

Funding the decommissioning of nuclear power plants

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The average age of nuclear power plants in OECD/NEA member countries is now about 18 years. The average operating lifespan is estimated to be 30-50 years with a trend towards lifespan extensions. It follows that the rate of withdrawal from operation will peak somewhere after 2015. In several countries a number of commercial nuclear power plants have already been shut down. In some cases, decommissioning and dismantling have been completed or are in progress. In other cases, strategic, conceptual and/or detailed planning for such activities is currently taking place.

The purpose of decommissioning and dismantling is to remove on-site hazards that could potentially affect the long-term safety of the public and the environment, while continuing to protect the health and safety of decommissioning workers involved in the process, and with the objective of arriving at a state at which some or all regulatory controls no longer apply to the site. A characteristic feature of policies and strategies for the decommissioning of nuclear power facilities are the relatively long time horizons involved. Thus, today's generations have to make – and

are already making – decisions with potentially far-reaching consequences for future generations.

The decommissioning of a nuclear power plant might well start 50-60 years after the facility became operational. In fact, a century or more could elapse between the construction of a nuclear power plant and the completion of decommissioning. This time horizon is outside the range of traditional economic and political decision making. Careful and early planning is also important because the costs involved are large. A recent NEA study³ shows that the average decommissioning cost is about US\$ 320M for a 1000 MWe pressurised water reactor (PWR) and US\$ 420M for a 1000 MWe boiling water reactor (BWR).

Financial assets or funds to cover decommissioning costs are currently being set aside in most countries with nuclear power programmes. The mechanisms for accumulating and managing these funds, as well as the types of costs to be covered by the funds, differ from country to country.

Most topics mentioned above have been addressed in recent NEA work and discussions^{2,3,4,5,6}. A number of conclusions have been drawn and are outlined in the paragraphs below. Many of the following considerations are equally applicable to non-nuclear facilities, such as chemical plants or other facilities containing toxic materials.

Ethical principles for decommissioning funding

When formulating principles for funding and sharing the costs of decommissioning, concepts such as equity and justice are indispensable:

- The current generation has an obligation to collect and to preserve the financial, technical and scientific resources necessary for the future decommissioning of nuclear power facilities.
- The generally acknowledged "Polluter Pays Principle"¹ should be applied when funding the costs of decommissioning nuclear power facilities.

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Before, during and after the decommissioning of the Maine Yankee NPP in the United States (completed in 2005).

- Funding the costs of decommissioning nuclear power facilities should be guided by the principle of avoiding the imposition of undue burdens on future generations.
- A principle of intergenerational continuity, whereby the present generation transfers resources and reasonable obligations to the succeeding generation, should apply when formulating principles for funding and sharing the costs of decommissioning.

The principle of avoiding imposition of undue burdens on future generations is found in the *Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management*. It is left to the Contracting Parties to decide how to achieve this. The Convention also states that adequate financial resources should be available to ensure the safety of decommissioning a nuclear facility. Access to human and financial resources is considered to be part of general safety provisions.

The principle of intergenerational continuity implies a *chain of responsibility*. A key element when applying the principle of intergenerational continuity is the creation and preservation of a system for funding decommissioning when needed. The collection

and administration of funds for decommissioning should fulfil stringent criteria of financial ethics, including:

- preservation, and possibly an increase, of financial resources;
- robustness (independence from a variety of societal, political and economic scenarios);
- transparency;
- availability when needed.

Establishing a funding system

The experience from NEA member countries is that many aspects are to be considered when setting up a funding system. Experience also shows that there are a number of ways to establish adequate funding systems.

First of all, decommissioning liabilities should be identified and properly managed. This is a prerequisite for all cost calculations. First steps include the establishment of a register of the location and the state of all nuclear installations and all sites that contain radioactive materials; estimation of the costs of their dismantling and remediation; evaluation of the existence and adequacy of the provisions for financing these future or current operations; and the updating of this register on a regular basis.

Basic options for decommissioning strategies are

immediate/early dismantling (within approximately ten years after operation phase-out), deferred dismantling (typically 30-50 years after) or entombment (on-site encasing of the radioactive material). Generally speaking, planning for decommissioning should start as early as possible, ideally at the design stage of the facility. A regulatory framework and facilities for waste handling and storage (or disposal) are necessary pre-conditions to begin the decommissioning of any facility. Co-operation and co-ordination between implementers, regulators and stakeholders are critical.

Experts have also found that decommissioning cost estimates must be made on an iterative, site-specific basis and are a prerequisite for adequate funding. There is no universally accepted standard for developing decommissioning cost estimates. In developing a funding basis for a decommissioning project, sufficient margins should be included to account for uncertainties. The main costs involved are highly dependent on the project in question and on country-specific factors.

A legal framework is required for the creation of decommissioning funds and for ensuring that the funds will not be inappropriately diverted for other purposes. The funding system should be based on the "Pol-

luter Pays Principle”, and should meet minimum criteria of sufficiency, availability and transparency.

A funding methodology must also be developed. Mechanisms for providing adequate funding for decommissioning nuclear power plants exist in NEA member countries with nuclear power programmes, but they vary according to different national legislation and practices.

The main type of funding arrangement in NEA member countries is based on a gradual build-up of the funds. In most cases, funds are set aside for decommissioning based on nuclear electricity production (kWh). Another way of raising the funds can be through a levy on sales of electricity (as in Italy and Spain). The funds can be managed internally within the operating organisations (such is the case in Canada, Germany and the Netherlands) or by external bodies (as in Finland and Sweden).

Estimating the contributions to be paid is a crucial step. Calculations are based on the estimated decommissioning costs, assumptions with respect to the time at which the costs will arise, inflation, and the anticipated interest rate on the accumulated capital. In addition to successive contributions, the growth of the fund is dependent on the investment strategy, i.e. how aggressively or conservatively the funds are invested. A proper balance is obviously required between maximising the return on the investment and the conservative approach needed to protect the capital in the fund.

Competent administration of the funding system is of paramount importance. Legal rules must ensure that funds collected cannot be diverted. Regular and frequent reviews of all calculations of future costs are vital. The real value of assets

in the fund must also be safeguarded against inflation.

Decommissioning funding uncertainties

When creating a funding system there will always be uncertainties which have to be evaluated, and measures must be implemented to minimise them. Such uncertainties can be grouped into four interdependent areas.

Estimation of decommissioning costs. Minimising uncertainties of this kind involves continuous development of cost estimates and using the lessons learnt from other decommissioning projects. Such reassessments of decommissioning costs should be undertaken throughout the operational phase of a facility.

Early shutdown consequences. An early shutdown means that financial resources for decommissioning have to be covered by other sources. To insure against such an eventuality, a system for alternative financing should be planned at an early stage.

Availability of funds. Assets have to be available when needed for their purpose. Careful liquidity management is therefore essential and reliable forecasts of when major costs will arise are a prerequisite for ensuring the availability of funds when needed.

Managing funds over long timescales. If the fund's capital is managed in order to provide a positive return, it is exposed to various financial risks such as inflation, market fluctuations, credit loss, liquidity problems and changes in currency exchange rates. These types of financial risks are the same for all kinds of capital management and must be addressed.

Key messages and conclusions

Three key messages can be derived from recent NEA

activities addressing decommissioning:

- In NEA member countries with nuclear power programmes, mechanisms are in place for providing funding for the decommissioning of nuclear power plants. These mechanisms may differ according to different national legislation and practices.
- Existing systems and practices for funding decommissioning of nuclear power plants are in agreement with widely accepted ethical principles and, in particular, with the principle of not imposing undue burdens on future generations.
- The availability of funds at the right time is one of the cornerstones of a successful funding system. The identification of related uncertainties, and the implementation of measures to minimise them, are essential for ensuring this availability. ■

References

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