Some Realities of Nuclear Power Plant Decommissioning

by L. Lanni

Nuclear power plants, like all other structures, wear out or must for other reasons be removed or replaced

Taking a nuclear facility out of service is generally termed "decommissioning", an operation which can be described in more detail as the measures taken at the end of the facility's operating lifetime to assure the continued protection of the public from residual radioactivity and to deal with other potential safety concerns associated with the retired facility. This can be done in several ways, however the IAEA currently has defined three basic options[1] for decommissioning a nuclear reactor

Option 1: Lock-up with surveillance

The reactor is left essentially intact but in a safe state. All fuel and heat transport fluids are removed Surveillance, maintenance and monitoring continues This is regarded as a temporary option prior to further work, but it provides safety for the public and the environment at low initial cost It allows time for decay of radioactivity and defers making irrevocable decisions regarding future plant disposition, but it does not make the site available for other uses.

Option 2: Restricted site release

The reactor is significantly decontaminated and remaining areas with important residual radioactivity levels are sealed. Fuel and heat transport fluids are removed from the reactor, radioactive components that can be easily dismantled are removed, other components that could constitute a radiological hazard during the planned timespan of this decommissioning option are also removed Various containment items generally remain, and are augmented where necessary Some surveillance and monitoring are maintained Parts of the facility or site may be available for other uses, but restrictions prevent the penetration of the containment barriers This option provides radiological safety and alternative use of part of the site, but does not allow complete freedom in future use or development.

Option 3: Unrestricted site release

All radioactively contaminated reactor structures are dismantled and all radioactivity above acceptable levels is removed No inspection, surveillance or monitoring is required on completion of this option and the site may be released for other purposes without restriction

[1] These options are termed "stages" in Ref [1]

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Variations exist on these three main options including taking the decommissioning of different parts of the same facility to different stages. Existing published information on decommissioning will be expanded considerably by the proceedings of the first international symposium on decommissioning, sponsored by the IAEA and OECD's Nuclear Energy Agency (NEA), and held in Vienna during November 1978.

SOME GENERAL ASPECTS OF DECOMMISSIONING

In the decommissioning of a reactor there are certain common tasks Each of these tasks has its own difficulties and uncertainties, these in turn vary with reactor type, size and age, they may overlap with environmental and other questions and they will also vary with the decommissioning option chosen. Some of the major generic tasks are described briefly below.

Decommissioning Plans

Decommissioning plans are required just as are operating plans. At present, preliminary decommissioning plans are generally prepared before reactor operation but more detailed plans are required before decommissioning can start. These plans must consider all aspects of the work, including radiation protection precautions for the decommissioning workers as well as for the public.

Another important aspect of the planning is the establishment of a quality assurance (QA) programme. The QA programme is set up to assure that all applicable regulations are met, to assure that the work is performed according to the plan, and to assure the safety of the public and of the decommissioning workers.

Decommissioning Methods

Specific methods to accomplish each of the decommissioning tasks must be laid out in detail. Selection of the decommissioning methods to be used requires a knowledge of the state-of-the-art of the various methods available, and implementation of specific techniques requires an intimate knowledge of these techniques. In general, the technology exists today for decommissioning a power reactor, although most plants will have to employ variations of existing techniques for specific items or problems.

Radiation Protection

Radiation protection in a decommissioning operation calls for (1) a detailed knowledge of the radioactivity at various locations in the plant (e.g. which radionuclides, how much, where and what their properties are); (2) a physical description of each area of the facility, (3) an assessment of decommissioning procedures before and during the operation to ensure that worker and public radiological safety is adequate, and (4) continued environmental monitoring while decommissioning is in progress.

A key element in radiation protection is to establish allowable standards for residual radioactivity levels. This must be done in compliance with regulations and take into account the characteristics of the radioactive species in each specific area of the facility. Once these standards are established, radiation protection procedures must ensure compliance with them.

Decommissioning Wastes

A significant amount of material that is contaminated with radioactivity will result from decommissioning a nuclear facility. These wastes must be converted to a stable solid form, packaged into suitable containers and transported off-site to an authorized repository in accordance with the regulations of the country concerned.

DECOMMISSIONING COSTS

A major concern of the public and operators of nuclear facilities is the cost of decommissioning. Estimates for dismantling large nuclear power stations show that these costs are important but not exhorbitant (generally about 10–15% of initial capital investment, escalated to current dollars). These costs can be financed so as to have relatively little impact on the cost of nuclear electricity Costs for dismantling small nuclear power stations (less than about 400 MWe) can be a higher fraction of the initial capital investment

A large fraction of the costs (i e one-fourth to one-half) of dismanting a nuclear station are directly attributable to waste management On the other hand, costs for surveillance and maintenance of a facility that has been decommissioned to one of the lesser options (especially Option 1), can become significant for time periods in excess of a few decades.

In general, decommissioning costs are secondary to environmental or political concerns These latter concerns will likely have greater impact on selection of the decommissioning plan or option and on when decommissioning should start

There is some concern that where nuclear facilities are owned and operated by private corporations, a mechanism must be in place to ensure that financing is available for decommissioning when it is needed, and that responsibilities for financing and decommissioning are well defined.

EXPERIENCE IN DECOMMISSIONING

Between 1960 and mid-1976, a total of 65 licenced nuclear reactors had been or were in the process of being decommissioned Ref [2] Of these, five were small nuclear power plants, four were demonstration power plants, six were licenced test reactors, 28 were research reactors, and 22 were nuclear criticality facilities. Of the 50 licenced research reactors and/or criticality facilities decommissioned or scheduled to be decommissioned, all but four had been or will be totally dismantled with the licences terminated These remaining four will retain a "possession only" type of licence for an indefinite period in Options 1 or 2 The Elk River reactor in the USA, a demonstration reactor of 58 MWth capacity, is the largest project to date that has been completely dismantled and removed from its site Ref [3]

This wealth of decommissioning experience is from at least seven countries Although there is no experience to date on decommissioning large nuclear power stations, the above experience is directly applicable In addition, the knowledge in many countries that has resulted from normal operations under radioactive conditions in maintenance, modifications and repair work is largely applicable to decommissioning Repair and refurbishing of reactors (such as the NRX and NRU research reactors in Canada and Dresden I in the USA) and

successful clean-up operations (work on the Lucens reactor in Switzerland) are also applicable to commercial scale decommissioning.

Aside from the reports arising from facilities already decommissioned, a number of studies of the decommissioning of commercial reactors have been completed or are in progress The results of these studies are very similar to those from actual decommissionings.

IAEA

Decommissioning has been under continual review and study by an international group of experts since 1973. Since then, the study group has met and reported in 1975, 1977, in the spring of 1978 and again during the IAEA/NEA International Symposium on the Decommissioning of Nuclear Facilities, held in Vienna, 13–17 November, 1978.

THE FUTURE

Demonstration power reactors, and small and large research reactors will continue to be decommissioned in various countries, this will contribute to both national and international experience Designs of future reactors will likely be influenced, where possible, to make the decommissioning of these stations in turn simpler, safer and less costly Good records of station construction and materials used can assist in decommissioning. The IAEA group on decommissioning, previously mentioned, has prepared a draft technical document outlining some principles and guidelines for decommissioning a nuclear reactor. It is anticipated that this document initially can form the basis of a code of practice, which when prepared and agreed upon internationally, will provide useful guidance.

It has been noted Ref. [4] that the French nuclear programme will, by the year 2000, see the decommissioning of about four large installations per year and that before that date about 80 installations currently operating will have been decommissioned. In the United Kingdom, 26 Magnox reactors in 11 stations, and various experimental and test reactors will likely have been decommissioned before the turn of the century Ref. [3]. These figures are only illustrative for countries that have nuclear power, but they show that decommissioning will soon assume the nature of a fairly large scale industrial activity

In conclusion, the present day status of decommissioning nuclear facilities is that

- no insurmountable problems are foreseen in decommissioning commercial power reactors using present day technology.
- there are radiological and industrial hazards associated with decommissioning, but they are related to those experienced during normal operations.
- there are various courses of action open in decommissioning a facility, one such is to defer dismantling it for some years to allow the radioactivity to decay to lower levels
- selection of a decommissioning option for any facility will involve legal, financial, industrial and environmental considerations.
- the distribution of responsibilities (financial, legal, environmental, health, etc.) will vary among nations but it must be clear to the public that all are adequately covered.
- the cost of dismantling a large nuclear power station can be expected to be in the range of 10–15% of original capital investment, escalated to current dollars.
- decommissioning is an international concern and there should be continued international co-operation on actual projects and on the development of decommissioning techniques.

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