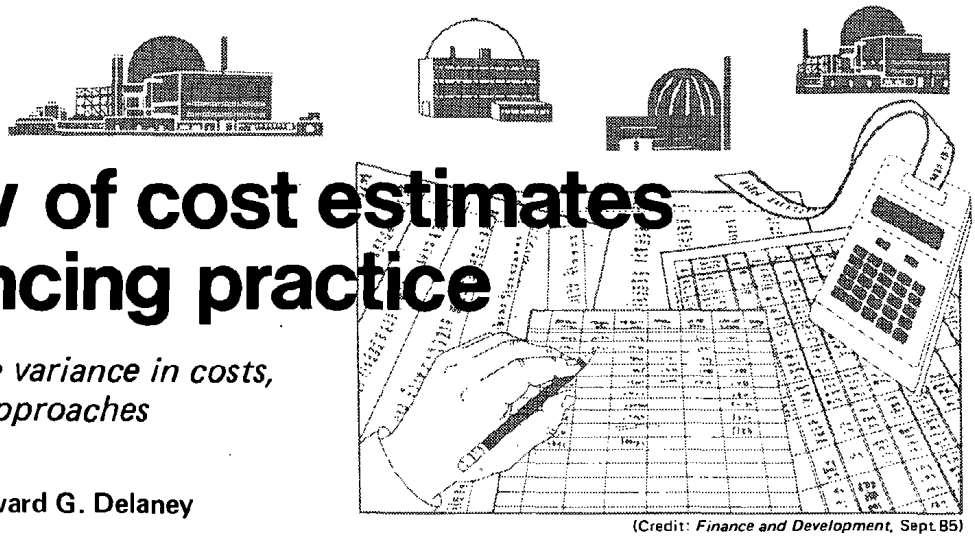

Overview of cost estimates and financing practice

Surveys show a wide variance in costs, a range of funding approaches

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(Credit: *Finance and Development*, Sept.85)

As many nuclear power plants around the world approach the end of their expected lives, decommissioning has taken on more than an academic interest. Worldwide, a number of plants have been offered for various stages of decommissioning in recent years. These include Gentilly-1 in Canada, the power demonstration reactor (JPDR) in Japan, Windscale (WAGR) in the United Kingdom, Shippingport in the USA, and a few others within the European Community.

Currently, there are several decommissioning alternatives that are technically, socially, and politically acceptable. A credible cost estimate is, therefore, an important tool to assist in selecting the most suitable decommissioning programme from among the options and to establish a practical funding mechanism for it.

Cost estimates vary widely

Having underlined the importance of a realistic and credible cost estimate, it should be pointed out that estimates reported by various sources hardly resemble one another, even for facilities of the same type and capacity. Such disparity is not only confusing to the theoretical practitioner but also disturbing to company financial planners and nuclear regulatory authorities, not to mention the general public.

Experts generally agree on the factors behind such divergent estimates. The single most important one is the scope of work delineated in the estimate (even when the same decommissioning stage, in accordance with IAEA definitions, is chosen). Another major source seems to be the lack of an accepted consistent methodology of cost estimating.

Other important factors include:

- Currency exchange rate
- Inflation rate
- Utility/site-specific conditions (e.g., labour rates and productivity)
- Contingency
- Disposal cost. (In the United States, for example, the disposal cost of low-level wastes (LLW) is likely to increase by a factor of three to four because of new requirements proposed by the US Nuclear Regulatory Commission (NRC), and the formation of LLW compacts.)

Generic cost estimates, however, provide a good basis for initial planning by the utility. Within the broad-band parameters of decommissioning stages, it is the utility who should decide upon specific decommissioning scenarios best suited to its needs and circumstances. For this reason alone, site-specific estimates are favoured by many.

Concept of "unit cost factor"

Efforts are under way in Canada and in the United States to standardize the methodology for estimating decommissioning costs. It is suggested that these costs can be conveniently classified into three broad categories:

- Activity-dependent – those related to dismantling, decontamination, packaging, shipping, and disposal.
- Period-dependent – those related to project and construction management, health, safety and security, licensing, and quality assurance.
- Special-item – those related to one-time costs, such as heavy equipment, taxes, permits.

The preparation of the first set of costs described above is dependent on the "unit cost factor" concept. Costs for repetitive events – cutting pipes and vessels, demolishing concrete, transporting and disposing of wastes – are estimated using "predetermined" unit costs. These unit costs or cost factors are expressed as cost-per-meter-cut, cost-per-cubic-meter-demolished, etc. They are strongly influenced by the degree of congestion in the work area; the degree of difficulty of operation (due to elevation, use of remote-

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Decommissioning cost survey

In a recent study on decommissioning by the Nuclear Energy Agency of the Organisation for Economic Co-operation and Development (NEA/OECD), decommissioning costs were reported by various countries, including Canada, Federal Republic of Germany, Finland, Sweden, and the United States. For the sake of comparison, the reported estimates have been scaled up for a hypothetical 1300-MWe reactor. Study results, which cover light-water reactors (LWR) and heavy-water reactors (HWR), are summarized below. A 25% contingency is included in the estimates, which are presented in 1984 US dollars.

- *For Stage-3 decommissioning (immediate),* the costs ranged from $103 million to $144 million.
- *For decommissioning to Stage-1, 30 years of storage, and then to Stage-3,* the costs ranged from $104 million to $116 million.

The same study concluded that decommissioning costs are relatively small compared to the total power generation cost. For a plant with an operating life of 20 years or longer, decommissioning costs are less than 5 to 6% of the lifetime generating cost.

control equipment, or special masks, etc.) and the use of measures to control contamination.

The "unit cost factors" should preferably be developed based on accumulated experience (such as Gentilly-1 decommissioning in Canada, and the Elk River decommissioning in the USA). The plant inventory of material and equipment requiring decommissioning would be used in conjunction with "unit cost factors" to arrive at activity-dependent costs.

Cost experience, surveys

As no large-scale commercial power plant has yet been decommissioned, the cost estimate is, by and large, based on experience gained with smaller plants and with maintenance-related activities in large nuclear plants.

A survey of nuclear decommissioning methods/costs was conducted for the American Gas Association (AGA) Depreciation Committee and presented at its meeting in October 1983.* The decommissioning costs approved by the state regulatory agencies for 32 pressurized-water reactors and 20 boiling-water reactors varied considerably – between US $50 to $210 (1985 dollars) per kilowatt-electric. The latest approved cost tended to be on the high end of the scale.

For plant sizes of 500-to-1150 megawatts-electric (MWe), the spread is, however, much narrower, between US $50 to $136 per kilowatt-electric. This corresponds to an average decommissioning cost of US $100 per kilowatt-electric, which is realistic for planning purposes for most commercial plants in operation today. It should be noted that for smaller plants, absolute cost may not be significantly different from larger units. However, the cost per kilowatt-electric appears much higher and may be misleading.

* The survey covered 34 US companies. Stage-3 decommissioning was used by 22 companies and 26 companies had done site-specific studies.

Financing the project

There are three principal approaches to the financing of decommissioning costs. At one extreme, a lump sum can be set aside at the beginning of operation. At the other extreme, a lump sum can be set aside at the end of the plant's life. An intermediate approach is the collection of funds gradually during plant operation, with these set aside in a special reserve account.

The lump-sum funding at the beginning of operation requires a large cash flow for the short term, but it provides the highest assurance (to outside parties) of the availability of funds. The lump-sum funding at the time of decommissioning requires the largest cash flow, and provides the least assurance, unless the government is the assurer of the funds. All these mechanisms have the ability to provide the necessary funds, provided the plans for decommissioning and its funding are reviewed periodically and adjusted as needed.

The control of the decommissioning fund can affect the security of the funds and the assurance that decommissioning will start when necessary. The fund may or may not be internally controlled by the utility and available for other uses. Internally controlled funds may be invested by the utility in constructing new revenue-producing facilities. This generally can be done at a higher rate of return, but at a higher risk than if the funds were invested in more secure government notes and bonds, as is usually done with externally-controlled funds.

Some variants on these three principal approaches may also be considered, primarily to provide for the time value of money. If the entire lump sum for decommissioning is set aside at the time of plant startup, interest from the investment could be returned to ratepayers as it accrued.

Alternatively, a smaller lump sum could be set aside at plant startup, based on a projection of the interest rate during the period from plant startup until decommissioning. This period could be 30 years assuming dismantlement soon after plant shutdown, or could be 100 or more years, assuming a delay of dismantling (as is being considered in several countries).

In any case, some decommissioning costs would be incurred shortly after plant shutdown in order to put the plant in a condition for safe storage. Some annual costs for plant surveillance and maintenance also would be incurred if plant dismantlement were delayed. The amount of the reduced lump sum at the time of plant startup clearly depends on the scenario for conducting the decommissioning, the projected plant lifetime, and the estimated interest rates for the decommissioning fund.

In addition to consideration of the time value of money in the decommissioning fund, other variations are often considered for added assurance of the availability of funds at the time of decommissioning, which could be over 100 years hence. The plant's premature shutdown due to an accident, or poorer performance than expected, may be covered by insurance from private companies or insurance pools in some countries, or by the government in others. The security of the decommissioning funds in the depository institution for long periods of time is another consideration. There are national and international institutions with proven stability for such long time periods, but they should be carefully selected.

Examples of financing practices

Decommissioning is considered as a part of the plant's life cycle (back-end). As such, cost of decommissioning should be borne by the electricity consumers who benefit from the plant. This notion has been generally accepted by many countries.

In Canada, utilities annually charge as depreciation expense a predetermined amount to electricity costs over the expected operating life of the plant (usually 40 years). This accumulated revenue, together with interest, would provide for future costs of decommissioning as they occur.

In the United States, the Nuclear Regulatory Commission has proposed that a decommissioning fund be set aside for each nuclear facility. The fund would be adequate to terminate the facility license by decommissioning to Stage-3. For a large nuclear power plant, the fund would be about US $100 million. Access to the fund by the facility owner would be controlled and limitations would be placed on the investments that could be made with it. The Public Utility Commission in each state would decide how the funds may be collected in the rate base.

According to the AGA survey mentioned earlier, most companies in the USA recover decommissioning costs separately from investment and the costs are collected primarily from depreciation.

In the Federal Republic of Germany, funds are collected during the operational phase of the nuclear power plant within a time period representing the useful lifetime of the steam generating system. Decommissioning costs are estimated based on the studies of the Biblis-A and Brunsbüttel plants. Details of funding have to be decided for each plant individually by the financial authority.

In Sweden, the nuclear power plant owner pays an annual fee which is related to the energy produced. The fee is determined annually by the government based on updated cost calculations provided by the reactor owner. The collected fees are deposited in an interest-bearing account with the National Bank of Sweden. The power plant owner may borrow from the collected fees. When the power plant is decommissioned and dismantled the owner will be reimbursed from the collected fees for these costs. The same procedure is used for other activities for the back-end of the fuel cycle.

Importance of planning, reviews

For effective pre-planning for decommissioning, the need for a credible cost estimate cannot be overemphasized. As the estimate includes many variables, the reasons for wide variations should be fully recognized and accounted for to attain a meaningful evaluation of cost. The merit in performing a plant-specific estimate can hardly be disputed. However, any estimate should be subject to periodic review and readjusted to reflect advancement in technology and changes in regulatory requirements. This is particularly significant when decommissioning will be carried out several decades in the future.

Decommissioning costs remain relatively small compared to the power generation costs. A number of financing methods are available, of which many are practiced by utilities around the world. However, in specific cases, particular circumstances and needs of a utility, within the overall national policy, should ultimately dictate the most suitable financing programme to provide the optimum assurance of decommissioning funds.