manage a nuclear project. In particular, a decommissioning project is based in an existing installation, built according to concepts, standards and criteria unfamiliar to a generalist technician.

New generations responsible for dismantling nuclear installations will need to acquire knowledge and experience from older professionals. This transfer of knowledge can most effectively be carried out on an international basis. The IAEA has an important role to play in meeting this challenge. ❐