C. Pescatore*

Decommissioning and dismantling nuclear facilities in NEA countries

The OECD/NEA member countries were among those involved in the earliest developments of nuclear technology in the 1940s and 1950s. They thus have a range of plant and equipment that has now served its purpose, and needs to be decommissioned and dismantled. A new range of challenges opens up as the more modern nuclear power programmes mature and large commercial nuclear power plants approach the end of their useful life by reason of age, economics or change of policy on the use of nuclear power. The scale of such challenges may be judged from the fact that over 500 nuclear power plants have been constructed and operated worldwide, most of them in NEA member countries. Given an average planned operating life span of 30 to 40 years and that the average age of nuclear power plants is about 15 years, the rate of withdrawal from service will peak some time after 2015. The statistical distribution is wide, however, with some countries having already retired certain commercial nuclear power plants from service, and having even decommissioned and dismantled them in some cases, whilst in other countries it will be some years before any plants are retired.

The decommissioning and dismantling (D&D) work done on earlier facilities has provided a substantial body of knowledge and experience over a wide range of complex technical issues, but the requirement now is to apply the available techniques to the D&D of the larger commercial facilities. In addition to technical issues, plans and procedures will need to address other major issues associated with impacts on society and the environment, regulatory arrangements and long-term funding. In other words, although much has already been accomplished, much also remains to be done.

The NEA has long recognised the importance of D&D of nuclear facilities, and this since the early 1980s. The NEA Working Party on Decommissioning and Dismantling (WPDD) has just issued an overview of the status of D&D of nuclear facilities and associated issues in NEA member countries.[1] The report draws upon a database of fact sheets produced to a standard format by individual member countries that can be accessed online from the NEA website.[2] The WPDD plans to update this database regularly. Some of the main points are presented hereafter.

The purpose of D&D is to allow removal of some or all of the regulatory controls that apply to a nuclear site.

The term "decommissioning", when applied in its broadest sense to nuclear facilities, covers all of the administrative and technical actions associated with cessation of operation and withdrawal from service. It starts when a facility is shut down and extends to eventual removal of the facility from its site (termed "dismantling" in this article). These actions may involve some or all of the activities associated with the dismantling of plant and equipment, decontamination of structures and components, remediation of contaminated ground and disposal of the resulting wastes. The purpose of D&D is to allow removal of some or all of the

* *Dr. Claudio Pescatore (e-mail: pescatore@nea.fr) is Principal Administrator for Radioactive Waste Management in the NEA Radiation Protection and Radioactive Waste Management Division.*

regulatory controls that apply to a nuclear site whilst securing the long-term safety of the public and the environment, and continuing to protect the health and safety of decommissioning workers in the process. Underlying this are other practical objectives including release of valuable assets such as site and buildings for unrestricted alternative use, recycling and reuse of materials, and the restoration of environmental amenity. In all cases, the basic objective is to achieve an end-point that is sensible in technical, social and financial terms, that properly protects workers, the public and the environment and, in summary, complies with the basic principles of sustainable development.

There is no unique or preferred approach to D&D of nuclear facilities.

It is generally presumed that the eventual end-point of D&D activities is return of the site to a condition in which it can be released for unrestricted use. Within NEA member countries, however, there is a wide range of opinions and policies on the route and time scales to arrive at this eventual end-point. These opinions and policies are influenced by national positions, or lack of them, on such matters as the future use of nuclear power, the continued availability of trained staff, societal issues associated with impact on neighbouring communities, possible alternative uses for the facility and the sites – e.g. for new nuclear installations – technical and regulatory issues, arrangements for waste management, and on economic issues associated with costs and cash flow.

Two main strategic approaches that are being implemented are the "Immediate Decontamination and Dismantling" and "Safe Storage" options, or some combination of the two. For example, early decontamination and dismantling of bulky peripheral equipment may be carried out in order to reduce the visual impact of the facility, the remainder of which may be left under safe storage.

In the Immediate Decontamination and Dismantling option, after a period of up to a few years to allow cooling and decay of the short-lived radionuclides, the equipment, buildings, and parts of the facility and site that contain radioactive contaminants are decontaminated to a level that permits removal of regulatory control. They are dismantled to the extent necessary shortly after cessation of operations. Residual radioactive waste is treated, packaged and removed to an appropriate waste storage or disposal site.

In the Safe Storage option, the facility is placed in a stable, safe condition and maintained in that state until it is subsequently dismantled and decontaminated to levels that permit removal of regulatory controls. To prepare for safe storage, any fuel is removed, and radioactive liquids are drained from systems and components and then processed. During the period of safe storage, the facility is kept intact while radionuclide decay occurs, thus reducing the quantity of contaminated and radioactive material that must be disposed of during later decontamination and dismantling. This period of safe storage can last from a few tens of years up to a hundred years or so.

Decommissioning work at a nuclear power plant in Germany.

Techniques for D&D are already available, and valuable experience is being fed back into plant design and decommissioning plans.

Techniques for decontaminating and dismantling nuclear facilities are already available. It is now standard practice in the design of facilities and selection of materials to facilitate the implementation of these techniques. It is important for the future to ensure that the accumulating experience of applying these techniques to large plants is shared throughout the D&D community, and that lessons continue to be fed back into new facility designs and D&D plans.

Many nuclear facilities have already been successfully decommissioned and dismantled.

Techniques are available and have been successfully applied to the D&D of many early facilities used for development and demonstration of nuclear power. Some sites have already been returned to a condition suitable for unrestricted reuse. This has provided a substantial body of experience on a wide range of complex applications that is now being used on larger commercial facilities. The challenges for the future are to further improve strategies and processes for securing safety, environmental protection and economy.

Current systems for protecting workers, the public and the environment are satisfactory for implementation and regulation of D&D.

The effects of D&D on the health and safety of both workers and the public, as well as on the environment, are well understood and the protection systems already in place will deal with them satisfactorily. However, because there are significant differences between operation and D&D of nuclear facilities, it is intended to review these issues in order to ensure the continuing safety of workers, the public and the environment over the whole D&D process, and to ensure continuity and transparency of the regulatory process.

Current institutional arrangements for D&D are sufficient for today's needs.

The bodies currently in place for establishing policy, legislation and standards; for operating nuclear facilities and managing radioactive waste; and for regulating these activities, are adequate for dealing with D&D. Depending upon individual national circumstances, however, it may be convenient to modify practical arrangements by creating new bodies, such as dedicated liabilities management organisations, to assume responsibility for D&D on behalf of operators that are no longer in business, and to maintain and further develop the related expertise.

Arrangements are in place for funding D&D, but evaluation of costs requires further attention.

It is recognised that provisions for funding D&D need to be made during the operating lifetime of a facility, and arrangements are now established in OECD/NEA member countries. The challenges are to ensure that D&D costs are calculated correctly and that sufficient funds will be available when required.

Fund management systems vary from country to country, depending upon the D&D strategies adopted, and may or may not involve liabilities management organisations of the kind described above. Waste management costs are a significant element of the overall costs of D&D and may dominate in some cases depending on how the costs, of residual spent fuel management for example, are assigned. Hence, it is important not only that waste quantities are minimised but also that the costs of waste treatment, storage and disposal are separately identified and assigned.

Most D&D wastes are similar to normal operational wastes but some present new challenges that will need to be addressed.

The management and disposal of radioactive waste is a key element in the satisfactory completion of D&D of nuclear facilities and is a major contributor to its overall costs. Much of the waste produced during D&D of nuclear facilities is similar to that produced during their operational lifetime, so a major part of this new challenge is already shared with current activities. The new element, characteristic of D&D specifically, is the large quantity of waste containing only small concentrations of radionuclides. This requires serious attention to development and application of principles by which valuable materials may be released from regulatory control for re-use or recycling, thus minimising the need for disposal as radioactive waste. The management of specific wastes containing materials such as graphite, beryllium, sodium, asbestos, etc. will also need further attention.

Local communities are increasingly demanding involvement in planning for D&D.

It is widely accepted that openness and transparency are essential for winning public approval of D&D plans. The local public is increasingly demanding to be involved in such planning and this may accelerate the introduction of concepts such as "stepwise decision making". The challenge for the future, therefore, will be satisfactory development of systems for consulting the public, local communities in particular, and the creation of sources of information in which the public can have full confidence. ■

Notes

1. The report, entitled *The Decommissioning and Dismantling of Nuclear Facilities: Status, Approaches, Challenges*, may be obtained free of charge by writing to neapub@nea.fr.
2. See www.nea.fr/html/rwm/wpdd.html/ for more information regarding the database of fact sheets and the activities of the NEA Working Party on Decommissioning and Dismantling (WPDD).