

**ASPECTS OF STRATEGY SELECTION FOR DECOMMISSIONING OF  
NUCLEAR FACILITIES IN NEA COUNTRIES -  
ACTIVITIES OF THE OECD\NEA WORKING PARTY ON DECOMMISSIONING AND  
DISMANTLING**

C. Pescatore, T. Eng  
OECD/NEA, France

A. Duncan  
EPR Systems, UK

**ABSTRACT**

The OECD/NEA Member countries have a wide 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 current situation is that much has already been done to deal with the decommissioning and dismantling (D&D) but much remains to be done. The work 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 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 with long-term funding.

A high-level international seminar was held in September 2003 in connection with the entering in the safestore period of the Vandellòs-I nuclear power plant. The seminar focused on strategy selection for the decommissioning of nuclear facilities. All the major types of facilities in the nuclear fuel cycle were represented. Some of the high-level lessons are as follows: LWRs are relatively easy to dismantle vis-à-vis, say, gas cooled reactors and some fuel cycle facilities; where to place the waste is an important issue but not necessarily a show stopper; regulatory flexibility is useful for licensing D&D projects; security of funds is an issue, especially in the case of safestore; pillars of trust vis-à-vis local communities are: safety, participation, and economic development.

**INTRODUCTION**

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 world-wide, 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 funding at the respective time scale. In other words, although much has already been accomplished, much also remains to be done.

The OECD/NEA has long recognised the importance of D&D of nuclear facilities, since the early 1980s. The NEA Working Party on Decommissioning and Dismantling (WPDD) was started in the year 2001 in order to complement at policy and regulatory level the technical work performed by the Co-operative Programme on Decommissioning Projects (CPD) that has been under the aegis of the NEA since the mid-80's. The WPDD has already achieved a number of the objectives that it set for itself in its forward work programme. Amongst these is an overview of the issues connected with strategy selection for D&D of nuclear facilities. The latter is the main subject of this paper and it will be presented following an overview of the WPDD and its activities.

### **THE WPDD AND ITS ACTIVITIES**

Current membership in the group is from 20 countries plus IAEA and the EC, and shows members with a diverse range of interests: policy-makers, regulators, decommissioning and waste management implementers, R&D specialists. This diverse membership allows the group to tackle issues that are interdisciplinary and it assures a balance of viewpoints in the position papers that it will issue. The current chairman is Stan Gordelier, of UKAEA.

To date, the group has had 4 formal meetings. These full meetings of the WPDD are interspersed with meetings of a much smaller Programme Review Group (Core Group), which operates as an executive body in managing the work of the WPDD. In addition, task groups have been created to carry forward work on particular subjects arising from the Topical Sessions held as a key part of the main meetings. A pattern is now established for the work of the WPDD as follows:

- One main meeting per year to be held in a member country.
- Meetings, where possible, should have presentations on and a discussion of the status of decommissioning in the host country.
- The programme to include a visit to relevant decommissioning projects where possible.
- Each meeting to focus on a topic of particular interest, which is explored via invited papers from WPDD members or other specialists and subsequent discussion. The outcome of topical sessions is recorded and made available on the NEA open web pages at <http://www.nea.fr/html/rwm/wpdd.html>
- Where appropriate, task groups are then set up to pursue the issues arising and report back to the main body.

Several topical sessions have thus been held and documented, e.g., on the Decommissioning Safety Case, on the Release and Reuse of Sites and Buildings, on the Management of Materials, and recently on the main outcomes of the Tarragona Seminar on strategy selection. These documents include perspectives from the R&D community, the regulators and the implementers and, in some cases, of the Local Community (i.e. nuclear site neighbours).

The 4<sup>th</sup> meeting of the group was held in September 2003, in Spain. Our Spanish members invited us to hold an invitees-only International Seminar on Decommissioning Strategy Selection. This was held in Tarragona, and marked the celebration of completion of a key stage in the decommissioning of Vandellòs-1 nuclear power plant. All the major types of facilities encountered in the nuclear fuel cycle were represented. Over 100 high-level specialists from all over the world attended, including

representatives of the Regulatory Commission of Spain and decommissioning projects managers from Spain, UK, USA, Japan, Italy, Slovak Republic, France, etc. Several mayors from both Europe and North America also attended. The seminar encouraged open discussions to share lessons learnt and identify possible solutions.

### **STRATEGY SELECTION AND ISSUES FOR D&D**

The subject of this seminar was "Strategy Selection for Decommissioning of Nuclear Facilities" and it was clear throughout that *safety* of D&D operations continues to be of importance in that selection, particularly in regard to the condition of the site and the risk it represents. In this context, it was noted specifically that a safety case for D&D needs to be kept under continuous review and needs to be flexible enough to accommodate appropriate modification as the work progresses and the nature of the risk changes. It was noted as well that the hazard presented by a facility in decommissioning is normally significantly less than during the operating phase (for a reactor, for example, the fuel has been removed, there are no pressurised systems and no high operating temperatures). The changing plant configuration and the reduced hazard potential lead to the observation that the safety management arrangements also need appropriate adjustment from those employed during the operating phase. It was recalled that a Task Group of the WPDD is addressing safety issues on an on-going basis.

It was also clear from the detailed presentations that techniques for D&D are already available and that they have been successfully demonstrated in practice. Nevertheless, because the costs of dismantling nuclear facilities make up at least a third of the overall D&D costs, there seemed to be a strong case for continuing R&D in this area in order to improve the cost effectiveness of such techniques. It was noted, however, that the extent of such R&D is now somewhat limited and that further work is first required to identify the most effective areas for future R&D projects. Throughout the seminar, it was emphasised that strategy selection must remain flexible since it is highly dependent on financing, societal input, technical feasibility, waste management options, and regulatory processes.

Against this background, five themes can be selected that appeared either to be important for successful D&D strategy selection, or worth further work in an international context, or controversial and worthy of further debate. These themes are:

- Policy, Regulations, prevailing case-by-case situation.
- Waste Management and Clearance.
- Funding and Costs.
- Stakeholder Involvement and Communication.
- Satisfying Social Demands.

The theme Strategy Selection was the overall theme of the seminar, of course, and the other themes all relate to it.

#### **Policy, Regulations, prevailing case-by-case situation**

“Waste management provisions”, “Costs and funding arrangements”, “Socio-economic issues” were the sub-themes of highest interest and priority, subject of course to the proviso about safety issues. These will be dealt with separately hereafter.

Several other issues have also to be taken into account having broadly similar level of importance. Namely: “Basic options”, “Flexibility”, “Project planning / analysis of materials flow”, “Regulatory / policy requirements. (Timing; release criteria.)” and “Strategy selection process. (e.g. Multi-attribute analysis.)”

As regards *Basic Options* and *Flexibility* it was noted that the basic D&D strategic options are early and deferred dismantling. The position of entombment is somewhat ambiguous and it is not clear just what its status is in the context of overall D&D strategy. It appeared from remarks made during the seminar that the majority is in favour of early dismantling but it was emphasised throughout that flexibility of strategy selection is essential and that "one size does not fit all". In fact it was clear that some early dismantling strategies are based on current expectations about availability of waste disposal routes and that they may be modified if these expectations are not delivered. The related question in the final discussion was "How far is it sensible to dismantle the facility without a waste disposal route being available?" There did not seem to be a single or specific answer to this question, and debate appeared to confirm the observation that individual strategies will invariably have to have regard to a wide range of factors and will be judged on a case-by-case basis.

For example, it was noted that there seems to be a general preference for early dismantling of light water reactors, even if a radioactive waste disposal route is unavailable and waste has to be stored temporarily on the site. For Gas Cooled Reactors (CGR) however, the timing of dismantling seems to depend on a route for disposal of graphite, at least, being available. In some cases, of course, strategy is driven by national economic or policy factors, where plant shutdown and site-clearance are required before normal end-of-life or obsolescence. Similarly, analysis of the effects of delay for radioactive decay on costs, dose commitment and waste generation, for example, do not necessarily result in the same choice. Differences in facility owners' perception of the commercial risks of deferral (e.g. increasing costs of waste disposal, increasing regulatory requirements, etc.) also impact on strategy selection. These differences are also found in decisions about D&D of some fuel cycle facilities where there is no benefit from delay for decay.

It was noted that detailed *Project planning / analysis of materials flow* is essential and that analysis of materials flow is a helpful tool in this regard. In this context, contrasts could be observed between the decommissioning of plants which had reached naturally the useful end of life and those which were experiencing premature shutdowns as a result of societal decisions. It was also recognised that *regulatory or policy requirements* are key inputs to project planning and that, in this context, any requirements relating to timing of D&D operations, management of radioactive waste or criteria for release of the site from regulatory control will be critical. It was remarked that regulatory arrangements need to recognise the differences between the stable, on-going activities of the operational phase of a facility and the transition to a lower risk state as D&D progresses. It was suggested that different regulatory approaches might even be required and it was noted that new arrangements for regulating D&D of NPPs have already been introduced in France. Until recently 3 authorisations were needed to cover all elements of the decommissioning and dismantling process, but now only one decree is required, thus simplifying the whole regulatory process. The US is already using a risk-informed approach as utilities transition during decommissioning. It was also suggested that WPDD might contribute to review of regulatory frameworks for D&D with a view to sharing experience on these regulatory approaches.

On the important matter of *site release criteria*, it was noted that the US authorities set an upper limit of dose at 0.25mSv/year, coupled with a requirement for ALARA, as compared with the figure of 0.01mSv/year as applied in Germany, for example. In discussion, it was suggested that the US ALARA requirement ensured that actual doses from sites released from regulatory control on this basis were much lower than the upper limit. It was reported that the IAEA are working on preparation of a standard for uniformity in this area. It was also mentioned that the Western European Nuclear Regulators' Association (WENRA) are discussing the concept of "reference levels" as opposed to "release criteria" in an attempt to provide an element of international uniformity. It was suggested that WPDD might usefully provide feedback to WENRA from an operator's perspective, either directly or by way of the Radioactive Waste Management Committee (RWMC), although developer-to-developer exchange may be better.

In concluding the discussion of this theme it was reiterated that differences between facilities and their surrounding circumstances militate against any form of strategic harmonisation (i.e. one size does not fit all). Politicians and the public might have an expectation that there should be a universal "right answer". It was suggested that, using the information provided in the seminar and other NEA studies as a basis, the NEA might consider further work in this area such as an exchange of experience in methods of strategy selection (e.g. use of multi-attribute analysis etc.) This might be extended by way of examples of reasons for apparently similar facilities choosing different approaches. With regard to the importance of decommissioning criteria, some participants indicated that decommissioning criteria are believed to be important to public confidence and establishing a consistent understanding of "clean enough". Others felt that a case-by-case treatment is more appropriate. Many felt that because of differences in work breakdown structures, cost impacts of different criteria are difficult to evaluate.

### **Waste Management and Clearance**

This was an important theme throughout the seminar. Amongst the several issues identified for this theme, "Availability of waste disposal routes" and "Standards for clearance, and effects of differences on costs and international business" were voted the most important issues by a large margin, followed by the issue of availability of a national "General Waste Management Plan".

It was generally acknowledged that the availability of a national *General Waste Management Plan* is most helpful in development of D&D strategy, as is an inventory of decommissioning liabilities. But, so far as participants were concerned, the key issue is availability of disposal routes. Of particular interest were the cases of the early gas-cooled, graphite-moderated reactors now undergoing decommissioning in Spain, France, Japan, Italy and the United Kingdom. Different decisions have been made about the timing of final dismantling but they seem to depend heavily on assumptions about the availability of a graphite-waste disposal route, and they are likely to be modified if these assumptions prove to be incorrect.

Most of this part of the discussion centred on the issue of *clearance levels for release of radioactive waste from regulatory control*. It was noted that this is different in principle from the issue of site release criteria. The latter is an essentially national issue. It has to have regard to such matters as local background radiation levels, which may be affected by presence of natural radioactive deposits such as monazite for example, and it is unlikely to raise any transboundary issues. National differences in clearance levels for radioactive waste, however, may raise various supra-national issues. They are likely to create difficulties with the transboundary movement of material that may have been cleared in one country but still requires regulatory control as radioactive waste in a neighbouring country. It may also have implications for the fairness of international business. Against this background, it was suggested that what is required is a set of clearance levels that operate in the same way as the internationally accepted standards for transport of radioactive materials.

It was also recognised that clearance levels have implications for the quantities of VLLW that arise in dismantling or site remediation, and thus for the costs of waste management. Consequently, they are likely to have implications also for basic D&D strategy, although experience with Vandellós I was reported as showing that the costs associated with demonstrating compliance with clearance levels may be greater than those of simply consigning the material to a VLLW disposal facility. It was noted also that there is still an on-going issue about the differences in clearance levels that apply to similar materials from nuclear and from non-nuclear sources.

## **Funding and Costs**

The issues that seemed to be important under this theme during the seminar were the potential “hazards to the long-term security of funds”, the relationship between “funding and safety” and “Cost effects of using in-house staff, contractors or separate body for D&D”.

There is concern that sufficient funds are available for D&D operations when they are actually required. The various interventions suggested a suspicion that segregated funds accumulated by way of a charge on electricity sales, for example, might be diverted for current requirements without sufficient guarantee of their availability when required for D&D. The majority opinion seemed to be that a truly independent fund managing body had advantages over plant operating companies, who may become bankrupt, or even Governments, whose priorities for funding may result in the funds being used for other purposes. Even in the case of an independent body, however, it was thought that there were hazards to the long-term availability of funds. These hazards ranged from errors in the assumptions about inflation, or discount rates used for estimation of the funds required, to a simple loss in value of the assets held by the fund. These uncertainties led to the observation that, if sufficient funds are available, and other relevant conditions are satisfied, D&D should proceed as soon as possible. This seemed to be an important strategic consideration.

The relationship between funding availability and safety was also briefly explored. It seemed to be taken for granted that, if funds are needed for reason of ensuring safety – as it is foreseen in the Joint Convention on Safe Management of Spent Fuel and Radioactive Waste and in a proposed Directive on Nuclear Safety by the European Commission –, any uncertainty in the security of funds entails an impact on the safety margins.

Interest had been expressed in the effects of staffing policy on D&D costs. The main options were use of in-house staff, contractors, or a completely separate body. Setting aside the advantages of in-house staff having retained knowledge of the plant and systems, it seemed that savings might be made by avoiding the training and management costs associated with introducing new staff for D&D operations. The same benefit might be achieved by using the alternative of contractors who now specialise in D&D. However, the broad conclusion of this discussion was that it is still very difficult to compare information on D&D costs because the cost-basis is different from country to country and even from Company to Company, despite efforts of the NEA, IAEA and the EC to put such cost estimation on a more consistent and accurate basis.

## **Stakeholder Involvement and Communication**

Four issues were identified appearing to be of most importance or interest under this general theme: “Early discussion of plans with stakeholders” and “Continued dialogue with local communities”, on the one hand, and “Identification of Key Stakeholders” and “Communication by demonstration. (Show us you can do it!)” on the other hand

Discussion around the first 2 items confirmed the importance of early engagement with stakeholders, and with the affected local community in particular, even prior to the planning of decommissioning, and of the need to continue this engagement throughout implementation. This participation, involving two-way communication, is necessary in the development of D&D plans and in their successful implementation. This also reflects the messages that emerged from the session on social aspects and re-confirms that the policy of Decide-Announce-Defend has been a major element in creating stakeholder resistance to developments involving D&D and radioactive waste management at nuclear facilities. The heightened awareness of the importance of these issues led to a suggestion that a database of experience of

stakeholder involvement might be helpful for those planning D&D for the first time, as well as for those wishing to share experiences. The NEA would be a suitable focal point for it<sup>a</sup>.

In the context of the other two items, it was noted that it is particularly important to engage those politicians representing the local community, in the context of social aspects. A "no surprises policy" was judged to be very important in this regard. Lessons learnt have shown that developing a communication plan, getting involved with the community prior to decommissioning, being candid and rational and meeting commitments, all contribute to trust and acceptance. As regards engaging the local population in a meaningful way, it was also noted that demonstration of techniques and activities, where practicable, is a particularly powerful means of communication. Similarly, it was reported that visitor centres and site-tours can play a valuable part in showing the realities of nuclear technology.

It was also noted that public attitudes changed, and hostility to proposed developments sometimes increased with distance from the nuclear facility concerned. In this regard, it was observed that the interests and motives of the various stakeholders needed to be understood. Cases were described where some NGOs, for example, claimed continuing inability to understand or accept even basic scientific information supplied to them. It was suspected that this was simply intended to obstruct progress on D&D as a means of discrediting nuclear power production. In such situations, it was suggested that referring them, publicly, to acknowledged, independent experts (e.g. university academics) was the best way forward.

Particular reference was made to the importance of keeping employees fully informed and confident of their continuing value. This is necessary in order to avoid any loss of morale associated with the idea that D&D is somehow less important than operation, notwithstanding the fact that it may lead eventually to site closure. The retention of staff with detailed knowledge of the plant during its construction and operational phases was judged to be a key element in securing the continuing safety of D&D operations.

### **Satisfying Social Demands**

Several issues are associated with social aspects: "Identifying and Implementing Pillars of Trust (safety, participation, economic development)"; "Providing channels for communication"; "Creating representative local committees"; etc. The participants clearly showed that *Implementing "Pillars of Trust"* is the most important in this context. In practice, it covers most of the social aspects.

The presentations showed that assurance of safety is essential for communities in the locality of a nuclear facility. This applies to all phases of the plant's life, including D&D, and it requires adequate information about the safety of the facility and about plans for dealing with emergencies. Given that such facilities already exist, and that ongoing safety is assured, it seemed that these "nuclear municipalities" avoided debate about the relative merits of nuclear power and concentrated on dealing with the day-to-day issues arising from plant operation and with plans for its future.

In the specific context of D&D, participation in decisions was judged also to be essential and it was emphasised again that the decide-announce-defend policy is not conducive to progress. It was suggested that the best way forward is for site operators closely to involve local politicians or community leaders and to co-operate with any local committees set up to oversee the community interests. This means providing them with transparently valid information about plans and programmes, living up to commitments, and being constantly available to listen to comments and answer questions. It also means providing valid information on safety and environmental matters including waste management and giving full consideration to concerns about the effects on society such as loss of employment, the need for alternative economic activity, future use of the site and about compensatory benefits for the community.

As regards channels for communication of this information, it seemed that all techniques have a place, from conventional meetings, seminars, debates and provision of information packages for local

discussions to television programmes and websites, supported with "chat-rooms" if appropriate. Timeliness was felt to be a key factor. Communities where facilities are shut down prior to the end of life have special communication needs as a result of termination of some employment.

The basic message from the representatives of local communities was that development of confidence and trust in the site operator is essential for effective progress of D&D.

## CONCLUSIONS

OECD Member countries will be faced increasingly with the task of decommissioning and dismantling (D&D) nuclear facilities with a view to final release of sites. Appropriate provisions will have to be made in terms of policy, financing, and of management of the relatively large volumes of materials that arise from this process. Depending on the path chosen, D&D of larger nuclear facilities may take a few years or several decades, which entails specific challenges in decision making, and also has an impact on such broad issues as the sustainability of nuclear power and preserving the well-being of local communities. During the WPDD work some interesting observations have been made:

- Local factors and national political positions have a significant input and often result in widely differing strategy approaches to broadly similar decommissioning projects. All facility owners have been found to have a rational process for strategy selection and compelling arguments for the choices made. Although there appears to be a trend towards early dismantling, there seems to be general agreement that technical solutions support a wide variety of safe decommissioning approaches. Thus, in terms of decommissioning strategy, it appears that no one size fits all.
- A number of common factors were defined for successful implementation of decommissioning strategies, i.e.
  - Safety
  - Technical feasibility of decommissioning options
  - Risk-informed progression of D&D activities as project proceeds
  - Maintenance of competency and corporate memory throughout project
  - Waste management and disposal capability
  - Financing that suits the scope of the project
  - A well-defined risk-informed and performance-based regulatory process
  - Establishment of effective communication with local and regional governments and key stakeholders, particularly personnel, at the earliest opportunity before decommissioning.
- LWRs are relatively easier to dismantle than GCRs, because of the large amounts of contaminated materials, such as graphite, associated with the latter.
- The techniques for dismantling fuel cycle facilities are essentially similar to those for dismantling nuclear power plants except that a safestore period would not be helpful in reducing the radioactivity of those facilities contaminated with long-lived radionuclides.
- It is important that stakeholders feel that their considerations and concerns are addressed throughout the project.
- A flexible regulatory approach is needed in order to recognize the changing operational risks and physical conditions of facilities with time, and to optimise their dismantling.
- The provisions for safety of the D&D process are closely linked to the availability of the necessary funds as and when required.
- Bilateral and multilateral cooperation might enhance progress in defining and implementing decommissioning strategies. Simpler decommissioning regulatory frameworks would be beneficial and is an area where such international cooperation could be useful.



**REFERENCES**

- 1 NEA, 2002a, *The Decommissioning and Dismantling of Nuclear Facilities: Status, Approaches, Challenges*, OECD Nuclear Energy Agency, Paris 2002 [may be obtained free of charge by writing to [neapub@nea.fr](mailto:neapub@nea.fr)].
- 2 NEA, 2002b, *The Decommissioning and Dismantling of Nuclear Facilities in OECD/NEA Member Countries - A compilation of National Fact Sheets*, <http://www.nea.fr/html/rwm/wpdd/welcome.html>.
- 3 NEA, 2003a, *International Seminar on Strategy Selection for the Decommissioning of Nuclear Facilities. Summary and Overview of Lessons Learnt*. NEA/RWM/WPDD(2003)6.
- 4 NEA, 2003b, *Decommissioning Nuclear Power Plants – Policies, Strategies and Costs*, OECD\NEA, Paris (2003). [may be obtained free of charge by writing to [neapub@nea.fr](mailto:neapub@nea.fr)].

**FOOTNOTE**

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- a. A publication reviewing the experience of stakeholder involvement approaches - mostly in the area of waste management - has recently been released by the NEA and could be of both use and inspiration for similar work in the D&D area. See: "Public Information, Consultation and Involvement in Radioactive Waste Management - An International Overview of Approaches and Experiences", OECD\NEA, Paris (2003).