Radioactive Waste Management

OECD

Strategy Selection for the Decommissioning of Nuclear Facilities

Seminar Proceedings
Tarragona, Spain
1-4 September 2003

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NEA No. 5300

NUCLEAR ENERGY AGENCY
ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT

ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT

Pursuant to Article 1 of the Convention signed in Paris on 14th December 1960, and which came into force on 30th September 1961, the Organisation for Economic Co-operation and Development (OECD) shall promote policies designed:

- to achieve the highest sustainable economic growth and employment and a rising standard of living in member countries, while maintaining financial stability, and thus to contribute to the development of the world economy;
- to contribute to sound economic expansion in member as well as non-member countries in the process of economic development; and
- to contribute to the expansion of world trade on a multilateral, non-discriminatory basis in accordance with international obligations.

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NUCLEAR ENERGY AGENCY

The OECD Nuclear Energy Agency (NEA) was established on 1st February 1958 under the name of the OEEC European Nuclear Energy Agency. It received its present designation on 20th April 1972, when Japan became its first non-European full member. NEA membership today consists of 28 OECD member countries: Australia, Austria, Belgium, Canada, the Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, Luxembourg, Mexico, the Netherlands, Norway, Portugal, Republic of Korea, the Slovak Republic, Spain, Sweden, Switzerland, Turkey, the United Kingdom and the United States. The Commission of the European Communities also takes part in the work of the Agency.

The mission of the NEA is:

- to assist its member countries in maintaining and further developing, through international co-operation, the scientific, technological and legal bases required for a safe, environmentally friendly and economical use of nuclear energy for peaceful purposes, as well as
- to provide authoritative assessments and to forge common understandings on key issues, as input to government decisions on nuclear energy policy and to broader OECD policy analyses in areas such as energy and sustainable development.

Specific areas of competence of the NEA include safety and regulation of nuclear activities, radioactive waste management, radiological protection, nuclear science, economic and technical analyses of the nuclear fuel cycle, nuclear law and liability, and public information. The NEA Data Bank provides nuclear data and computer program services for participating countries.

In these and related tasks, the NEA works in close collaboration with the International Atomic Energy Agency in Vienna, with which it has a Co-operation Agreement, as well as with other international organisations in the nuclear field.

FOREWORD

Several OECD/NEA member countries were involved in the earliest developments of nuclear technology in the 1940s and 1950s. These countries have a wide range of plant and equipment that in part 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 decommissioning and dismantling (D&D), but much also 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 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.

The international seminar in Tarragona was held in connection with the entering of the Vandellós-I nuclear power plant into the safestore period. The seminar focused on strategy selection for the decommissioning of nuclear facilities. All the major types of facilities encountered in the nuclear fuel cycle were represented. Over 100 high-level specialists from around the world attended, including representatives of the Regulatory Commission of Spain and decommissioning projects managers from, *inter alia*, France, Italy, Japan, the Slovak Republic, Spain, the United Kingdom and the United States. Several mayors from both Europe and North America also attended. The seminar encouraged open discussions to share lessons learnt and identify possible solutions. A summary of the seminar can be downloaded from ww.nea.fr/html/rwm/wpdd/tarragona/index.html.

These proceedings are published under the responsibility of the Secretary-General of the OECD. The opinions expressed are those of the authors and do not necessarily reflect the views of any member country or international organisation.

Acknowledgements

On behalf of all of the participants, the NEA Secretariat would like to thank the *Consejo de Seguridad Nuclear* (CSN) and ENRESA who were the hosts of the seminar, as well as the programme committee and all the co-operating organisations in Spain.

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A. Duncan, Rapporteur
C. Pescatore, NEA Secretariat
M. Federline, Chair of the seminar

During the Tarragona International Seminar the participating high-level specialists had very open and fruitful discussion concerning strategic decommissioning issues. The lessons learnt and possible solutions for future work issues can be found below.

Although there appears to be a trend towards early dismantling, there seemed 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 flexible regulatory approach is needed in order to recognise the changing operational risks and physical conditions of facilities with time, and to optimise their dismantling.

The NEA has released a comprehensive study on decommissioning strategies and costs that indicates world-wide progress.[1] According to this report, over 50% of countries with nuclear facilities have a framework of decommissioning requirements and 60% have defined radioactive waste clearance levels. Up to about 70% of the costs of D&D are attributable to dismantling and waste management.

The provisions for safety of the D&D process are closely linked to the availability of the necessary funds as and when required.

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, and 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.

Several programmatic and policy issues were raised including:

- Should the costs/benefits of adopting internationally consistent radioactive waste clearance levels, for use in decommissioning projects, be more heavily emphasised in the context of international business and competition?

- To what degree should institutional controls be relied on in safety cases for decommissioning options involving an element of long-term stewardship?

- Does the international trend toward independent national organisations having responsibility for waste management and disposal set a useful precedent?

- Is early dismantling and successful demonstration of technology a significant factor in establishing public confidence for building new plants? (This is key in the French and Japanese strategy.)

Regarding views on where bilateral and multilateral co-operation might enhance progress in defining and implementing decommissioning strategies, the following points were agreed.

- On the issue of radioactive waste clearance, an adequate scientific basis is available for defining clearance levels, but a high level discussion of is needed to look for solutions that can satisfy both international and national interests.

- There was general agreement, supported by the regulators present, that a simpler decommissioning regulatory framework would be beneficial.

- Although it was agreed that exchange of information on funding requirements and systems might be useful, differences in decommissioning work breakdown structures make it difficult to get good cost data.

- An international database on decommissioning experience would be useful. Several databases now exist and it may be useful to look at combining them.

- Societal factors are key to successful decommissioning projects and establishing pillars of trust is important at the earliest opportunity before decommissioning.

In addition to the above points, the seminar attendees were asked to identify the issues that were of significance to them and where they believed advice and further work by the international community might enable progress. They identified the following issues.

Stakeholder involvement

- Early discussion of plans with stakeholders.

- Continued dialogue with local communities.

Strategy selection

- Waste management provisions.

- Costs and funding arrangements.

Waste management and clearance

- Availability of waste disposal routes.
- Standards of clearance and effects of differences on decommissioning costs and international business.

Funding and costs

- Relationship between funding and safety.
- Hazards to the long-term security of funds.

Social demands

- Implementing "Pillars of Trust". (Safety, participation and economic development.)

Concluding remarks

There may be an expectation amongst politicians and the public that there is a "right answer" to the choice of strategy selection for a particular type of facility, or even all facilities. This seminar and, indeed, wider experience shows that this is not the case.

- 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 represented could demonstrate a rational process for strategy selection and compelling arguments for the choices made.

The NEA, and in particular its Working Party on Decommissioning and Dismantling, which was one of the joint organisers of this event, will use these outcomes to inform its future work programme.

References

[1] NEA, 203b, *Decommissioning Nuclear Power Plants – Policies, Strategies and Costs*, OECD\NEA, Paris (2003).

OPENING SPEECHES

ACTIVITIES OF THE OECD/NEA
IN THE AREA OF DECOMMISSIONING AND DISMANTLING

Luis Echávarri
Director-General of the OECD/NEA

Introduction

The member countries of the OECD Nuclear Energy Agency are among those that were involved in the earliest developments of nuclear technology in the 1940s and 1950s. They thus have a range of plants 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 400 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 given that the average age of nuclear power plants is, at present, about 15 years, the rate of withdrawal from service will peak some time after 2015. The peak will, however, be sometime later if the tendency to extend operating lifetimes continues. The statistical distribution is wide, anyhow, 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 work of the NEA and main lessons learnt so far

The OECD/NEA has long recognised the importance of D&D of nuclear facilities, since the early 1980s. Within the NEA, decommissioning is discussed within several standing technical committees, although the WPDD – the Working Party on Decommissioning and Dismantling, that has organised this international seminar – is the only working party totally committed to decommissioning and dismantling.

A few recent NEA publications [1, 2, 3, 4] provide an overview of where we stand on many issues. Namely, they state that the purpose of D&D is to allow removal of some or all of the 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.

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.

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, and to ensure continuity and transparency of the regulatory process, these issues are under continual review.

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, to maintain and further develop the related expertise, and for public confidence.

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. Waste management costs are a significant element of the overall costs of D&D and may dominate in some cases. 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, 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 materials 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 radio-active 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 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.

The NEA is working on all the identified issues. The Working Party on Decommissioning and Dismantling – the one that has organised the present International Seminar – is performing outstanding work on issues interfacing between regulatory, policy, technical, and social aspects. The programme of this Seminar also demonstrates this.

Next year an NEA International Workshop will take stock of where we stand on several of the issues. The workshop is likely to take place late Summer of early Autumn 2004.

Closing remarks

Having worked in Spain – in the capacity of Commissioner of the Nuclear Safety Authority – and on Vandellós specifically, let me tell you, dear colleagues, that I take special pleasure seeing that we have moved so far in this decommissioning project. Namely, a period of safestore lasting a few decades. This will require the continued cooperation of several of the main actors that have taken the project this far.

On behalf of the NEA – as organiser of this meeting – and on behalf also of the Programme Committee – I would like to thank the Consejo de Seguridad Nucleár, here represented by Marìa-Teresa Estevan Bolea, and the ENRESA, here represented by Antonio Colino, for hosting the meeting as well as for the openness that these organisations have shown in sharing the lessons learnt with the international community. In the end, this is also a service to Spain and to Catalunya. This must have been the thought of Julio Barcelò, Commissioner in the CSN, who first suggested this seminar to the NEA. I'd like to thank also him for this excellent idea.

Finally, let me welcome all of you in the audience. I wish us all excellent interactions and a fruitful stay.

References

[1] NEA, 2002a, *The Decommissioning and Dismantling of Nuclear Facilities: Status, Approaches, Challenge*s, OECD Nuclear Energy Agency, Paris, 2002. [http://www.nea.fr/html/rwm/reports/2002/3714-decommissioning.pdf] [may be obtained free of charge by writing to neapub@nea.fr.]

[2] NEA, 2002b, *The Decommissioning and Dismantling of Nuclear Facilities in OECD/NEA Member Countries – A Compilation of National Fact Sheet*, OECD Nuclear Energy Agency, Paris, 2003. [http://www.nea.fr/html/rwm/wpdd/welcome.html]

[3] NEA, 2003a, *The Regulatory Challenges of Decommissioning Nuclear Reactors, and Dismantling*, OECD Nuclear Energy Agency, Paris, 2003 [may be obtained free of charge by writing to neapub@nea.fr.].

[4] NEA, 2003b, *Decommissioning Nuclear Power Plants: Policies, Strategies and Costs*, OECD Nuclear Energy Agency, Paris, 2003.

DECOMMISSIONING AND RADIOACTIVE WASTE MANAGEMENT IN SPAIN

María-Teresa Estevan Bolea
President of Nuclear Safety Council of Spain

Good morning ladies and gentlemen.

It's a pleasure for us to receive you at this lovely place, the city of Tarragona. Welcome, again, to Spain.

For the Nuclear Safety Council of Spain this Seminar is developed in a very opportune time because we face a new task like the licensing of the shutdown and decommissioning of José Cabrera NPP, in Zorita, in April of 2006.

The same case is being experienced by many NEA member countries, so we are thankful for your work, which I'm sure it would be really useful to us.

In Spain, we are having an experience in decommissioning, Vandellós-I NPP. And now we begin another one. Each one is different from the other. Why? Because they use different technologies but specially because in the first case, Vandellós-I, it was not necessary to store the spent fuel immediately, and in Zorita's case it's imperative to provide a temporary storage, immediately, may be in the very power plant.

So in April of 2006 we'll begin a new task but before this date, as regulatory body, we need to finish all the procedures and documents for the closing and dismantling of the NPP.

There are many NPPs in Europe in the same situation.

Decommissioning and radioactive waste management in Spain

Old regulations on nuclear and radioactive facilities, in force up to the end of 1999, included no specific references that might serve as a regulatory framework for licensing the decommissioning process of such facilities. All facility decommissioning projects initiated in Spain up to that date, including Vandellós-I Nuclear Power Plant Decommissioning Plan, were licensed according to an approach worked out specifically for each one.

Ministerial authorisations for decommissioning

The reference regulatory framework for the decommissioning of the Spanish nuclear facilities is established in the *Royal Decree 1836/1999* adopting the current *Regulation on Nuclear and Radioactive Installations* that provides, for the first time, for the administrative process of licensing the decommissioning of nuclear and radioactive facilities, and regulates the whole administrative procedure, specifying the documentation that the licensees of such facilities must provide. Chapter VI of this *Regulation on Nuclear and Radioactive Installations* is dedicated fully to the system of administrative authorisations required for the decommissioning and dismantling of such installations.

The aforementioned regulations establish two basic ministerial authorisations for the decommissioning of a nuclear facility to begin: the **dismantling permit** to be granted once its operation has ended and the so-called **decommissioning statement**, which would release the old operator from its liability for the facility's safety.

Permanent cessation of operations and pre-dismantling activities

Regulations provide that the Ministry of Economy must specify in the official permanent shutdown statement, whether due to a planned or unforeseen cessation of operations of the facility, for certain preliminary activities to be carried out by the holder prior to the request for and granting of the dismantling permit:

- The conditions that must be met by the activities to be carried out at the facility until a dismantling licence is obtained.
- The period within which such a dismantling licence must be requested.

The holder of the facility operating permit must in any case carry out two activities before a dismantling licence is granted:

- Unloading of fuel from the reactor and the storage pools.
- Conditioning of waste generated during the facility's operation.

The Regulations also envisage the possibility of authorising the dismantling of nuclear power plants with the fuel still located in the fuel pools, provided that the licensee has prepared a plan for the management of that spent fuel, previously approved by the Ministry of Economy.

Licence holder for the decommissioning of nuclear power plants

A rather peculiar system is in force in Spain, where ENRESA, the Radioactive Waste Management Agency, takes the responsibility for the management of dismantling operations arising as a result of the decommissioning of nuclear power plants.

That means that trusteeship of these facilities must be transferred from the operating licensee to ENRESA. The latter will then become the licence holder of the facility during the performance of dismantling activities and up to the moment of awarding of the decommissioning statement. At which moment the site, now free of the facility, is returned to its owner, the former operating licensee.

The transfer of trusteeship is authorised by the MINECO at the same time as the authorisation for dismantling, on completion of the pre-dismantling activities that are the responsibility of the plant operator.

Dismantling authorisation

The dismantling permit, awarded by the MINECO following a favourable report by the CSN on the dismantling plan proposed by the licensee, and positive evaluation of its environmental impact by the Ministry of the Environment, allows the licensee to implement the said plan and to initiate activities relating to the decontamination and disassembly of equipment, the demolition of structures and the removal of materials, ultimately to allow for the total or restricted release of the site.

The procedure for requesting a nuclear facility dismantling permit requires the submission of documentation quite similar to that required during the operating stage, but whose contents are to be in keeping with the new stage of the facility's life.

- **Safety study**, giving a description of the facility's initial status and an outline of the main activities to be undertaken during the project. Its contents include:

- **Operating regulation,** with a description of the organisation, functions and responsibilities of personnel.

- **Technical specifications** applicable to operational equipment and systems during dismantling activities.

- **Quality assurance manual,** establishing the scope and contents of the quality programme devised for the dismantling process.

- **Radiation protection manual,** with the radiological standards and protection criteria applicable while dismantling activities are carried out.

- **Site emergency plan,** providing for the possibility of critical accidents where nuclear power plants are dismantled with spent fuel inside. The probability of occurrence of accidents with radiological impact such as fires, explosions, etc. may rise owing to the type of materials used and the activities carried out.

- **Radioactive waste management plan**, which should set out the basic criteria for the management of all waste materials generated in the process, both radioactive waste and cleared materials.

- **Site restoration plan**, a document characteristic of dismantling licences which should include plans for carrying out a final radiological analysis of the site to be released following the decommissioning statement.

- **Financial study**, with financial forecasts for the dismantling project.

If the dismantling plan for the facility presents different phases of performance, separated by intermediate periods of inactivity (dormancy) or by any other significant separation, the authorisation granted will regulate only the phase immediately following its issuing, new authorisations being required for the performance of subsequent phases.

Decommissioning statement

The process of dismantling a facility ends with the so-called "Decommissioning statement", which frees the licensee from his responsibility as operator and defines, in those cases in which the release of the site is restricted by some kind of conditioning factor, the limitations on use that will be applicable in the future, while appointing the organisation responsible for their maintenance and for ensuring their compliance.

The decommissioning statement is awarded by the MINECO on completion of the dismantling activities, once the Nuclear Safety Council has verified that the technical conditions established in the dismantling project, especially what is stated in the waste management and site restoration plans, have been fulfilled.

We are working just now in the project of shutdown and decommissioning of José Cabrera NPP.

Surely the spent fuel will be storaged in the very power plant, in an Independent Temporary Storage – ATI.

Management of the waste materials generated

Radioactive waste generated in facility dismantling processes is initially subject to the same conditioning requirements as that generated during its operating phase. Atypical waste, with significant differences compared to radioactive operating waste, needs to be reconditioned so that it also fulfils the criteria of being accepted by the facility to which it is to be despatched for final management or disposal.

A particularly sensitive regulation is that relating to the management of very low level activity waste materials which may be potentially liable to declassification or to be cleared and potentially incorporated into the conventional materials management sphere.

Legal and regulatory grounds for clearance

Article 76 of the above mentioned regulation establishes that the disposal, recycling or reuse of radioactive substances or materials containing radioactive substances coming from any nuclear installations shall be subject to authorisation by the General Directorate for Energy and Mining Policy of the Ministry of Economy, following a report by the Nuclear Safety Council.

Nevertheless, the disposal, recycling or reuse of such substances or materials may be exempted from this requirement, as long as such substances contain or are contaminated by radionuclides in concentrations or levels of activity equal to or lower than those established by the Ministry of Economy, in relation to the definition of radioactive waste referred as “Any waste product or residual material for which no further use if foreseen and which contains or is contaminated with radionuclides in concentrations or activity levels higher than clearance values, as defined by the Regulatory Authorities”.

Up to now, the Ministry has not yet implemented any clearance levels for residual materials or any clean up criteria for lands or sites to be applied in a general way. However, there have been particular ministerial authorisations linked to particular decommissioning projects for certain facilities which lay down declassification levels for residual material and radiological criteria for site release that are only valid for these projects.

Clearance policy in Vandellós-I NPP decommissioning programme

The Vandellós-I decommissioning project has three authorised basic possibilities for the application of clearance of residual materials: the unconditional clearance level (N_1 level); the generic conditional clearance level (N_2 level); and the specific conditional clearance level (N_3 level). Different sets of radionuclide specific figures for unconditional clearance levels (N_1) and for generic conditional clearance levels (N_2) have already been established for some generic materials, building and concrete demolition debris among them (see annex).

Table 1. Management options for residual materials in the Vandellós-I NPP decommissioning programme

CLASSIFICATION	MANAGEMENT
Radioactive waste	Radioactive waste management
N_3	**SPECIFIC CONDITIONAL CLEARANCE**
Specific material or waste stream (To be proposed)	Specific management route (To be proposed)
N_2	**GENERIC CONDITIONAL CLEARANCE**
Defined material or waste stream	Defined management route
N_1	**UNCONDITIONAL CLEARANCE**
No contaminated material	Conventional management

Finally, I'm very thankful to the NEA for its works and publications about this topic. They are really useful for our work and I wish you all a very productive Seminar and a pleasant time in Tarragona.

Thank you very much.

DECOMMISSIONING AND RADWASTE MANAGEMENT IN SPAIN

Antonio Colino
Chairman of ENRESA, Spain

Institutional framework

The management of radioactive wastes in Spain is undertaken by "*Empresa Nacional de Residuos Radioactivos, S.A.*" (ENRESA), the Spanish national radioactive waste company, constituted in 1984. ENRESA operates as a management company, whose role is to develop radioactive waste management programs in accordance with the policy and strategy approved by the Spanish government. Its responsibilities include the decommissioning and dismantling of nuclear installations.

ENRESA is a state company whose shareholders are CIEMAT (Centre for Energy-Related, Environmental and Technological Research), previously known as the "*Junta de Energía Nuclear*" (Nuclear Energy Council) and SEPI (State Industrial Holding Company). Both of them are governmental institutions with an eighty and twenty percent of the company respectively.

In 1980 the Spanish Nuclear Safety Council (CSN) was constituted as the sole competent organisation in the field of nuclear safety and radiological protection, and in general is responsible for regulating and supervising nuclear installations. This organisation, governed by a legal statute, is independent from the administration and reports directly to parliament.

General radioactive waste plan

As it is above mentioned, ENRESA was set up as a state-owned limited liability company, independent of waste producers, in order to be responsible for all waste management activities in the country. The company is supervised by the government, to whom it is obliged to submit an Annual Report of Activities and proposal for a General Radioactive Waste Plan (*Plan General de Residuos Radiactivos – PGRR*) on a yearly basis.

In accordance with the Royal Decree authorising the constitution of ENRESA, the costs of activities deriving from the management of radioactive wastes and decommissioning activities are to be borne by the producers of such waste. The system established for the nuclear power plants consists of applying a percentage fee based on the billing of electricity sales by the entire electricity industry, while for other producers payment for the services rendered is based on tariffs, billed at the moment of waste collection.

For the nuclear electric sector a system of payments on account is established, such that the income collected through the application of the percentage fee is accumulated for financing of costs that will normally occur years later. In order to ensure automatic financing in accordance with the system established, ENRESA will transfer to a provision those funds which are to be collected thorough billing on electricity sales throughout the operating lifetime of nuclear power plants. It should also be pointed out that the final economical balance of the management performed by ENRESA should be zero. Both the income from the quota and arising as a result of the financial yield of net surpluses should be set aside for the creation of a special fund. This fund may be used only for compliance with the objectives for which. ENRESA was created and therefore for financing the costs of waste management. The supervision, control and qualification of the financial investments of the fund is the responsibility of the Ministry Tracking and Control Committee.

For the rest of radioactive waste producers, other than the nuclear power plants (CIEMAT, ENUSA, hospitals, industry, etc.), the financing system is based on economic consideration for the services rendered, through payment of the established tariffs. The prices are drawn up in accordance with the criteria established in the Standard Contract approved by the Ministry of Economy.

In accordance with the Royal Decree regulating its foundation. ENRESA is due to draw up a proposal of a General Radioactive Waste Plan every year to be submitted for the government approval. This Plan is a basic document which outlines the strategies and main lines of action projected to accomplish the objectives in the different areas of responsibility.

The fifth General Radioactive Waste Plan, approved by the government in July 1999, is currently in force. It basically contains the current generation and forecast of radioactive wastes and spent fuel in Spain, as well as the management strategies for low and intermediate level waste, spent fuel and high level waste and for decommissioning of nuclear installations, including the related economic and financial aspects.

For the purposes of economic calculations and waste generation and planning, the present PGRR is based on a reference scenario whose hypotheses are: open cycle, not consideration of future incorporation of new reactors, operation NPPs lifetime of forty years, and the complete dismantling of all the NPPs currently in operation at the end of their service lifetime (operations commencing 3 years after definitive shutdown and following the removal of the fuel from their pools and of operating low and intermediate level wastes).

Activities of ENRESA

Management of low and intermediate radioactive level wastes

In Spain, El Cabril Centre is the installation for the management of low and intermediate level wastes. This facility provides an integrated management system that includes waste collection, transport, treatment and conditioning, as well as accurate information on the waste inventory, radiological characterisation and quality assurance, all of which is compatible with the type of disposal applied.

Except in the case of radioactive installations, the preliminary treatment and conditioning of low and intermediate level wastes is the responsibility of the producer, who is required to generate waste packages meeting the acceptance criteria defined by ENRESA, for subsequent conditioning and definitive disposal at El Cabril. In the case of radioactive installations, waste treatment and conditioning is carried out at the El Cabril facilities, since given the small volume generated, the large number of producers and their different characteristics there would be no justification for each such producer having the necessary installations.

Management of spent fuel and high level wastes (HLW)

In the current strategy, as addressed in the 5th Radioactive Waste Plan, a distinction is made between the temporary and definitive technological solutions to be applied, which to some extent defines a different approach to previous plans, in particular as concerns the time schedule in the decision-making process. In principle, no decision for the final solution will be taken before 2010.

With these considerations in mind the present strategy can be summarised in the following steps:

- Increasing the storage capacity at the reactor pools by means of reracking.
- Providing flexible complementary solutions, to be applied when needed.
- Providing a centralised interim storage facility by the year 2010.

Regarding temporary storage of Spent fuel, activities in this field have basically been aimed at completion of the construction and start-up of a temporary spent fuel storage facility at the site of the Trillo nuclear power plant, and at the manufacturing in Spain of the metallic dual-purpose (transport and storage) casks to be used.

The construction of the Trillo NPP facility, authorised by the government through the Cabinet of Ministers held on 31 July 1999, was completed in March 2002, the installations becoming operative in the following months. On 29 July, Trillo NPP completed the process of loading the first cask (DPT) with 21 spent fuel assemblies, this then being located in the position assigned to it in the storage facility. The loading of the second cask began immediately afterwards, the process being completed on 13 August, 6 units are scheduled for delivery up to year 2003.

The strategy adopted to date by ENRESA for the definitive management of spent fuel and HLW has been based on ensuring the availability of the scientific and technological know-how and capacity required for two possible solutions: final disposal in deep geological formations and partitioning and transmutation.

Decommissioning

Spain occupies a leading position at international level in the field of installation decommissioning, since decommissioning projects have already been performed in relation to uranium mills (Andújar and La Haba), the rehabilitation of disused uranium mines and the dismantling of the Vandellós-I Nuclear Power Plant.

The aim of the Vandellós-I NPP dismantling project is to release 80% of the site during the initial phase (level 2). Following a latency period of some 25 years, which will allow the levels of radiation to decrease significantly, the dismantling of the remaining parts, basically the concrete structure or shroud housing the reactor, will be addressed under more favourable conditions (level 3).

International participation and collaboration

ENRESA has established bilateral agreements with numerous national agencies of different countries and have had a significant contribution in the development of EDRAM organisation (Environmental safe Disposal of RAdioactive Materials).

Regarding the participation in programmes in the European Union: 37 cost share projects with more than 500 researchers in the R&D framework programme (DGRTD), technical assistance for DG Enlargement and DG Relex with more than 40 projects in Phare/Tacis programmes, and technical co-operation in a plan of action for RWM (DG Tren) can be highlighted.

THE SPANISH DECOMMISSIONING SCENE

THE REGULATOR'S VIEW

Paloma Sendín
Commissioner, CSN, Spain

Spanish experience holds a relatively important position in the field of the decommissioning of nuclear and radioactive facilities. Nearly completed decommissioning projects of uranium concentrate mill facilities and some old uranium mine sites already restored have been joined by several projects for the dismantling of various small research nuclear reactors and a few pilot plants, some of them completed now while others are at various phases of the dismantling process. The most notable Spanish project in this field is undoubtedly the decommissioning of the Vandellós-I nuclear power plant that, as you know, is currently being carried out and is ready now to start a safe enclosure or dormancy period.

Nuclear facilities are subject to a system of prior authorisation by the competent authorities before they come into service and to subsequent regulation and control during their operating life. Nuclear and radioactive facilities that stop operating, for technical or financial reasons or because they are compelled to, remain subject to this regulatory control system as long as the competent authorities consider that their residual radioactivity represents a potential source of radiological hazard to the individuals affected or entails an unacceptable environmental risk.

The decommissioning of nuclear facilities is contemplated in Spain a further or an additional step of their life cycle in which, in principle, the whole regulatory framework in force during the previous stages – sitting, construction, commissioning, operation, etc. – remains applicable. The term decommissioning is used to delineate the final stage of the life of a definitely non-operational facility and also to introduce a new licensing regime and a new regulatory control scheme.

In the regulatory context, the decommissioning of a facility is understood as a set of administrative and technical actions and processes whose purpose, once a facility has been withdrawn from service, is to release it from regulatory control and so to relieve the former licensee of its previous responsibilities relating to the facility's safety.

With the increasing age of nuclear and radioactive facilities in service, and as the number of facilities reaching the end of their operating life rises, the administrative process required in order to decommissioning them safely has become a real challenge in all countries, especially in those like Spain with an old nuclear power programme.

Let me first give you a quick overview of the Spanish regulatory decommissioning framework. Then I will try to analyses the challenge that the decommissioning of nuclear facilities represents for the Spanish Nuclear Safety Council and to share with you some of the lessons learned when licensing and supervising the decommissioning of nuclear power plants.

Ministerial authorisations for decommissioning

The reference regulatory framework for the decommissioning of the Spanish nuclear facilities is established in the *Royal Decree 1836/1999* adopting the current *Regulation on Nuclear and Radioactive Installations* that provides, for the first time, for the administrative process of licensing the decommissioning of nuclear and radioactive facilities, and regulates the whole administrative procedure, specifying the documentation that the licensees of such facilities must provide. Chapter VI of this *Regulation on Nuclear and Radioactive Installations* is dedicated fully to the system of administrative authorisations required for the decommissioning and dismantling of such installations.

The aforementioned regulations establish two basic ministerial authorisations for the decommissioning of a nuclear facility to begin: the dismantling permit to be granted once its operation has ended and the so-called decommissioning statement, which would release the old operator from its liability for the facility's safety.

Permanent cessation of operations and pre-dismantling activities

Regulations provide that the Ministry of Economy must specify in the official permanent shutdown statement, whether due to a planned or unforeseen cessation of operations of the facility, for certain preliminary activities to be carried out by the holder prior to the request for and granting of the dismantling permit: the conditions that must be met by the activities to be carried out at the facility until a dismantling licence is obtained and the period within which such a dismantling licence must be requested.

The holder of the facility operating permit must in any case carry out two activities before a dismantling licence is granted: unloading of fuel from the reactor and the storage pools and conditioning of waste generated during the facility's operation.

The Regulations also envisage the possibility of authorising the dismantling of nuclear power plants with the fuel still located in the fuel pools, provided that the licensee has prepared a plan for the management of that spent fuel, previously approved by the Ministry of Industry and Energy.

Licence holder for the decommissioning of nuclear power plants

A rather peculiar system is in force in Spain, where ENRESA, the Radioactive Waste Management Agency, takes the responsibility for the management of dismantling operations arising as a result of the decommissioning of nuclear power plants.

That means that trusteeship of these facilities must be transferred from the operating licensee to ENRESA. The latter will then become the licence holder of the facility during the performance of dismantling activities and up to the moment of awarding of the decommissioning statement. At which moment the site, now free of the facility, is returned to its owner, the former operating licensee.

The transfer of trusteeship is authorised by the MINECO at the same time as the authorisation for dismantling, on completion of the pre-dismantling activities that are the responsibility of the plant operator.

Dismantling authorisation

The dismantling permit, awarded by the MINECO following a favourable report by the CSN on the dismantling plan proposed by the licensee, and positive evaluation of its environmental impact by the Ministry of the Environment, allows the licensee to implement the said plan and to initiate activities relating to the decontamination and disassembly of equipment, the demolition of structures and the removal of materials, ultimately to allow for the total or restricted release of the site.

The procedure for requesting a nuclear facility dismantling permit requires the submission of documentation quite similar to that required during the operating stage, but whose contents are to be in keeping with the new stage of the facility's life.

If the dismantling plan for the facility presents different phases of performance, separated by intermediate periods of inactivity (dormancy) or by any other significant separation, the authorisation granted will regulate only the phase immediately following its issuing, new authorisations being required for the performance of subsequent phases.

Decommissioning statement

The process of dismantling a facility ends with the so-called "Decommissioning statement", which frees the licensee from his responsibility as operator and defines, in those cases in which the release of the site is restricted by some kind of conditioning factor, the limitations on use that will be applicable in the future, while appointing the organisation responsible for their maintenance and for ensuring their compliance.

The decommissioning statement is awarded by the MINECO on completion of the dismantling activities, once the Nuclear Safety Council has verified that the technical conditions established in the dismantling project, especially what is stated in the waste management and site restoration plans, have been fulfilled.

Regulatory challenge

Although most of the decommissioning projects undertaken up to the present have been on medium and low power reactors, the technical process for decommissioning such facilities has evolved from initial programmes that we could describe as "research and development", through programmes in which the activities to be carried out were analysed case by case, into an increasingly standardised procedure that we may now call an "industrial process".

Up to now, the regulations applicable to decommissioning processes have been mostly developed case by case through the regulatory authorities' interpretation and application of the criteria, standards and rules established to control the operating life of the facilities concerned. This has also been the case in Spain where old regulations on nuclear and radioactive facilities, in force up to the end of 1999, included no specific references that might serve as a regulatory framework for licensing the decommissioning of such facilities. All facility decommissioning projects initiated in Spain up to that date were licensed according to an approach worked out specifically for each one.

Decommissioning on the basis of case-by-case regulatory decisions has the advantage of certain flexibility, which has, up to a point, been indispensable in the initial period of decommissioning processes carried out so far. But now that there is sufficient practical experience of these processes, there is an increasingly apparent need to establish a specific set of regulations applicable across the board to all decommissioning processes, and to set guidelines and technical standards so as to systematise the regulatory process, making assessment results more predictable and thereby helping to optimise both financial costs and those arising from radiological risk.

The types of safety, environmental and public policy issues that arise in decommissioning can be quite different form those during operation, and often public interest and concern can be quite high. The population living near a nuclear facility may have become accustomed to its normal operation, but they are naturally concerned that a new activity like decommissioning be done safely, and they may be even more concerned about plans for the long-term condition of the site. These new safety, environmental, organisation, human and social factors and public issues produce new challenges for the regulator.

It should be recognised that the main problem to be solved in Spain and all other countries, before tackling the decommissioning issue as an "industrial" one is to establish a viable spent fuel management strategy. The question of waste treatment, waste storage and waste disposal is also an important challenge of nuclear facility decommissioning and requires regulatory guidance in order to do not waste the waste disposal capacity of the Spanish low level waste repository "El Cabril".

The recent IAEA Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management requires the competent authorities to take steps to ensure the safety of the decommissioning process of nuclear facilities withdrawn from service. The following points are highlighted:

- availability of qualified staff for the decommissioning process;
- provision of adequate financial resources for the process;
- keeping of records of information important to decommissioning;
- preparedness for emergencies that may arise during decommissioning;
- operational radiation protection during decommissioning activities;
- radioactive discharges and uncontrolled releases into the environment.

We can also mention here some other decommissioning aspects requiring later development, regulated up to now on a case-by-case basis and currently being subject to wide-ranging national and international debate:

- the management of specific decommissioning radioactive waste;
- the clearance and recycling of materials originating from facility dismantling;
- the adaptation of the facilities' operating regulatory oversight to the decommissioning stage;
- the administrative procedures for releasing sites of old facilities and for the verification that safety criteria for release are fulfilled;
- the transitional stage at nuclear power plants following their permanent shutdown;
- the oversight of safety systems technical specifications evolution during decommissioning activities.

Developing the above-mentioned aspects has become a real challenge for all the competent regulatory authorities dealing with decommissioning. New emerging regulatory issues appear like those related with the removal of control for the clearance of materials and the release of sites. There are also others regulatory challenges worth mentioning here. These challenges that are even more important than previous ones, imply a genuine change in the regulator's mind and are particularly related with a new approach that should be applied in regulations when regulating decommissioning. Regulatory bodies should modify in some way their old and almost familiar methods that are used for controlling and supervising facilities' operations when they are dealing with the control of the last period of the life of these facilities.

Lessons learned

Most of the regulatory factors that are addressed to ensure the safety during the operational phase of a nuclear facility will continue to apply during its decommissioning, but decommissioning also raises to issues that are in some respect different from those prevailing during the operation of the installation.

Let me summarise now, as a lesson learned from the decommissioning of Vandellós-I nuclear power plant, some important considerations to have in mind when regulating the decommissioning of nuclear facilities.

Once the spent fuel had been fully removed from the site, as it was in the case of Vandellós-I nuclear power plant, there are four main characteristics to define the basic criteria and conditions to achieve the safe decommissioning of a particular facility:

- The progressive reduction of the existing radioactive inventory and its characteristics and the associated evolution and change on the remaining radiological risk.

- The inherent need to progressively remove from service safety systems and destroy confinement barriers that can increase temporarily the risk, especially for workers.

- The dynamism of the dismantling activities, in comparison with those implemented during the operational stage that are much more static and repetitive.

- The non-reversible nature of the activities that forces to focus regulatory control very much on quality assurance of dismantling tasks and the training of workers.

A principle of proportionality and evolution between risk and the safety requirement should inform the level of control established during the full decommissioning process (risk informed regulations). This is not only due to the change in the level of risk but also to the different safety perception, focusing no longer on the potentially catastrophic events but much more on risks involving hazards that are less serious but much more likely. The concept of an "intensive" safety control measurement to prevent risk of criticality, heat generation, high radiation levels or spent fuel safety and security, should be substituted by an "extensive" approach.

On the other hand, the regulatory approach should also take into account aspects such as the lost of physical barriers, the proximity of radiation sources to workers and the existence of diffuse levels of radiation and contamination during long periods and in large zones within the facility being decommissioned.

Radiological protection of workers must be optimised on the basis of a detailed knowledge of the work environment and a valid estimate of the duration of project task. Staff training and the preparation and monitoring of the work environment are key parameters for ensuring that the dismantling work is done in suitable radiological conditions.

The Spanish framework for decommissioning commercial nuclear power plants implies the facility is temporarily transferred to a different licensee in charge to perform the main decommissioning and dismantling activities, however, the original licensee will retain responsibilities for a period of time while executing several pre-dismantling activities. This transition period between operation and decommissioning has demonstrated to be a critical one. Some peculiar regulatory concerns arise from this situation, especially with the documentation and records transfer and the loss of historic knowledge about the plant operation.

A considerable number of dismantling tasks are performed in decommissioning projects by expert contractors or other types of outside personnel that are not used to nuclear industries methods of work and the responsibilities for safety could not be clearly allocated at all time. A clear and unequivocal allocation of responsibilities for safety shall be ensured by regulatory control in these cases. The regulatory body should also promote a safety culture in order to encourage a questioning and learning attitude to protection and safety.

The management of residual material is a key component in the decommissioning of nuclear facilities and a matter of regulatory concern. A well-documented decision process with a quality control programme is very important form the regulatory point of view for the clearance of residual materials. Regulatory control must assure that materials are not deliberately diluted in order to meet the clearance levels and adequate monitoring system is implemented before its release to the environment or recycled to the conventional market.

The final regulatory overseen activity at all decommissioning site will be, obviously, to review the plans for the final radiological site survey and to accept the result of their implementation. The design of a regulatory mechanism for the license termination of a facility is the last but, as you see, not the least regulatory challenge of the decommissioning issue.

Just to finalise my presentation I have to say that a particular decommissioning strategy may vary depending on the facility type and other various factors including the structure of the nuclear power program of each country, the availability of final radioactive waste disposal facilities, the assignment of responsibilities among different organisations involved in the decommissioning, etc. Early or deferred decommissioning can be acceptable options and both are used world-wide. Strategies of decommissioning are strongly affected also by business and political decisions that makes harmonisation very difficult if not impossible.

I think that from a regulatory viewpoint safety regulations and the regulatory body must assure safety whichever the strategy is chosen for decommissioning.

Most important for implementers is a regulatory scheme and methods established according to the real decommissioning safety case. It has been said somewhere that it is absolutely necessary to avoid “decommissioning regulatory uncertainty” to obtain a more predictable regulation for decommissioning processes in order to facilitate future projects.

DECOMMISSIONING AMD DISMANTLING POLICY IN SPAIN

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Decommissioning and dismantling nuclear installations is an increasingly important topic for governments, regulators, industries and civil society. There are many aspects that have to be carefully considered and planned, in many cases well in advance when they really need to be implemented.

In my speech I am going to focus on policy-making considerations. Firstly I will go briefly over the current Spanish strategy on D&D, discussing the know-how we have gained from past experience. Then I will review the challenges that we will have to face in the near future, suggesting possible alternatives and approaches. I will finish talking a little bit about the international scene.

Spanish policy

Legal framework

Spanish regulations provide the legal framework upon which the procedure for decommissioning and dismantling nuclear installations must be carried out. The Nuclear and Radioactive Installations Regulation establishes the administrative procedure to deal with decommissioning of nuclear installations. The current version of this regulation is dated December 1999.

According to this legal framework, the operator is accountable of the radioactive wastes generated during the operation of the facility while they are on the site and is responsible for:

- Executing and updating the radioactive waste management plan during the operation of the facility; and
- Cooperating in all activities related to the D&D procedure until the National Radioactive Waste Management Company has taken over the facility in order to implement the D&D plan.

The institutional main players involved in the decommissioning procedure are:

- The Ministry of Economy is responsible for:

  – granting licenses;

  – following up D&D activities from technical and economic standpoints.

- The Ministry of Environment is responsible for:

  – issuing the environmental impact statement.

- The Nuclear Safety Council is responsible for:

  – providing the Ministry of Economy a binding report on the D&D plan towards its authorisation;

  – supervising the implementation of the plan in all aspects related to nuclear safety and radiological protection;

  – giving support to the Ministry of Environment in relation to the evaluation of the radiological aspects of the environmental impact assessment.

- The National Radioactive Waste Management Company (ENRESA) is responsible for:

  – developing the D&D plan in cooperation with the operator;

  – applying for approval of the D&D plan to the Ministry of Economy;

  – taking over the facility as licensee to implement the D&D plan;

  – managing the radioactive wastes generated during the process;

  – applying for a decommissioning statement at the end of the process.

The Spanish policy for D&D is established in the General Radioactive Waste Plan. This is an official document developed by ENRESA and approved by the Government at the proposal of the Ministry of Economy. The Plan is updated periodically. The current version is the fifth that was approved in 1999.

The General Radioactive Waste Plan

This Plan includes a comprehensive description of all the necessary activities and technical solutions applicable to the management of radioactive wastes and decommissioning, and covers an updated economic-financial study of the costs of such activities.

Concerning D&D strategy and activities, the General Radioactive Waste Plan establishes the reference scenario for dismantling nuclear power plants for the purpose of economic calculation and planning. The current basic assumptions of the reference scenario are:

- seven nuclear sites, with nine reactors in operation;

- forty years of service lifetime;

- open cycle (i.e. reprocessing is not contemplated);

- complete dismantling (level 3) at the end of service lifetime, starting dismantling activities 3 years after definitive shutdown and following removal of spent fuel from the plant pool and of operating low and intermediate level wastes.

There is a national fund for implementing the activities of the General Radioactive Waste Plan. The fund receives contributions from different sources. In the case of NPPs, the contributions are made by way of a fee, consisting of a percentage of total electricity bill.

Considering the mismatch between the time when the contribution to the fund are made effective and the time when payments are needed, ENRESA carries out financial investments. There is a supervisory committee responsible for verifying that financial investments satisfy the principles of security, profitability and liquidity, in accordance with regulations in force. This committee is chaired by the Ministry of Economy.

Concerning radioactive waste management, the present policy can be summarised as follows:

a) Low and intermediate level radioactive wastes

These wastes are handled in El Cabril low and intermediate level radioactive waste storage facility. The capacity of the plant is 50 000 m^3 and the current occupation is about 50%.

A new facility for very low radioactive waste storage is under consideration at El Cabril site. This facility is meant to store waste coming from different sources that can not be treated as conventional but that have such a low radioactive level that do not deserve to be stored in the current facility.

b) High level radioactive wastes

Spanish authorities have decided to postpone any decision concerning a final solution for managing high level radioactive wastes and spent fuel until 2010. Up to that date, research on state-of-the-art techniques and procedures on deep geological disposal and transmutation and separation must be continued, as well as follow up of developments in the international scene.

Concerning spent fuel management, until a final solution is available, the General Radioactive Waste Plan takes into account two possible interim solutions: a central storage in surface or near surface facility or many individual storage in surface facilities on the nuclear sites.

Decommissioning & dismantling activities in Spain

Experience in D&D activities

There are several installations in Spain related to the front end of the nuclear cycle, such us disused uranium mines and mills, which are currently in different stages of dismantling. In addition, there are a number of research reactor and other research installations that are either being dismantled at present time or its dismantling is planned for the near future. Given the specific characteristics of these facilities, they allow experience of great technological value to be acquired. This is particularly true concerning some environmental aspects, such as restoration of land altered by operation.

All in all, decommissioning and dismantling of nuclear power plants is the most significant subject. So far, Vandellós-I is the only nuclear power plant that is in an advanced stage of dismantling. Nevertheless, the definitive shutdown of José Cabrera nuclear power plant is planned for mid-2006, and preparatory work for dismantling activities have started over this year. No further decommissioning of nuclear power plants is foreseen in the medium term.

The decision of the definitive shutdown of Vandellós-I was made after a fire seriously damaged the turbine building of the plant in 1988. In this sense, this D&D process can not be considered a standard case, in which the decision for final shutdown is made well in advance. In addition, as said, although there was some experience in relation to dismantling fuel cycle facilities, Vandellós-I was the first time that a nuclear power plant was going to be dismantled in Spain. On the basis of the experience acquired in other countries, especially in France, the country of origin of the technology, and taking into account the specific situation of Vandellós-I plant, several dismantling strategies were studied. The alternative finally chosen was immediate dismantling to level 2, followed by a period of waiting for completion to total dismantling of the remaining parts of the plant (less than 20% of the territory of the site). The waiting period is estimated around 30 years. After the completion of dismantling the site will be decommissioned and left free for subsequent unrestricted use.

The involvement of the different players in the D&D plan has been outstanding since the very beginning of the process and, although many difficult issues and shortcomings have been faced, for example the management of contaminated graphite shrouds of fuel, development and results of the Vandellós-I D&D plan are considered to be excellent. The experience achieved from this process is fundamental to feedback our current policy on D&D. In addition, ENRESA has gained capital experience and it is now better prepared to face future nuclear installation D&D plans.

An important contribution from the experience acquired in Spain from D&D activities, specially from the Vandellós-I case, is a complete review of the legal framework in relation to D&D procedures. The content of the Nuclear and Radioactive Installation Regulations, the legal instrument that establishes the licensing procedure, has been substantially improved and the current version includes a detailed description of the authorisation procedure for dismantling and decommissioning activities.

Lesson learned and challenges for future D&D plans

Beyond any doubt, the operator should not reach the final shutdown of the plant, due either to the end of service lifetime or to any other unplanned reason, without a clear **plan to carry out D&D activities**. Consequently, our current licensing procedure call for considering decommissioning and dismantling activities from the very beginning of the licensing procedure. The information to be provided corresponds to the global strategy to be followed, including final disposal of radioactive wastes, dismantling costs-study, and assessment of economic and financial provisions.

Certainly, in advance development of D&D provisions during operation is a fundamental factor, particularly in those cases in which the final shutdown was reached unexpectedly before the end of service lifetime. Existence of D&D provisions prevent from long and costly delays, as well as from making rash decisions due to any reason. There are other many other positive effects, such as **creating a solid culture among staff** for waste volume reduction in all activities during operation and facilitating a smooth and safe departure from normal operation towards dismantling, with plant staff ready and fully aware of their new duties and responsibilities under the new operating conditions. Provision for preserving design information and records of the as-built plant lay out must also be taken into consideration, specially when the chosen strategy is deferred dismantling. In this sense, it is a key element to ensure a good balance between maintaining experienced staff, with knowledge of the plant and able to keep “the memory of the installation”, and recruiting new staff with specific experience in dismantling.

Among the many technical aspects that can be highlighted from a policymaking standpoint, one of the most complex and relevant is the **huge amount of low level waste** that needs to be handled in the dismantling process of a NPP. Beyond any doubt, waste volume reduction programs during operation and during the dismantling process itself is a key element that need to be addressed at any given time.

Most of low level wastes come from putting down buildings and structures, where significant volume reduction is not an easy matter. In some cases the contamination of the material is only minor and not much in excess of naturally occurring radioactivity, such concrete of some buildings. These materials, after appropriate classification and testing, can be disposed of through normal disposal pathways or be used for restoring empty spaces left after dismantling. In other cases, slightly contaminated structural materials (tubing, structural supports, etc.) can be recycled after having reduce its contamination below clearance levels. In this regard, considering that there are **no universal clearance criteria and conditions**, it would be desirable to progress toward international harmonisation, considering an adequate balance between safety and cost.

On the other hand, having available **storage space for very low level radioactive waste** can be critical. This storage space can be of benefit not only to dispose of wastes from dismantling nuclear installations, but also to deal with slightly contaminated materials coming from other industrial activities. For example, events in which a sealed source has been smelted in a steel mill could give rise to hundreds of tons of low level radioactive waste, most coming from dust and smoke powder that can not be disposed of through conventional pathways, posing an important problem to be dealt with. Certainly having a very low level storage disposal will alleviate these situations and, at the same time, would be very valuable to complement storage needs during dismantling nuclear installations.

In a similar context, another important subject to be dealt with is the decision about **what to do with some buildings on the site**, for example the containment. Level 3 dismantling is usually the reference criterion for dismantling nuclear sites in many countries, including Spain. However, there can be cases in which level 3 dismantling is not fully justified in terms of economic savings due to the many technical difficulties and constrains.

Complete dismantling could not be advisable for sites with a territory that is not valuable from an economic or strategic point of view, or for sites where subsequent controlled industrial activities are planned at the time of dismantling. In this latter case, after having secure the area and verify there is not any risk for health, these buildings can be used for other non-nuclear industrial uses or can be simply left aside.

Finally, **public participation** has proven to be also a key element to be taken into consideration. Certainly, the start of dismantling activities may raise much interest and concern among the public, especially of neighbouring towns. From experience, the public is particularly concerned with the safe management of radioactive wastes as well as with the residual risks and limitation for reuse of the site. In cases in which the site will be used for interim storage of plant radioactive wastes before releasing the site for unrestricted use, it is also vital a good understanding by the public of the safety measures that will be in place all along this period of time.

The Spanish regulations call for establishing an information committee all along the construction, operation and dismantling of nuclear installations. This committee is made of representatives from the installation, the Nuclear Safety Council, and central and local authorities. The duties of the committee are to inform about development of plant activities and any other related subjects that are considered of interest.

In spite of the life extension programs that are being under consideration in many nuclear countries all over the world, the fact remain that progressively an important number of nuclear power plants will finish their service lifetime in the near future. The average age of nuclear power plants in

OECD member countries was about 15 years at dawn of the current century, so, given an operating life span of at least 30 years, the rate of withdrawal from service will peak some time after 2015, although the statistical distribution is rather wide.

This trend has a number of implications for governments and industry. From a governmental standpoint one essential aspect is to ensure that money from decommissioning will be available when needed, while from the industry viewpoint is essential to asses and monitor decommissioning costs in order to develop a coherent decommissioning strategy. Consequently, development of state-of-the-art D&D technologies and procedures is becoming more and more a fundamental subject.

International co-operation in the field of decommissioning is paramount, particularly concerning decommissioning large commercial nuclear power plants. Activities hosted and coordinated by the NEA, mainly through the Working Party on Decommissioning and Dismantling set up by the Radioactive Waste Management Committee, as well as the program of work of the IAEA on decommissioning, are essential to improve decommissioning technology, covering key aspects such as: cost estimation, planning, organisational and management aspects, technology for decontamination and dismantling, quality assurance during decommissioning, record keeping, etc.

In the EU framework, apart from research related activities carried out within the 5th Framework Programme, many of them focused on networking across Europe, it is also relevant to mention the new legislative initiative pursued by the European Commission. As it is well known, the EC has recently proposed a package of directives on nuclear subjects, dealing, among other things, with decommissioning funds. The primary objective of the proposed directives in this regard is to make sure that sufficient resources are collected over the operating lifetime of an installation to cover all end-of-life liabilities, including decommissioning, waste management and other liabilities. The directives calls for setting up guaranteed decommissioning funds, managed in such a way that sufficient resources would be available when necessary for the safe decommissioning of all nuclear installations.

Finally, it is also worth mentioning the recent entry into force of the Joint Convention on the safe management of radioactive waste and on the safe management of spent fuel. This new Convention represents a fundamental commitment of the member parties towards guarantying safe management of wastes and spent fuel for the benefit of current and future generations. The Convention also includes provisions related to decommissioning funds, and, in many aspects, it has been a reference for the nuclear package of the EC.

THE IMPLEMENTER'S VIEW

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Institutional framework: relationships

ENRESA was constituted in 1984 as the company responsible for the management of radioactive wastes in Spain, its responsibilities including the decommissioning and dismantling of nuclear installations. ENRESA is a state owned company whose shareholders are the CIEMAT (Centre for Energy-Related, Environmental and Technological Research) and SEPI (State Industrial Holding Company), both of which are governmental institutions. ENRESA operates as a management company, its role being to develop radioactive waste management programmes in accordance with the policy and strategy approved by the Spanish government.

The Spanish standards define a technical-administrative procedure for approval by the Nuclear Safety Council (CSN) and the Ministry of Economy of the Decommissioning Plan proposed by ENRESA. Subsequent to this, a positive evaluation is required from the Ministry of the Environment (or from the competent regional environmental authority in case of transfer of competencies to autonomous regions), by means of the Environmental Impact Statement, following a period of public consultation. Finally a local permit by the municipality is required to start the works.

I shall not be speaking about this regulatory framework or about the administrative procedure, since these have been dealt with by my predecessors, but rather shall focus on the operational and management aspects linked to the dismantling of the Vandellós-I plant, but to a large extent potentially applicable to any other Spanish nuclear power plant.

As the company responsible for dismantling, ENRESA is required to draw up a dismantling plan, along with the rest of the mandatory documentation required by the standards in force, and to submit this Plan to the nuclear authorities.

When the decommissioning plan is approved, the site is temporarily transferred from the owner company to ENRESA, as the organisation responsible for performance of the decommissioning work, such transfer lasting until the decommissioning operations are completed and the site is returned to the original owner.

In accordance with Royal Decree 1522/1984, by which the creation of ENRESA was authorised, the costs of radioactive waste management and of the decommissioning of nuclear installations are financed by the producers of such wastes. The financing of these responsibilities is by way of a fund set up for this purpose.

Decommissioning strategy – Vandellós-I

Vandellós-I was a 497 MW gas graphite type nuclear power plant located in the Province of Tarragona. Its construction began in 1967 and it started operating in 1972. Its design was very similar to the French plant at St.-Laurent-des-Eaux. In 1989 a fire in the turbine house led to the final shutdown of the reactor. Before responsibility for the site was transferred to ENRESA in February 1998, some post operational activities were undertaken by the utility who operated the Plant: post operational clean out, conditioning of spent fuel and treatment of operational wastes, including the graphite components from fuel elements.

Decontamination and dismantling activities have been extended to the conclusion of stage 2 of decommissioning, in June 2003. This stage includes confinement of the reactor shroud, the performance of demolition and backfilling operations and release of a large part of the site. The facility is currently being prepared for the latency period, which will be followed by total dismantling of the remaining parts of the plant (stage 3). On completion of the latency period, around the year 2027, the last level of dismantling will begin. This will imply the total release of the site and its return to the owner.

The dismantling schedule for stage 2 has included two main phases: the first phase was performed between February 1998 and February 1999, and its objectives were as follows:

- to condition the site for disassembly work in radioactive zones;
- to dismantle and remove conventional equipment and structures from the site.

The second phase began in March 1999 and has been completed in June 2003. The objectives were as follows:

- to address the active parts dismantling plan;
- to separate conventional materials from radioactive wastes;
- to control and ensure that the conventional materials are not contaminated, by means of the so-called clearance process;
- to dispatch low and intermediate level wastes to the El Cabril Disposal Facility;
- to dispatch conventional materials to authorised centres for recycling or disposal at authorised tips;
- to complete the dismantling of conventional zones.

The management of materials generated during dismantling is one of the major tasks that is being undertaken by ENRESA. In this respect, a specific organisation model has been developed with a view to guaranteeing complete efficiency in the production, characterisation and treatment of the large volume of materials generated at the site. Specifically, the Execution, Operations, Radiological Protection, Waste Management and Decontamination Services participate directly in the process, with their work co-ordinated by the Materials Control Service, dedicated exclusively to guaranteeing exhaustive control of all materials dismantled at the site.

Stage 2 has produced about 296 000 tons of materials, less than 1% of which has been managed as low and intermediate level radioactive wastes.

In order to meet the objective of minimising the production of radioactive wastes from Stage 2 Dismantling, a segregation and decontamination plan has to be put into place, and complete efficiency must be guaranteed throughout the process. In this respect, the site has five controls that are applied to all materials considered to be candidates for clearance, in other words those coming from active zones and to be removed from the site and sent to conventional destinations. Only such treatment can ensure that all the materials removed from the plant do not exceed the levels of activity imposed by the Spanish regulatory authority, for clearance as non-radioactive wastes.

Once these five controls have been performed with satisfactory results, conventional materials are given a permit to leave the site and to be transported to their destination, either a recycling plant or an authorised tip. However, in keeping with the legal standards in force, all conventional wastes are required to have an Acceptance Docket subscribed between the producer, in this case ENRESA, and the company or organisation responsible for subsequent management.

Finally it should be pointed out that at the Plant, different mechanical and manual decontamination techniques have been used for both metallic and concrete surfaces. Basically these techniques consist of washing, grinding and blasting for metallic surfaces, and removal of concrete by spalling or scarifying.

Organisation of decommissioning projects

As in the case of the construction of nuclear power plants, dismantling is an industrial activity, the performance of which requires a series of organisational, technological, human and economic and financial capacities, within a specific legislative framework and under rigorous control.

Within ENRESA's internal organisational structure dismantling projects depend functionally on the Operations Division, and receive the necessary internal logistical support from the Divisions of Strategy, Finances, Administration and R&D.

As a management company, ENRESA operates within a framework of optimal use of resources, with minimal in-house human resources at the Vandellós site. ENRESA's personnel are placed in key positions and maximum support is provided from head office (Madrid). The organisational structure adopted by ENRESA at the Vandellós-I site includes a site manager and a technical manager supported by specialists in different areas. The project team is completed with subcontracted engineering companies, which provide engineers and experts for the different activities.

This organisation receives support from the ENRESA head office for project activities such as planning, costs, delivery dates, R&D, waste management, engineering, radiological protection, licensing, etc.

At this point it would be appropriate to reflect on the organisational model used for the works. When the different packages were prepared for the contracting of services, consideration was given to the possibility of selecting a major contractor (architect-engineer) to undertake responsibility for the project, or alternatively of breaking down the activities in order to involve a larger number of companies, particularly local firms. Although the first of these options had the advantage of several previous references in dismantling projects (Fort Saint Vrain and Connecticut Yankee, among others), the option selected was the second, involving all types of companies. This approach requires (and has required) major co-ordination efforts by ENRESA, but has two advantages. Firstly, there is a larger number of companies with the necessary know-how, which in subsequent projects (for example Zorita, PIMIC) will mean a greater possibility of competition and will also increase the possibility of Spanish companies participating in international projects.

Secondly, and even more important, the participation of local companies allows the reduction in activity in the area due to closure of the plant to be palliated, and also serves as a vehicle for implementation and communication with the local society.

The co-ordination efforts made by ENRESA should extend to the period following completion of the works, since a large amount of information is created during the dismantling operation. This information covers many areas, not only technical areas but also others relating to organisation or planning. Actual technical data from the dismantling operations are registered, evaluated and duly fed back into the Waste Management Information System (SGR).

In parallel, a knowledge management system is being developed, identifying the most relevant indicators, in order to keep records of all the main activities carried out during Vandellós-I decommissioning, for reuse in future D&D projects, and of the most important lessons learned.

Social aspects and communications

The decommissioning of a nuclear installation has a social and economic impact on the surroundings, this being greater the higher the degree of dependence that existed during the operational phase. For this reason it is critically important to consider the social and economic aspects that arise as a result of shutdown of the facility, among them the loss of job posts, the local employment generated by the dismantling activities and the future recovery of the terrain as industrial land, to be returned to the operator for use without any restrictions deriving from its previous use.

Within this framework of reference, attention should be brought to the logical desire of the population in the area of influence to be involved in the project, to be kept informed and to participate in decision-making processes.

In view of this situation, and on the basis of the experience acquired during the dismantling of Vandellós-I, ENRESA has standardised a series of strategic actions to be taken in the area surrounding the facility during the dismantling stage in order to promote the participation of society and the local administrations in the approval processes and at the same time keep the population informed.

An example of the above is the commission created for Vandellós-I, made up of representatives of ENRESA, the Town Council, institutions and local organisations, with the following basic objectives: tracking of project evolution, verification of compliance by the project of the licensing conditions, analysis of the physical and radiological safety of the workers and keeping relevant groups informed through their representatives. Level 2 of the Vandellós-I project having been completed, this Commission has proven to be a particularly valid instrument.

As regards the economic aspects, and as has been pointed out above, the most important impact of a decommissioning project is the creation of local employment, both direct and indirect. In the case of Vandellós-I, some 2 000 people have been contracted during the dismantling period, 65% of which is local manpower. Indirect employment has materialised in an increase in the economic activity of the area of influence, especially in the services sector.

Another source of support for economic activity in the area is the contribution made to the local administrations for licences and permits, compensations for the temporary storage of wastes and agreements for the promotion of cultural activities and for urban equipment.

Complementary to these activities is the communications policy, which provides support for them and covers the need to keep the general public informed. Particularly noteworthy in the case of Vandellós-I are the visits received at the Information Centre, and the permanent contacts with the local media to cover information needs.

For this purpose, the company has developed an active and transparent policy with political groups, the media and the scientific community, based on dialogue and information transfer. The general population living close to the installations at which ENRESA carries out its activities is a preferential target as regards this policy.

Lessons learned and forecasts for the future

The completion of the level 2 (IAEA) dismantling of the Vandellós-I nuclear power plant, with a duration of 63 months and a defined latency period of 25 years, has served to obtain a series of highly useful lessons that are exportable to any dismantling project. Of these, the following may be underlined in each area:

- *Regulatory area*: The Spanish standards contemplate specific procedures to grant the authorisations associated with dismantling projects; nevertheless, during dismantling the nuclear power plant is required to adhere to the same licensing process as an operating plant. Specifically, one of the basic documents involved in this process consists of the Technical Specifications, a document that is fundamentally important for plant operation and any changes to which – few and tightly scheduled – are subject to an assessment and licensing process that is often very lengthy. During dismantling the number of changes is high and these occur at great speed; at certain times during the project the plant may change radically from one week to the next as entire systems or buildings are removed from service or dismounted. Under such conditions, the system habitually used to manage modification to the Technical Specifications may become a heavy burden for both the regulators and ENRESA. For this reason the need to define an approach for adaptation of the nuclear power plant operating Technical Specifications to the decommissioning phase will be considered particularly important.

- *Owner company*: Establishment of agreements facilitating preparation of the site for decommissioning during the later stages of nuclear power plant operation.

This allows dismantling periods to be shortened, especially the period between shutdown of the plant and the initiation of dismantling.

In particular it is to be highly recommended that consideration be given with sufficient notice to the progressive adaptation of the framework of standards applicable to the plant, from operating conditions to those existing during dismantling.

- *Implementor’s area*: Early planning of the decommissioning process, including the transition phase from operation to decommissioning, is essential to optimize operations and material management.

Likewise, consideration of all the possibilities regarding the management of materials, in particular radioactive wastes, allows the scope of the work to be scheduled depending on the destination of each.

- *Social environment*: Policies of transparency and collaboration with the institutions and the media.

An especially important lesson learned in the case of dismantling of the Vandellós plant is that communication actions have been considered on-line activities, like any other technical discipline, and have been taken into account systematically when scheduling project actions or preparing works infrastructures. In this respect it should be pointed out that the Vandellós plant dismantling works have been open to the general public, inasmuch as a series of appropriately protected viewing platforms were prepared, allowing visitors to view the dismantling works first hand. This has been seen to have a much more direct and positive impact than the posters, videos or publications habitually provided to visitors.

In conclusion, all this experience, included in the ENRESA corporate systems as pointed out above, is being evaluated with a view to establishing a decommissioning methodology which may be applicable to future decommissioning projects, such as the one foreseen following the shutdown in April 2006 of the José Cabrera NPP (Zorita).

THE R&D VIEW

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CIEMAT, the Spanish National Research and Technological Development Centre on Energy and Environment, is a public Institution ascribed to the Ministry of Science and Technology. Its main mission is to promote and conduct research and technological development projects in the field of energy and its impact on the environment. It had its origins in the *Junta de Energía Nuclear* (JEN), that for several decades endeavour to develop nuclear energy in Spain, with activities including different topics of the nuclear fuel cycle. In order to achieve it, CIEMAT built more than fifty radioactive facilities and laboratories, as well as some nuclear installations, nowadays in decommissioning status; that allowed mastering the knowledge of this technology and made possible the definition of national energy plans that managed the construction and operation of nuclear power plants up to a total installed power of 7,8 GWe.

Several companies and institutions originated from JEN, such as *Empresa Nacional del Uranio* (ENUSA), with the missions of uranium prospecting, mining and milling and nuclear fuel elements manufacturing; *Consejo de Seguridad Nuclear* (CSN) as Spanish regulatory authority for nuclear and radioactive installations and radiological protection for individuals; *Empresa Nacional de Residuos Radiactivos* (ENRESA) as responsible for radioactive waste management and decommissioning of nuclear and radioactive installations.

From the end of the eighties, CIEMAT has undertaken some actions aimed at eliminating the “radioactive source term” present in the Centre as a consequence of its previous activities. First of all, radioactive installations were grouped in order to proceed to licensing them and changing their activities. At the same time, the irradiated fuel from the JEN-1 research reactor as well as the fertile material from the Coral fast reactor were transferred to foreign centres. All these activities led to the conditioning of radioactive wastes that were managed by ENRESA.

Ever since the creation of ENRESA in 1984, CIEMAT has been acting as one of its advisors in the radiological characterisation of wastes generated in Spanish nuclear and radioactive installations, as well as in the intervention and temporary storage of “orphan” sources and in the operation of El Cabril repository. CIEMAT has done that through the transfer of technology and analytical methods allowing a more precise classification of wastes from different origins.

This collaboration has been based upon different agreements and research projects between CIEMAT and ENRESA, enabling at CIEMAT the maintenance of working groups capable of advising those responsible of waste management in matters such as the assurance of the repository site safety and the minimisation of storage space, normally scarce. These working groups participate in international projects of several European Union (EU) framework programmes, in which they have been well distinguished for their prestige and competence. It must be also noted that CIEMAT, with the support of ENRESA, has set up two modern equipments that will permit undertaking several new projects.

As a consequence of its past history, CIEMAT has considered necessary to undertake a project including rehabilitation and decommissioning of the old and closed nuclear and radioactive installations as well as of some areas of influence of these installations. To do this, a project named "*Plan Integrado para la Mejora de las Instalaciones del CIEMAT*" (PIMIC) (Integrated Plan for the Improvement of the CIEMAT Facilities) has been initiated in the year 2000 by the Direction of CIEMAT. It will, probably, go on until 2006 or 2007 with a budget of EUR 26 million. This project includes dismantling of installations now stopped or in the decommissioning phase, which are concentrated in a well defined local zone of CIEMAT, besides the rehabilitation of buildings, equipment and soils considered as influenced by past radioactive works. The dismantling project, a part of PIMIC, will be managed by ENRESA.

R&D activities in radioactive waste management

In decommissioning, as in every activity involving radioactive materials, the management cannot be qualified as adequate without considering the radioactive wastes.

The activities at CIEMAT, supporting the management of radioactive wastes from decommissioning, have as a main objective the radiological characterisation of materials resulting from dismantling operations. This must be done in such a way that the necessary information can be obtained, not only for waste to be stored, but also for materials potentially disposed of in a conventional way, without any restriction, or under more or less controlled conditions, in order to assure the non-existence of undue risks.

CIEMAT is supporting ENRESA in the management of wastes from decommissioning, with measurements including destructive as well as non-destructive techniques for radiological characterisation.

In the field of destructive techniques, analytical procedures have been developed to identify and quantify some thirty alpha emitters, pure beta emitters, weak gamma emitters and X-ray emitters, that in real waste appear in presence of non weak gamma emitters, as ^{58}Co, ^{60}Co, ^{134}Cs, ^{137}Cs and some other.

In many instances, the intrinsic difficulty of the measuring process is compounded by the waste characteristics. This is the case of some metals very resistant to chemical attack and also of graphite. In this context, CIEMAT, as the main technological Centre in Spain in the nuclear field and the only capable of successfully and exhaustively studying radioactive graphite, has been responsible for the characterisation, not only of the graphite sleeves from the fuel elements of the Vandellós-1 reactor, but also the graphite structure of its core moderator. Along this process, the obtained results have clearly shown the existing dependence between the sampling point and its ^{14}C content, which facilitates the estimation of total inventory of this radionuclide.

CIEMAT has also acted as a quality control laboratory for analysis performed by service companies over samples of varying nature from materials selected to be conventionally evacuated.

Concerning the non-destructive techniques, CIEMAT has developed two systems for the radiological characterisation of some type of radioactive waste packages received in the repository of El Cabril. The first one executes a gamma exploration of the package by splitting it into several segments. It informs in each segment on existing emitters, which are identified and quantified, and allows to allocate the situation of “hot spots” in the package. The second system, faster than the first one, conducts the exploration in a single measuring process and identifies and quantifies the total activity of existing emitters. Equipments incorporating these two systems are operating at CIEMAT, at El Cabril and at two Spanish nuclear power plants; two other equipments are at present being designed and manufactured.

Furthermore, CIEMAT has advised ENRESA in the acquisition and start up of systems used in the dismantling of Vandellós-I (Camberra ISOCS equipment and box-counter).

The dismantling of radioactive lightning-rods and the management of their sources, as well as the system for radiological characterisation of technological wastes (paper, gloves, etc.) from hospitals and small research installations with a radioactive content generally very low, can be mentioned as CIEMAT’s complementary developments in non destructive techniques.

The normalization tests, according to NEA criteria, on ionisation chamber smoke detectors, collected by ENRESA or provided by their manufacturers should also be mentioned. The objective is allowing these companies the classification of detectors either as a marketable conventional waste or as a radioactive waste.

R&D decommissioning projects

As previously mentioned, CIEMAT has operated in its Moncloa Centre several nuclear and radioactive installations; some of them have already been dismantled and decommissioned and the remaining ones are at present undergoing this process, as a part of the PIMIC project. The most singular facility is the JEN-1 reactor, which operated between 1958 and 1984 and whose final shut down was decided in 1987. At that moment, a working team was created at CIEMAT to study and apply dismantling techniques for decommissioning nuclear installations; its first tasks were launched within the EU R&D framework programmes. These activities were also supported by ENRESA whose R&D Programme included several projects related to decommissioning.

A technical infrastructure, oriented to the study and application of different techniques that could be required, was made available by CIEMAT to the mentioned working team. That infrastructure includes the following experimental equipment and installations:

- robotics underwater cutting facility for metallic materials: cutting by plasma arc, by consumable electrode, by contact arc;
- mechanical cutting equipment (pneumatic saw) to operate underwater or atmospheric;
- facilities to study decontamination techniques of metals by electropolishing and by ultrasonics;
- melting facility for metals, by electric induction furnace.

In the field of R&D decommissioning activities, CIEMAT has participated in the following projects:

- Dismantling of the JEN-1 Reactor core (3rd EU framework programme): its objective was the study and development of cutting, decontamination and melting techniques on aluminium components of the reactor core. Such core components were dismounted maintaining the water level of the pool and radiologically characterised. Previously, the spent fuel elements were taken out of the reactor and stored into wells. Later, these elements were finally transferred to the USA. This project included the mounting of melting and underwater cutting equipment previously mentioned.

- Implementation of two data bases on techniques and costs in decommissioning (4th EU framework programme): one data base concerned with the techniques and tools and the other one with the costs and dose rates in decommissioning operations.

- Development of a technique to cut metals by contact arc (4th EU framework programme): applied to underwater cutting of metals, this technique was implemented by using a master-slave robot working on aluminium and stainless steel pieces from the JEN-1 Reactor.

- EC Decommissioning information Network (5th EU framework programme): at present, an ongoing work. It is the extension of the data bases initiated under the 4th EU framework programme, now unified in a single one with a new informative structure and to be accessible by Internet.

- Project on Decommissioning Techniques for Research Reactors, supported by IAEA (1997-2001) aimed at gaining and transferring the know-how on research reactor decommissioning.

- Co-operative programme on decommissioning, supported by OECD-NEA and directed to the exchange of scientific and technical information concerning nuclear installation decommissioning projects in OECD countries.

Conclusions

CIEMAT, as a R&D Centre with responsibilities in the nuclear energy field, has always been concerned with subjects relating to decommissioning of nuclear installations.

CIEMAT, through its participation in international programmes and projects, has acquired a know-how on decommissioning, and can act as an advisor not only to the company responsible for decommissioning tasks (ENRESA), but also to the regulatory authority (CSN) and other national administrations.

Collaboration between CIEMAT and ENRESA in the PIMIC project will certainly be an interesting experience that will supply useful information for future decommissioning of nuclear installations.

SOCIAL ASPECTS OF DECOMMISSIONING AND DISMANTLING IN SPAIN

Mariano Vila d'Abadal
AMAC, Spain

Figure 1. Situation of the NPP in Spain

Nuclear territories: background

- Early development of nuclear energy.
- 1979: First local elections.

  First conflicts: Ascó;

  Trillo;

  Vandellós.
- 1988: Creation of municipal movement.

What is AMAC?

- Objectives:

  – security of the facilities;

  – plans for nuclear emergency;

  – economic development.
- 8 nuclear sites:

  – 7 with nuclear power plants;

  – 1 with M&L radioactive waste.
- 70 municipalities.
- 80 000 inhabitants.
- Rural or semi-rural areas.

Territory and nuclear facilities

- Previous reality;
- Staying away from the yes/no debate on nuclear energy;
- Risk consciousness;
- Necessity of cohabitation with the facility;
- Future foreseeing;
- Safety → guarantee for the future.

Figure 2. Which of the following attributes do you associate with NPP?

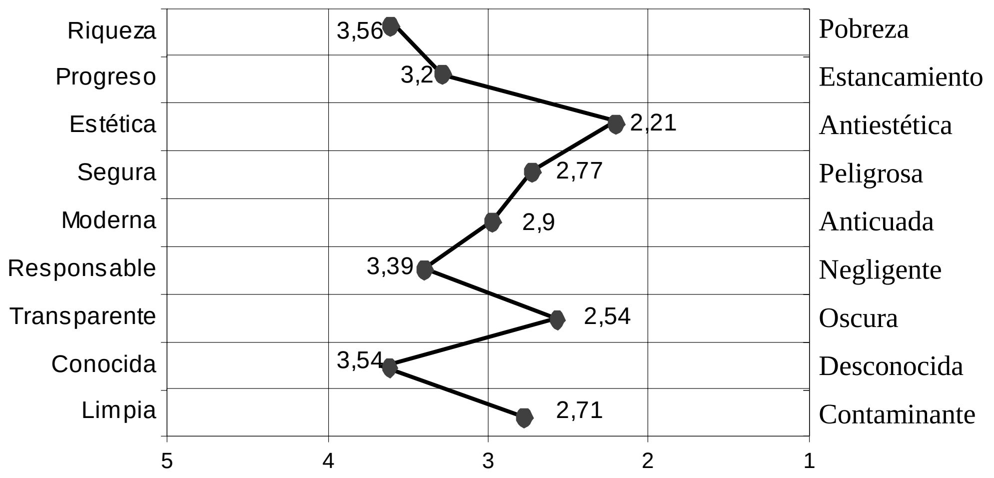
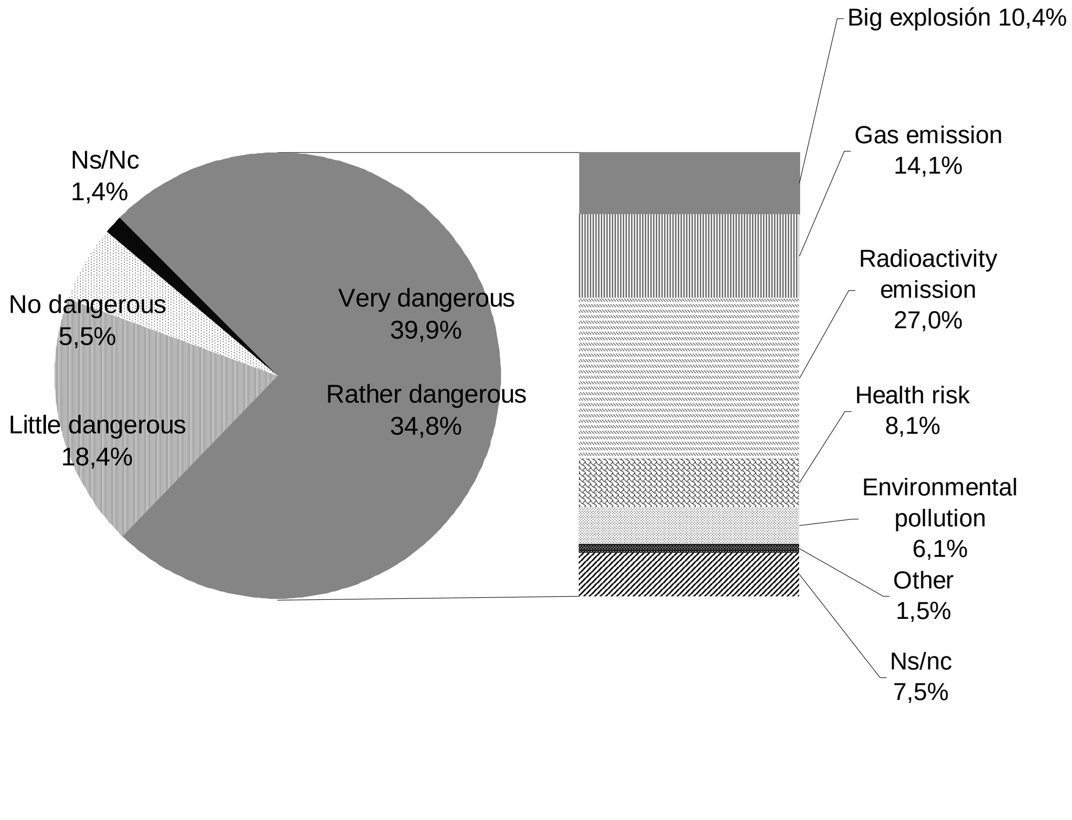


Figure 3. Opinion about real risk and what kind of risk



Fuente: CERES, 2003

Figure 4. Do you think that NPP pollute the environment?

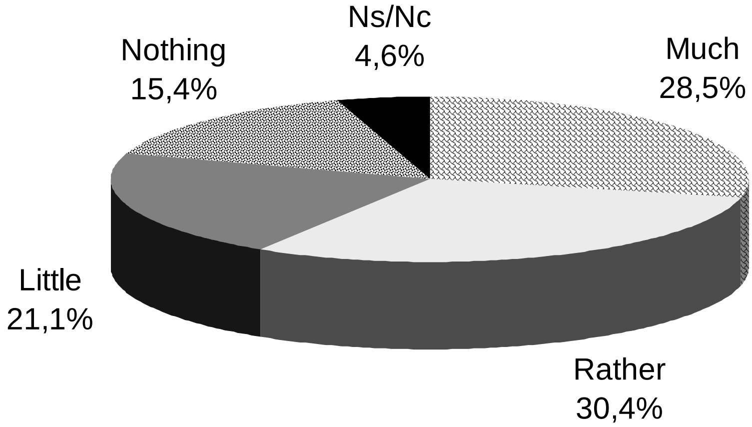


Figure 5. Do the NPP fulfil the safety standards?

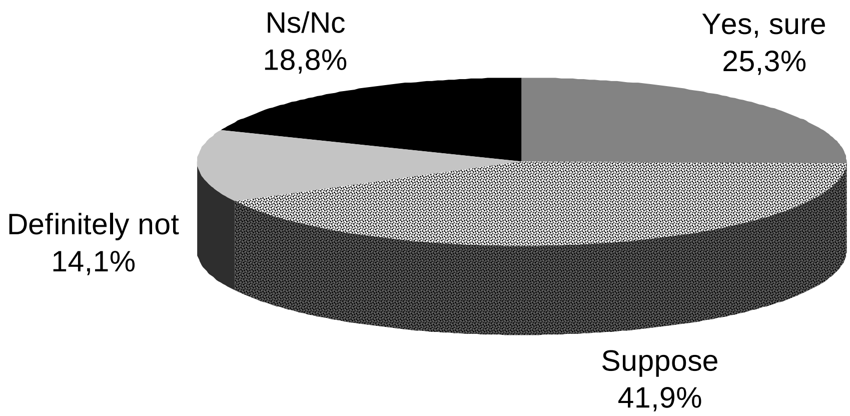
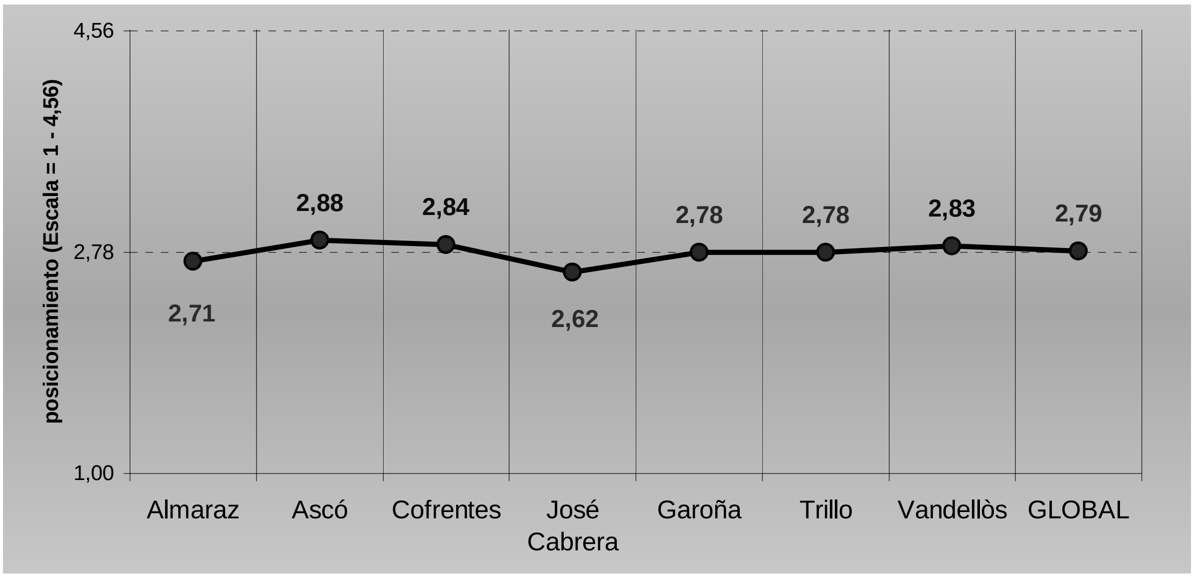


Figure 6. People's average position before NPP



Municipal responsibilities

- Municipalities as a means of information;
- There is a political obligation for representatives to participate;
- There is a legal obligation for the administration:
  - general competences in environment, public health, civil protection and territorial planning;
  - specific competences in urbanism and building license as well as in environmental issues;
  - participation in some other proceedings: nuclear facilities authorization and environmental impact assessment;
  - direct responsibility and participation in the emergency planning.

Local governance vs. nuclear energy

- Three basic pillars to earn people trust:
  - safety: nonnegotiable concept & guarantee of nuclear policies;
  - information/participation: necessary policy;
  - economic development: guarantee for the future.

D&D of NPP (I)

- Territory involvement in the earliest steps of the decision: a right and an obligation for the municipalities;
- Safety in technical proceedings;
- Public information and participation policies: local commissions as forum for participation and information tool.

Information and transparency

The confidence as the basis for information: whoever receives the information has to believe in it.

- **Transparency**. Information must be fully given.
- **Availability**. Permanently on-line.
- **Objective**. No convincing should be needed.
- **Comprehensible**. Difficulty of technical terms vs. Public access to the information.

Participation

- Public participation in DMP as a proceeding for a solution and also as a guarantee for long term governance
- The Aarhus agreement and other experiences within the EU and western countries: Wellenberg, Stola-Mona, La Hague, Erajoki, etc.
- Participation implies:
  - constant exchange of information;
  - information credibility;
  - stakeholders involvement;
  - coherence of the debate;
  - efficiency in the relations among administrations;
  - social-scientific dialogue;
  - final consensus for decisions.

Figure 7. Do you think that there is enough information about NPP?

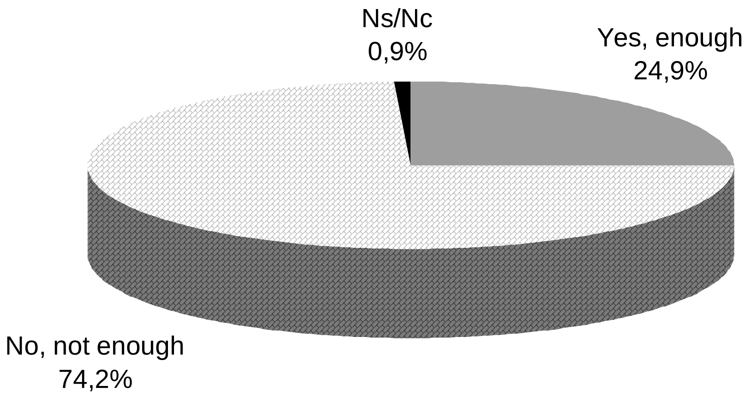


Figure 8. What kind of information would you like to get?

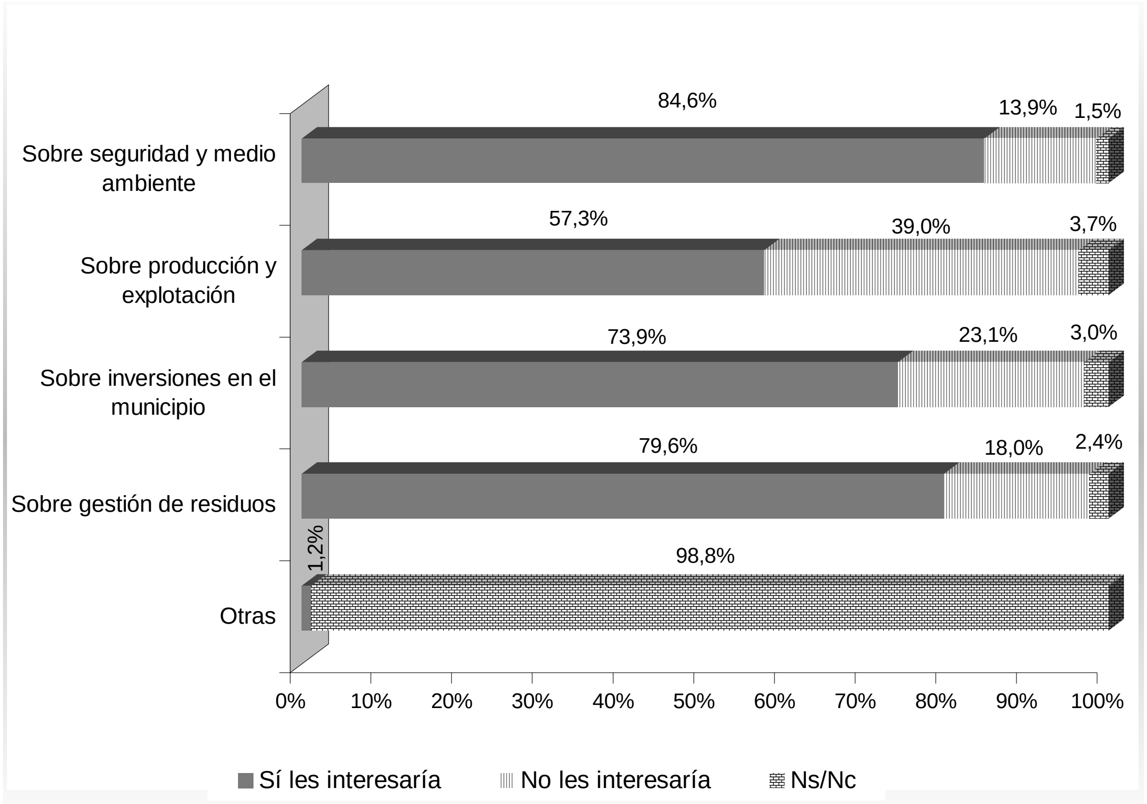


Figure 9. What channel do you think could be the best to spread the information?

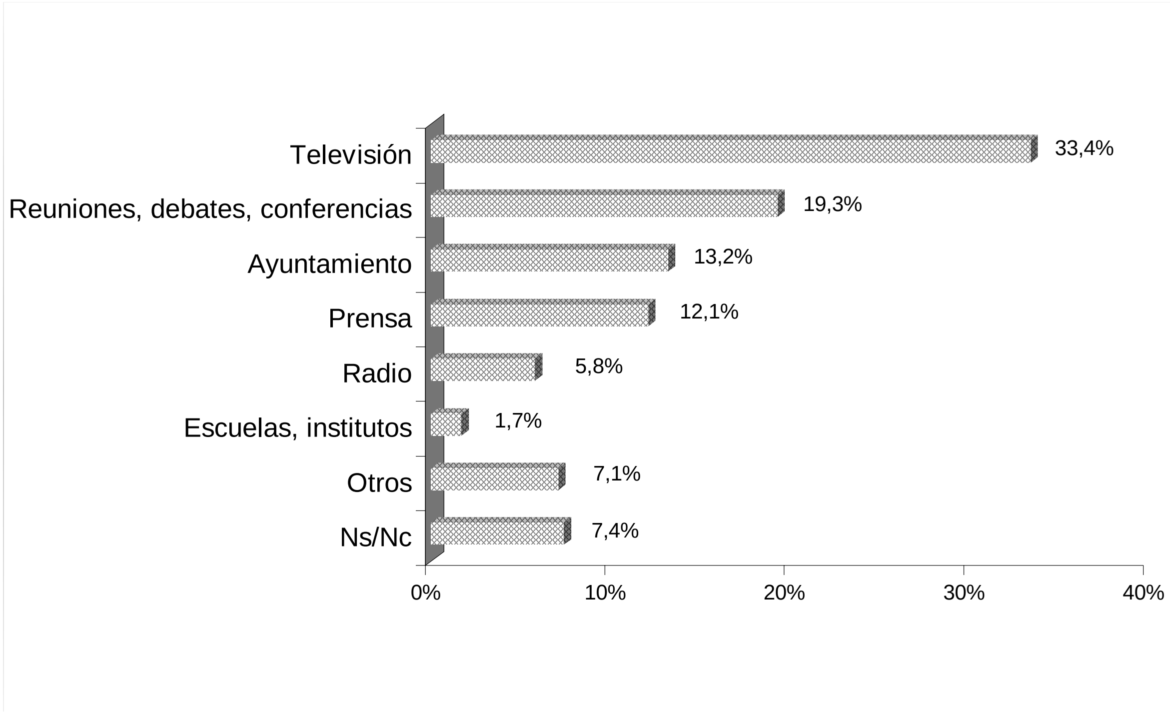
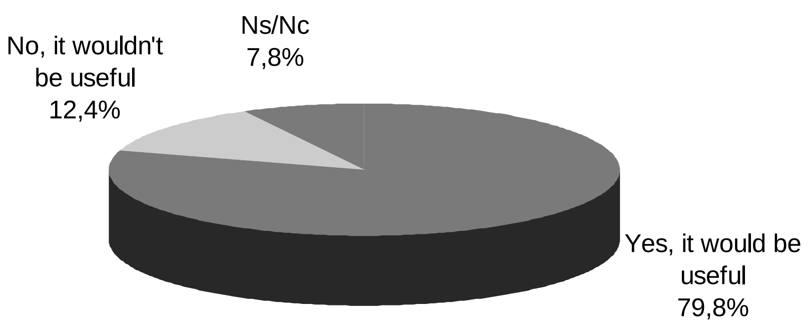


Figure 10. Do you think that the existence of a local commission of information could be useful?



Local committees of information in Spain

- Information committees:
  - members: Ministry of Economy;
    Consejo de Seguridad Nuclear;
    Facility manager;
    Government delegate;
    Regional government;
    Municipality hosting nuclear facility.
  - competences: Information to the members about the development of nuclear activities and other matters of interest.

Local commissions: AMAC proposal

- Right to the information:
  - any type;
  - for everyone;
  - creation of guarantees.
- Local commission:
  - participation of all the actors;
  - transmitter of information;
  - forum of debates.
- National commission of information:
  - independent character;
  - ultimate guarantor of the right to the information;
  - driving force for national debate.

D&D of NPP (II)

- Economic impacts:
  - loss of: jobs;
    economic activity;
    municipal incomes.
  - need of alternative economic activity;
  - future use of land.
- Environmental issues:
  - radiological protection;
  - waste management.

Figure 11. Have you noticed any changes in your municipality after the settlement of NPP? How do you value these changes?

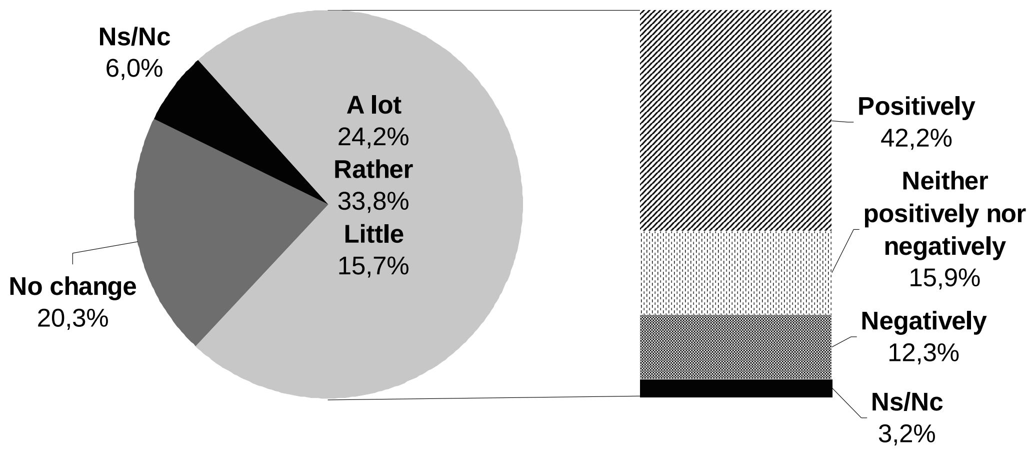
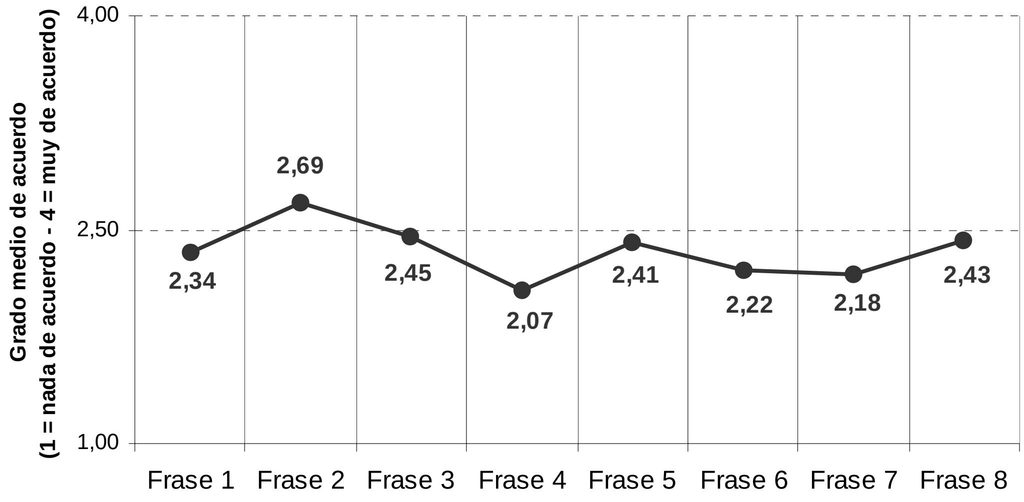


Figure 12. Average agreement with different ideas related to the influence of NPP on the economic development



1 = The economy of the municipality mainly depends on the NPP.

2 = When the NPP closes down the economy of the area will be weakened.

3 = The NPP has influenced the improvement of local services.

4 = The NPP is a handicap for the development of other economical activities.

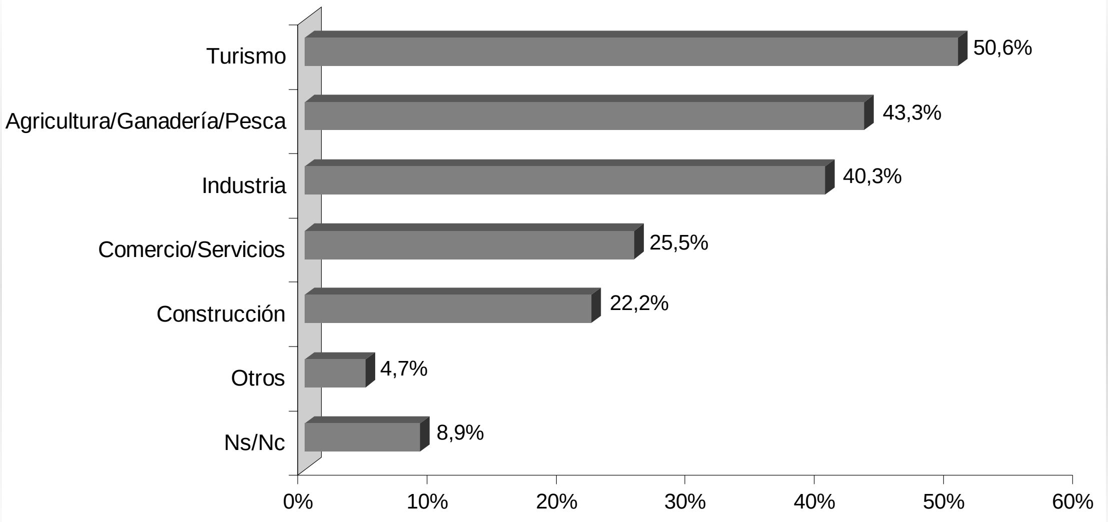
5 = There are very important economic sectors besides NPP.

6 = The territory is ready with alternatives when the NPP closes down.

7 = The NPP has not been useful to develop the services.

8 = The wealth generated by the NPP is also positive for the future.

Figure 13. Alternative economic sectors after NPP



The Spanish cases: Vandellós

- Sudden closure of the NPP;
- Strong municipal involvement;
- Lack of information policies;
- Development of the municipal policy;
- Involvement of ENRESA in the future of the municipality: close collaboration between the municipality and the dismantling company.

The Spanish cases: Zorita (I)

- Decision of future closing down.
- Institutional framework:
  - public information;
  - economic impact assessment;
  - environmental impact assessment;
  - following of the proceeding.

The Spanish cases: Zorita (II)

- Following commission:
  - objectives: knowledge on dismantling planning & nuclear waste management;
    creation of alternative economy;
    institutional co-ordination.
  - members: local administration;
    state representative;
    regional government;
    nuclear companies;
    ENRESA;
    economic & social representatives.

The Spanish cases: Zorita (III)

- Sustainable development planning:
  - communications & infrastructures;
  - technical training;
  - encouragement of private initiatives in all of economic sectors;
  - public investment.
- Nuclear waste management:
  - public information & participation in DMP;
  - intermediate disposal.

Conclusions

- D&D need a public framework and local involvement in order to reach a stable decision and management as well as an acceptance in nuclear waste policies.
- A correct policy is essential so that the land can be used for future energetic projects.

INTERNATIONAL STOCKTAKING

DECOMMISSIONING OF NUCLEAR POWER PLANTS: POLICIES, STRATEGIES AND COSTS

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As many nuclear power plants will reach the end of their lifetime during the next 20 years or so, decommissioning is an increasingly important topic for governments, regulators and industries. Commercial nuclear power plant decommissioning activities, impending in some countries and in full swing in others, have led to a generally growing trend in industrial, regulatory and policy-level activities in the field over the past 10 years. This trend is expected to continue, as an increasing number of facilities enter into their active decommissioning phase.

This trend has several interrelated implications for governments and for the nuclear industry.

From a governmental viewpoint, particularly in a deregulated market, one essential aspect is to ensure that money for the decommissioning of nuclear installations will be available at the time it is needed, and that no "stranded" liabilities will be left to be financed by the taxpayers rather than by the electricity consumers. For this reason, there is governmental interest in understanding decommissioning costs, and in periodically reviewing decommissioning cost estimates from nuclear installation owners. Robust cost estimates are key elements in designing and implementing a coherent and comprehensive national decommissioning policy including the legal and regulatory bases for the collection, saving and use of decommissioning funds.

From the industry viewpoint, it is essential to assess and monitor decommissioning costs in order to develop a coherent decommissioning strategy that reflects national policy and assures worker and public safety, whilst also being cost effective. For these reasons, nuclear power plant owners are interested in understanding decommissioning costs as best as possible and in identifying major cost drivers, whether they be policy, strategy or "physical" in nature.

National policy considerations will guide the development of national regulations that are relevant for decommissioning activities. Following these policies and regulations, industrial managers responsible for decommissioning activities will develop strategies which best suit their needs, while appropriately meeting all government requirements. Decommissioning costs will be determined by technical and economic conditions, as well as by the strategy adopted.

Against this backdrop, the study analyses the relationships among decommissioning policy as developed by governments, decommissioning strategies as proposed by industries, and resulting decommissioning costs. Major cost drivers, of policy, strategy and technical nature, are also discussed. The findings from the study are based on responses to a questionnaire sent to participating countries. It should be noted that not all responses were of the same level of detail, and it was felt that further detail in responses would have allowed more in depth comparisons in a more valid fashion.

It should be noted that the costs reported by participating countries for the purposes of this study reflect specific models and strategic choices, and were developed in each national situation and in some cases in the context of establishing funds to support decommissioning.

Furthermore, although the questionnaire requesting policy, strategy and cost data was clear with respect to elements to be considered in the scope of decommissioning, national programmes do not necessarily divide their estimate elements in the same fashion. This leads to a wide variety in what was globally included under the reported cost estimates.

The review of the data collected for the study showed a wide variation in many aspects of national decommissioning policies in the participating countries. Decommissioning strategies adopted by industries also vary from country to country and from operator to operator. The variability between countries, utilities and power plant characteristics in a number of areas related to decommissioning leads to cost differences that are identified and analysed in the report.

Table 1. Policy and strategy

Of the 26 participating countries:
• 50% have defined decommissioning end-point; • 25% have mandatory time-scale for completion; • 80% require decommissioning licence; • 60% have defined radwaste clearance levels; • 30% only consider the option immediate dismantling as cost base.

Important aspects that were found in the study to have significant effects of decommissioning costs include:

- the end state of the facility after decommissioning (e.g. green field, long-term stewardship of some facilities, site reuse for other industrial or nuclear purposes);
- the national policy and site-specific application, of site release criteria;
- the inclusion of waste disposal costs, totally, partially, or not at all, in the decommissioning scope and cost estimates;

- the manner in which waste arising from decommissioning is classified, in terms of whether or not radiologically regulated disposal is required;

- the assumed costs for waste disposal, recognising that no country reported having operating disposal facilities for all types of waste that would be generated by decommissioning processes;

- the decommissioning strategy option assumed for costing purpose (e.g. longer or shorter safe-store periods and choice of decommissioning end-point);

- the national labour costs that were assumed;

- social and political factors, such as the decision to decommission very rapidly, or to release sites only to very stringent radiological criteria;

- uncertainties in the estimates and their treatment in cost models.

In addition to these general aspects that affect costs, the study also identified several physical characteristics of the power plant considered that were also significant cost drivers:

- type and size of the reactor;

- number of units on the site;

- operating history of the plant; and

- the amount of waste assumed to be generated.

In spite of cost variability, the study showed that decommissioning cost estimates reported remain below USD 500/kWe for nearly all water reactors but are significantly higher for gas cooled reactors (around USD 2 500/kWe).

Table 2. Decommissioning cost expressed in US dollars per installed electric power ($US/kWe)

Reactor type	Average value	Standard deviation
PWR	320	195
VVER	330	110
CANDU	360	70
BWR	420	100
GCR	>2 500	–

Labour costs generally represent a significant share of total decommissioning costs ranging from 20 to 40%. Some analysis of cost structure was performed based upon the responses including data on various cost components. According to the information provided, the two cost elements representing a major share of total costs are dismantling and waste treatment and disposal, accounting for around 30% each. Three other cost elements represent around 10% each of the total: security, survey and maintenance;

site cleanup and landscaping; and project management, engineering and site support. Other cost items generally do not exceed 5% of the total decommissioning cost.

In its findings, the study stresses that in all countries, decommissioning costs are robustly estimated and thoroughly analysed by the operators, the regulators and the governments and that measures are in place to ensure that adequate funds are accumulated timely to fund decommissioning expenses.

Table 3. Decommissioning cost elements

Cost element	% of the total cost
Dismantling	25 – 35
Waste processing & disposal	17 – 43
Security, survey, maintenance	8 – 13
Project management, site support	5 – 24
Site cleanup and landscaping	5 – 13

It is suggested that further work in the field could be undertaken in an international framework to support a more robust quantitative analysis of decommissioning cost drivers. Such studies could contribute to additional clarity, particularly with respect to comparison of decommissioning estimates taking into account scope variability.

Acknowledgements

This study would not have been possible without the assiduous efforts from the members of the expert group and the good data supplied by the respondents to the questionnaire. In particular, thanks are due to Dr. Paul B. Woollam (chair) and Mr. Geoff Holt; both affiliated at the BNFL and to the Secretariat consisting of Mrs. Evelyne Bertel and Mr. Edward Lazo; both at the OECD/NEA. Special thanks to the representatives of the international organisations: Mr. Jose A. Hoyos Perez, DGTREN, European Commission and Mr. Marius Condu, Division of Nuclear Power, IAEA. Thanks are also due to the Working Party on Decommissioning and Dismantling, WPDD, set up by the OECD/NEA Radioactive Waste Management Committee, for their valuable comments to the draft report of the expert group.

FINDINGS OF THE INTERNATIONAL CONFERENCE ON SAFE DECOMMISSIONING FOR NUCLEAR ACTIVITIES

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1. Introduction

The International Conference on Safe Decommissioning for Nuclear Activities took place in Berlin, Germany, from 14 to 18 October 2002. More than 200 senior officials, scientists and local community representatives from 37 countries and three international organizations participated in it.

The conference was organized by the IAEA and was hosted by the government of Germany. The conference president was W. Renneberg of the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety, Germany.

The proceedings of the conference, including a record of the discussions of the panel sessions, will be published by the IAEA.

This paper provides a summary of the main findings of the conference.

2. General findings

The conference president concluded that the conference had served an important purpose in bringing together and consolidating information from around the world. However, the information presented at the Conference was concentrated on the decommissioning of large nuclear facilities. There are many smaller types of facilities spread in developing as well as developed countries of the world which need to be considered in any comprehensive review. A concerted international effort should therefore be made to obtain a realistic picture of the scope of the decommissioning task to be expected from the many other practices using radioactive material in medical, industrial and research applications.

It was noted that the IAEA is currently compiling information on the magnitude of the decommissioning problem in the world and the IAEA was encouraged to continue with this work in order to provide a solid basis for international discussions of actions to begin solving the problem.

The conference also heard about a great deal of practical decommissioning experience that has been accumulated. The president suggested that the international community should consider ways to make this information more widely available. The IAEA could contribute to this by means of a Web-based ‘chat room’ dedicated to decommissioning.

One general conclusion from the discussion was that the IAEA should ensure that its safety standards on decommissioning are continuously improved and kept up to date.

3. Specific findings

A number of distinct themes emerged, and they are discussed in the following paragraphs.

3.1 Early planning for decommissioning

With regard to the issue of early planning for decommissioning, emphasis was placed throughout the conference on the importance of planning decommissioning thoroughly. Planning should start as early as possible, ideally at the design stage of a facility, as required by the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management. A fundamental first step in this planning is to obtain a thorough understanding of the condition of the facility at the end of operations, including knowledge of all the waste streams to be expected during decommissioning. The decommissioning plan for the facility should include a description of the intended management approach for each of these waste streams. This in turn requires that the state should have national plans in place for the safe management of this waste.

Another prerequisite for planning decommissioning, as emphasized throughout the conference, is the existence and implementation of an appropriate and stable regulatory framework and requirements.

The overall decommissioning strategy to be adopted should be identified as early as possible in the planning process.

3.2 Decommissioning strategies

Three basic decommissioning strategies are envisaged as possibilities for nuclear installations: immediate dismantling; safe enclosure prior to deferred dismantling; and entombment. All have advantages and disadvantages, but immediate dismantling is the generally preferred option. However, there are a number of factors that might lead operators to choose one of the other strategies, and each situation should be examined case-by-case to identify the optimal strategy.

Immediate dismantling

Immediate dismantling typically has the fewest uncertainties, eliminates the risk associated with the facility as promptly as possible, will normally cost less than delaying, and allows the retention of operational staff who know the facility and its history to contribute their expertise and experience during decommissioning.

Safe enclosure

Safe enclosure may have benefits for safety in facilities for which short-lived radionuclides represent an important source of the risk, may provide ‘breathing space’ in cases where sufficient funding is not yet available, or may be convenient where there are multiple facilities on the same site. However, such benefits should be considered in the context of the additional costs associated with providing long term surveillance and maintenance, the problem of ensuring that sufficient expertise and knowledge will be available for dismantling, and the additional uncertainties introduced by delay. For example, financing may be more difficult to guarantee, there may be unforeseen changes in regulatory requirements or the availability of waste disposal facilities, the condition of the facility may deteriorate despite care and maintenance programmes and some equipment may need to be re-commissioned after a long period.

Entombment

Entombment is used in some member states for certain types of facility, and these need to be considered case-by-case. As a general guide, entombed facilities should comply with radiological criteria for waste disposal facilities, but more specific international guidance would be welcome on the acceptability of and conditions for use on the entombment strategy. Entombment may be an option for states needing to decommission a single facility, for example, one research reactor, and not having the resources to develop or obtain the infrastructure needed for dismantling and waste disposal.

The presentations and discussions at the conference indicated a distinct shift towards immediate dismantling as a preferred strategy. This preference seems to be based on a range of considerations, notably the availability of know-how and experienced staff from the operational phase, and certainty of funding. Nevertheless, there will still be cases in which one of the other strategies – safe enclosure or entombment – may be appropriate in the circumstances.

3.3 Safety culture

The transition from operation to decommissioning will usually be accompanied by organizational changes, particularly reductions in staff. Such reductions may be inevitable, but the operator must manage the change so as to retain the expertise needed and to guard against a degradation of safety culture due to demotivation of the remaining staff. The regulator also needs to be particularly vigilant in relation to the possible effects of such changes.

3.4 Social issues

The participation of the public, including community leaders, work forces and interest groups, in the decision-making processes should be initiated as early as possible and should continue throughout the decommissioning process. The aim is to minimize the negative social and economic effects of decommissioning.

The impact on the work force and the local community due to cessation of operation of a facility must be recognized and addressed early in the transition from operation to decommissioning. Factors such as uncertainty, potential job losses and diminution of career paths as research careers are replaced by construction/deconstruction jobs all lead to poor morale and an exodus of qualified staff.

3.5 Funding

Funding is clearly vital to decommissioning. Three main types of funding arrangement are being used: direct funding from government; funds managed internally within operating organizations (sometimes segregated from operating funds, sometimes not); and externally administered funds specifically established for the purpose (or, in some cases, for the broader purpose of radioactive waste management). Within the European Union, systems of both internal and external types are operating successfully at present.

Provision needs to be made to ensure that sufficient funds will be available, with a high degree of confidence, when they are needed. An appropriate mechanism should be in place before a new facility is licensed to operate. However, there are significant uncertainties associated with both the estimation of future costs and the performance of funds designed to meet those costs, even when an appropriate funding system is in place. One way of minimizing the uncertainty would be to complete decommissioning as early as possible. A particular concern relates to facilities that need to be decommissioned but for which funds are not available.

3.6 Waste management issues

In the discussion on waste management issues, it was noted that progress in the provision of national repositories for radioactive waste would be of great benefit to decommissioning. However, the absence of a repository should not be considered an obstacle to early dismantling. If repositories are not available, regulators should provide guidance to operators on the appropriate conditioning of waste.

3.7 Long term retention of knowledge

The long-term retention of knowledge is of great importance in two respects: people and records. The knowledge and experience of staff involved in the operation of the facility needs, if at all possible, to be exploited during decommissioning. If the early dismantling strategy is adopted, this can be done directly by retaining the people, but if decommissioning is delayed a way needs to be found to preserve their knowledge and experience in a form that can be used later. The second aspect is to ensure that proper records of the history of the site are retained in the long term after decommissioning. Failure to do this can lead to situations in which there is a risk of accidents, substantial costs and the generation of further waste.

3.8 Removal of regulatory controls

With regard to the removal of regulatory controls, it was noted that the recycling or reuse of materials from decommissioning can greatly reduce the amount of waste that needs to be disposed of in a repository. This can preserve resources and repository capacity. Criteria for the international trade in such materials are needed, and therefore should be internationally agreed. A great deal of work has been done with the aim of establishing criteria for the removal of materials from regulatory control. Work aimed at reaching international consensus on an acceptable methodology for establishing clearance levels should continue.

Questions remain as to whether the criteria for the release of sites should be the same as those for the release of materials, whether natural and artificial radionuclides can be subject to the same criteria, and whether there is a market for materials released from a nuclear facility, even if they have been declared "non-radioactive". The international community should make concerted efforts to resolve these issues.

4. Conclusions

The findings of the conference serve to focus attention on the important issues needing resolution in the field of decommissioning safety. The international elements of the findings will form the basis of an international action plan for implementation by the IAEA.

A proposal for such an action plan on the Safety of Decommissioning containing the following items will be put to the Board of Governors of the IAEA in September 2003:

- assess the worldwide magnitude of the decommissioning problem;
- prepare a high level safety standard on decommissioning;
- establish international consensus on criteria for the release of materials, buildings and sites from regulatory control on the termination of operations;
- develop guidance on internal, external and governmental strategies for funding decommissioning;
- promote, in the safety standards and elsewhere, the concept that a waste management strategy is a necessary element of every nuclear programme;
- establish a Web-based forum to provide for information exchange on decommissioning.

A EUROPEAN PERSPECTIVE ON THE FUNDING OF DECOMMISSIONING AND RELATED ACTIVITIES OF THE END OF THE NUCLEAR CYCLE[1]

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1. Background

1.1 Nuclear safety, a subject of European dimension

The Green Paper entitled "Towards a European strategy for security of energy supply", adopted by the Commission on 29 November 2000, provided the opportunity for an open, objective and rational debate on nuclear energy to take place. On 26 June 2002, the Commission adopted the final report on the Green Paper, which concluded that "the range of choices available to the member states has to be as wide as possible, without prejudice to their sovereignty in these matters. The nuclear option remains open to those EU member states who would like it."

Civil nuclear activities are regulated in the European Union by the EURATOM Treaty, signed in 1957. The main purpose of the EURATOM Treaty was to supervise the secure management of nuclear installations, including a high standard of health protection. The experience accumulated through several decades, including the overall safety record and statistics on load factors, supports the view that nuclear energy is a reliable source of electricity in the European Union.

A broad set of specific measures, similar but distinct from those which evolved under the auspices of the International Atomic Energy Agency (IAEA), has been developed by the EU in the field of radiation protection. However, although nuclear safety is to be understood as the preventive set of guarantees for protecting populations against ionising radiation, equivalent measures regarding the safety of nuclear installations have not developed at a European level. This is in spite of the fact that it is an area in which the Commission has, for many years, had undeniable technological expertise through its Joint Research Centres (JRC).

It is therefore necessary to add safety standards for nuclear installations, during and at the end of their working lives, to the body of legislation dealing with radiation protection. This follows on from declarations and proposals by the European Council, in particular at its meeting in Laeken (December

1. Disclaimer: "*The views expressed in this paper are personal and do not necessarily reflect those of the European Commission*".

2001), and by the European Parliament in the Rübig report, adopted on 8 July 2002, on the Commission's report on the activities of the EURATOM Safeguards Office in 1999-2000. It must be clear that the intention is not to reduce the national competencies in nuclear safety, which should remain at their present level, but to add a European dimension in view of greater transparency and a better capacity to respond to the forthcoming challenges.

1.2 New members, a broader approach

The forthcoming adhesion of new member states from Central and Eastern Europe will draw even more attention to the nuclear sector. In 2004, five of the ten countries that will enter the Union have a total of 19 reactors in operation. The complex nature of the relationship of these countries with the Russian Federation, resulting from their former links with the Soviet Union, and the new requirement for them to adopt all elements of Community law, has brought to light a new objective need for Community intervention in the nuclear sector. During the negotiation phase preceding the accession, the nuclear safety issues were brought to the table. The European Council, in co-operation with the Commission, carried out an exercise evaluating the safety of the nuclear plants operating in the candidate countries. The goal was to identify the improvements which would have to be made for the candidate countries to attain the high level of safety as required by the Cologne Council (June 1999).

This community evaluation exercise provided a new European perspective on nuclear safety. However, today we are in the rather paradoxical situation where community action on nuclear safety in third countries is internationally accepted while domestic action remains very limited. This issue was addressed by the Laeken European Council when it endorsed the approach for use in the future and asked for reports on nuclear safety to be presented on a regular basis by ***all*** member states. However, this would not be possible without the establishment of a community reference framework on nuclear safety. The ruling of the European Court of Justice in December 2002, that "it is not appropriate to draw an artificial distinction between the protection of the health of the general public and the safety of sources of ionising radiation" further endorsed the new community approach and clearly indicated that the community had wide competencies in the area of nuclear safety. These include :

- the establishment of a legislative and regulatory framework to govern the safety of nuclear installations;
- measures relating to the assessment and verification of safety;
- emergency preparedness;
- the sitting of a nuclear installation; and
- the design, construction and operation of nuclear installations.

1.3 An ageing nuclear park

A significant number of nuclear installations in the European Union are coming towards the end of their operational lives. Some member states with nuclear plants are planning to abandon the nuclear option as the current facilities come to the end of their normal life – or even before. In addition the European

Union agreed with three candidate countries to close eight nuclear reactors between 2002 and 2009: Bohunice 1 and 2, Kozloduy 1 to 4 and Ignalina 1 and 2.

These facts underline the need for clear provisions to be put into place in the electricity sector, in all member states and candidate countries, in order to fund the decommissioning of power stations *to the highest safety standards*. Decommissioning nuclear power stations requires the commitment of considerable sums of money. Estimates of the sums required for complete rehabilitation of the site of a nuclear power station vary widely, but are in no case lower than 15% of the total investment cost of each reactor to be decommissioned, which may be anything from EUR 200 million to more than a billion.

While member states with nuclear power stations have made some financial provisions to ensure the availability of sufficient funds to cover the expense of decommissioning such plants, their approach to the management of these funds varies significantly from one member state to another. In addition, the current situation involves disparities which may be a hindrance to the smooth functioning of the internal market and could undermine healthy competition in the electricity sector. In the context of the debate on the proposed directive on common rules for the internal energy market the European Parliament has drawn attention to this issue.

Sufficient funds obviously have to be available to cover decommissioning costs, but it is also necessary to ensure that those funds are used only for those activities.

Although the candidate countries now have laws similar to those in present member states concerning the establishment of funds of this type, the funds available are in general inadequate, having been established only recently. In the case of the plants subject to early closure, the reduced time for contributing to the decommissioning fund makes it clearly impossible to achieve the target amount of the funds.

The PHARE programme, along with EURATOM loans, can partially compensate for the shortfalls, but completion of the internal energy market, along with environmental considerations, will require the introduction of new rules for the enlarged EU to ensure the availability and sufficiency of funds.

1.4 Radioactive waste

Whatever the future of nuclear technology, whatever uses it is put to, for energy, industrial or medical purposes, and whether one is for or against its use in general, the management of radioactive waste resulting from such uses requires a definitive framework.

In many countries there has not so far been an active policy in favour of disposal of high level radioactive waste. High level radioactive waste has been building up in the EU for half a century or more. It is held in temporary storage which varies from country to country.

These types of temporary storage, sometimes above ground, raise concerns, both from the safety and security point of view.

The Commission is convinced that the nuclear option can only be pursued if a satisfactory and transparent solution can be found to the question of the management of nuclear waste. It is therefore necessary for the EU to ensure that member state decisions are taken within a reasonable time and with future generations in mind.

According to most experts, deep geological disposal is the safe and sustainable option for the long-term management of radioactive waste. Research into partitioning and transmutation, which could lead to a reduction in long-lived radioactive elements in the waste stream, has not yet resulted in a practical or economic alternative to geological disposal. It should, nevertheless, be pursued in order to give future generation's access to possible alternative technologies for the treatment of radioactive waste.

1.5 The EC initiative

The lack of a community framework for the safety of nuclear installations, uncertainty as to the availability of financial means to ensure safe decommissioning, the lack of progress on the management of nuclear waste are, therefore, areas in which it is desirable to develop community legislation.

The commission is responding to this challenge and has proposed two directives for adoption by the Council. One covers the "setting out basic obligations and general principles on the safety of nuclear installations" and the other covers "the management of spent nuclear fuel and radioactive waste".

2. Decommissioning, as referred to in the proposal for a directive on "Safety"

2.1 Safety and the need of funds for decommissioning

Maintaining a high level of safety in nuclear installations, during their active life as in the decommissioning phase, requires adequate resources to be available. Decommissioning a nuclear installation is a major industrial undertaking, which can take many years. The costs of decommissioning operations can be very high.[2] To deal with these it is necessary that financial resources should be available. These will have to be provided for by the operator during the active life of the nuclear installation. After closure of an installation, it is essential that decommissioning operations can begin at once in conformity with a high level of safety.

The main concern of the general public, of national authorities and of operators is to ensure that safety and radioprotection obligations will be fulfilled throughout the decommissioning phase.

It is essential to avoid any possibility that the decommissioning of a nuclear installation will not be able to start as planned, is not carried out according to the appropriate procedures, or is abandoned before completion due to a lack of resources. The availability of the financial resources necessary for decommissioning of nuclear installations must be guaranteed over a long period of time.

2. The Directive actually addresses the funding of all the end-of life liabilities: "*as to cover decommissioning of the installation; safe, long-term management of the conventional and radioactive waste from decommissioning of the installation; and safe, long-term management of the spent fuel from nuclear power stations and of the wastes from reprocessing operations not already fully covered as an operational cost*".

The alternative situation would be that a substantial quantity of radioactive material would not be monitored or managed in an acceptable way, with severe implications for radiological safety. Under such circumstances, one of the fundamental objectives of the EURATOM Treaty, might not be met.

There is widespread agreement on the principle that the operator should take into account during the productive life of the nuclear installation not only technological, social and economic issues relating to the cost of production but also the financial viability of the life cycle as a whole, including all the future costs arising for the decommissioning of the installations.

At present, operators make use either of company resources or of contributions to externally managed funds set up by various mechanisms for this purpose.

2.2 Securing the funds

Even if reserves are set aside to enable decommissioning to be undertaken and to ensure the management of radioactive waste and of spent fuel, the fundamental question is to ensure the availability of these resources in the long term, often several decades hence. To this end, the creation of decommissioning funds with their own legal personality distinct from that of the operators is, in the view of the commission, the best option to achieve the objective of decommissioning with all the necessary safety conditions.

The creation of external funds, managed on prudential principles, should ensure the long term availability of funds and guarantee the maintenance of a high level of nuclear safety throughout the decommissioning phase.

2.3 Common understanding and transparency

The implementation of a European common approach to decommissioning funds will immediately increase transparency in this area as there will be a requirement for regular reports by member states to the commission. These reports will need to incorporate, among other things, information on the boundary conditions for the estimations of the costs (i.e. strategy of decommissioning, end point of decommissioning, radioactive waste release policy, economic parameters), the mechanism for raising the contributions and details of the methodology used for the calculations.

Given the impact that different input data and assumptions have on the overall costs of decommissioning, a thorough knowledge of these is absolutely necessary in the interest of transparency in the application of the common rules.

2.4 The situation in the candidate countries

In June 1999 the Cologne Council asked the commission to ensure the application of high safety standards in Central and Eastern Europe. On the basis of this mandate, the commission negotiated, on behalf of the EU, the closure of a number of nuclear reactors. In return, the EU contributes towards the costs related to the definitive shutdown of these reactors.

Three candidate countries are concerned by the early closure of nuclear reactors: Bulgaria (Kozloduy 1 to 4), Lithuania (Ignalina 1 and 2) and Slovakia (Bohunice 1 and 2). The first closure took place on 31 December 2002 when Bulgaria shut down Kozloduy 1 and 2.

In the case of the three countries concerned by the early closure of nuclear power stations, it is clear that the national funds for decommissioning will not have sufficient resources to cope with all the work needed until complete dismantling.

Through the PHARE programme, the community is the main contributor to the international decommissioning funds managed by the European Bank for Reconstruction and Development (EBRD).

2.5 Strategy selection for decommissioning

Regarding the strategy for decommissioning, it is important to realise that the commission’s new proposals for legislation in the nuclear sector are “directives”. In simple terms, this means that the Council adopts objectives that the member states must achieve, but leaves much of the details of how this is to be done to the individual states.

The clear objective of the decommissioning part of the safety directive is that sufficient funds be available to cover all the nuclear liabilities at the end of operating life of a facility so that the full decommissioning can be done safely. However, the directive clearly places the responsibility for making sure this is done with the member states. They must be responsible for determining all the details, including the size of the funds and the way in which they are managed. The directive makes no proposals concerning the choice of the strategy to be followed for decommissioning – either the time it starts, the speed at which it is achieved, or the status of the site at the end of the process. That being said, we would urge member states to make it clear exactly where the different responsibilities lie. I would also add that from our many discussions on the subject, in particular during recent months, we are strongly leaning towards immediate or “near-immediate” decommissioning where this is possible.

3. The management of spent nuclear fuel and radioactive waste as proposed in the waste directive

3.1 The magnitude of the problem

After half a century of developing and using nuclear energy and accumulating radioactive waste none of the most hazardous form of this waste has been disposed of in the EU or elsewhere in the rest of the world. However, as the Green Paper on the security of energy supply emphasised, the nuclear option can only be pursued if a satisfactory and transparent solution is found to the question of the management of nuclear waste.

The issue mainly arises for the most dangerous form of the waste, that is generated at the back-end of the fuel cycle.

This waste only represents 5% of the total volume of nuclear waste but contains 95% of the radionuclides. It is currently held in temporary storage at or near the surface.

This storage method raises concerns about the vulnerability of such sites, particularly in the light of the events of 11 September 2001.

Based on many years of research and other studies, there is now a very wide consensus among experts that deep geological disposal is currently the most feasible and reliable option and that the construction and operation techniques to achieve it are sufficiently well developed to be implemented now.

Although deep geological disposal is a permanent solution, the waste can be retrieved at a later date if other technological solutions are found in the future that offer increased levels of safety at a reasonable cost.

Therefore, the development of alternative technologies should be pursued in order to offer future generations the possibility of having methods for treating waste, possibly "partitioning and transmutation" technology.

3.2 Towards a safe solution

The commission considers that the time has come to take concrete decisions in the field of radioactive waste management, with regard to making progress towards final disposal and increasing research in this field.

A choice in favour of disposal

The commission proposes that member states should commit themselves to national programmes with defined timetables for the disposal of radioactive waste in general and for deep disposal of highly radioactive waste in particular. They will have to take decisions authorising the choice of a disposal site or disposal sites by 2008. For highly radioactive waste the sites should be authorized for operation by 2018 at the latest. For low-level, short lived radioactive waste, disposal the site should be authorized for operation by 2013. These deadlines would not prevent the implementation of solutions which may arise from future scientific developments.

Increasing funding for research

Successful implementation of deep disposal must not lead to a reduction in the level of research in other areas of radioactive waste management. Research could continue to explore new technologies for minimising the quantities of such waste.

The community framework programme has played, and will continue to play, an important role in promoting research and development in the field of radioactive waste. However, this is only a small fraction of what is being spent – and what will need to be spent in future.

To reinforce the cooperation in research, the commission intends to propose to the Council the creation of one or more joint undertakings to be responsible for steering specific research programmes on waste management.

4. Conclusions

In view of the necessity of guaranteeing a high level nuclear safety in an enlarged EU, and the Union's undertaking to pave the way to a true community approach in this field, the commission has submitted to the Council proposals for:

- A directive setting out basic obligations and general principles on safety in nuclear installations during and after their active lives in the enlarged EU, with a view to introducing a control mechanisms to verify the application of safety regulation and criteria throughout the enlarged Union and, to facilitate this in future, the development of common safety standards. This directive also requires adequate financial resources to be available for both the safety of nuclear installations during their operating lives and decommissioning.

- A directive on the management of radioactive waste, with emphasis on the high-level and long-lived geological disposal of waste as the safest method of disposal in the present state of the art. It provides that member states should adopt national programmes, with a defined timetable for the disposal of radioactive waste in general and deep disposal of highly radioactive waste in particular.

These directives are currently under discussion in the European Council. The commission expects their adoption in the coming weeks.

VIEWS OF PLANT OPERATORS – WORK DONE AT EURELECTRIC AND EUR

Manuel Ibáñez, Spain
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EURELECTRIC

1. Introduction

The Union of the Electricity Industry – EURELECTRIC, formed as a result of a merger in December 1999 of the twin Electricity Industry Associations, UNIPEDE and EURELECTRIC, is the sector association representing the common interests of the European Electricity Industry and its world wide affiliates and associates.

Its mission is to contribute to the development and competitiveness of the Electricity Industry and to promote the role of electricity in the advancement of society.

As a centre of strategic expertise, the Union of the Electricity Industry – EURELECTRIC will identify and represent the common interests of its members and assist them in formulating common solutions to be implemented and in co-ordinating and carrying out the necessary actions. To that end it will also act in liaison with other international associations and organisations, respecting the specific missions and responsibilities of these organisations.

The Union of the Electricity Industry – EURELECTRIC is also the association of the Electricity Industry within the European Union representing it in public affairs, in particular in relation to the institutions of the EU and other international organisations, in order to promote the interest of its members at a political level and to create awareness of its policies.

The EURELECTRIC's work agenda and main policies and strategies of the association are determine by the five committees of its organisational structure: Energy Policy and Generation, Networks, Markets, Environment and Sustainable Development, Management.

Each committee has its own specific working group structure of expertise and adopts positions or undertakes studies on all issues falling within its competence.

One of the working groups of the Energy Policy and Generation Committee is the Working Group Nuclear. Its Terms of Reference include as main items of the working agenda the radioactive waste management and plant decommissioning.

2. EURELECTRIC reports

2.1 Decommissioning of Nuclear Power Plants and Related Waste

In 1993 UNIPEDE issued a report titled "An International Survey of Radioactive Waste and Decommissioning in Terms of Policy, Strategy, Finance and Public Relations".

The report titled "Decommissioning of Nuclear Power Plants and Related Waste" was published in June 2000, to update some information contained in the UNIPEDE report and to summarise available information on the subject without duplicating the detailed and useful work made by the Nuclear Energy Agency (NEA) of the OECD, the International Atomic Energy Agency (IAEA) and the European Commission (EC). It gives an overview of the main areas of NPPs decommissioning and related waste such as technologies, policies and strategies, regulations, funding, waste categorisation and treatment, personnel and public acceptance. For each of these items possible options and remaining problems to be solved (including harmonisation needs) are mentioned. The overview has been established on the basis of the different situations related to each domain in the participating countries.

The report contains also a status report of the work performed by the IAEA, the NEA and the EC with their programmes for further work. These organisations each analyse decommissioning under different aspects: safety and regulations for the IAEA, industry and technologies for the NEA and environment and R&D for the EC.

An update of the country-specific situations, which were described in the 1993 UNIPEDE report, illustrates the general overview. The most important literature on the subject mainly drawn up by these organisations is listed at the end of the report. This list shows that much work has been performed to allow for efficient and safe NPP decommissioning. The plant operators who participated in this work represented Belgium, the Czech Republic, Finland, France, Germany, Hungary, Italy, the Netherlands, South Africa, Spain, Sweden, Switzerland and the United Kingdom.

The purpose of this report is to serve as a guidebook for any reader interested in the issue, with information on the main subjects, on who is doing what, on the situation in some countries, and on the existing literature. The report does not consider decision-making factors that lead to the decision to decommission a NPP, although some considerations on this subject are provided by other organisations.

This report provides evidence that NPP decommissioning and related waste is at a mature industrial stage with no critical point to be solved urgently. Nevertheless research and development is to be continued, as for any other industry, and some harmonisation is still necessary.

The main areas that are analysed in the report are:

I. **Technology**: the huge amount of developments and international exchange of experience shows that NPP decommissioning is not an incipient and inexperienced industry.

The technologies necessary for plant decommissioning (decontamination and dismantling) are often the same as those usually applied during the operational life of the plants during large maintenance works (e.g. primary system steam generators replacement which needs a dismantling of structures, decontamination, cutting, welding, etc.).

As a result of world-wide activities and of the application of the technologies during the operating life of the plants the technologies necessary for the dismantling of NPPs can be considered as being at a mature industrial stage. Nevertheless, in order to improve the efficiency, some research and development seems to be necessary in the following main areas:

- decontamination technologies: chemical, electrical, mechanical, ultrasonic, etc.;
- dismantling technologies: cutting, etc.;

- improvement of waste volume minimisation;
- non-metallic material recycling;
- control and measurement techniques;
- remote operation; and
- deep geological repositories.

II. **Policies and strategies**: the different countries all have policies and strategies according with their needs.

The differences as regards policies and strategies adopted by different countries are mainly related to the time frame for the various options which may ranges from immediate dismantling to deferred dismantling (about 50 years). Other differences are related to:

- the decision to select one option: re-use or not of the land according to scarcity of sites, re-use of the site for activities other than nuclear, presence or not of spent fuel storage on the site, other units in operation on the same site, etc.;
- exemption and clearance level of very low-level waste (VLLW) and availability of repositories for such waste.

The factors which may guide the choice are like:

- Finance: are the necessary funds available? Is it not better to use them as soon as possible?
- Radiological protection: according to the ALARA (As Low As Reasonably Achievable) principle the health protection of workers in charge of dismantling could benefit from deferred dismantling. (decrease of radiation levels by a factor of about 3 for a deferred dismantling).
- Availability of waste repositories: this availability is related to factors such as the adoption by the country of release thresholds (e.g. for VLLW), financial worthiness of national repositories as a function of the number of national nuclear installations (as opposed to regional repositories for countries with small nuclear activities). The economical worthiness of expensive solutions, like geological repositories, depends on the importance of the national nuclear activities (including all other nuclear applications than electricity generation).
- Political decisions for one of the alternatives are not based on balanced financial arguments.
- Regulations: as above they are in place with different stages of development which fit to the different situations of the countries. They are based on international guidelines (basic rules and nuclear safety standard recommendations).

It is important to recall that decommissioning of a NPP is subject to licenses granted and controlled by safety authorities.

III. **Cost estimates and funding**: these important factors for sustainability (present customers pay for future generations) are under control, as long as there is economic stability and no political interference. The cost for future radioactive waste processing and storage and decommissioning of the plant after its useful life time has to be estimated as precisely as possible and appropriate mechanisms have to be set up to save this money and have it available in due time.

The factors affecting the decommissioning costs could be grouped into the following categories:

- scope of calculation;
- decommissioning timing;
- technical factors: the most important technical factor is of course the type and size of the reactor (decommissioning of a gas cooled reactor would normally be larger task than decommissioning of a light water reactor);
- waste management system: during decommissioning a large volume of radioactive waste will have to be managed. The cost of decommissioning will therefore be affected in different ways by the specific waste management system in the country. The influence will be both direct, for example fees for transport and disposal, and indirect, for example cutting to reasonable sizes, need for decontamination and waste conditioning;
- administrative factors (labour rates and legal systems); and
- financial factors.

In any case the assignments of responsibilities to the different actors is usually clearly defined in the national regulation establishing the national policy (responsibility for plant decommissioning, for cost establishment and review, for the collection of the necessary money and for the management of the funds).

It is important to link the responsibility for decommissioning activities and the management of the decommissioning funds to make sure that the money will be available in due time.

IV. **Waste**: different radioactive waste processing and disposal policies and technologies are analysed.

A NPP produces during its operation phase two kinds of radioactive "waste": the spent nuclear fuel and the process waste (gaseous, liquid and solid). The spent fuel is considered as waste only if there is no further reprocessing. In the case of reprocessing only fission products are final waste. But these two categories of waste are not related to NPP decommissioning except if the spent fuel is stored on site.

Decommissioning wastes originates from the structures of the plant which are either irradiated or contaminated.

For irradiated materials, such as the reactor vessel, only the natural decay of radionuclides or appropriate shielding can reduce the radiation levels. This explains the option of deferred decommissioning for which the workers dose is reduced.

Contaminated materials will be decontaminated before being dismantled.

Another selection criteria for wastes related to NPP decommissioning is to considerer low and intermediate level waste and very low level waste.

The problem to be solved in relation to very low level waste (VLLW) is related to its large volume even after decontamination. The volume of such waste is a function of the clearance criteria. The clearance "is the removal of material from a system of regulatory control provided that the radiological impact of these sources after removal from the system is sufficiently low as not to warrant any further control". The definition of clearance will of course have an important impact on the quantities of waste to be stored as VLLW and on the materials that can be reused as conventional. Two mains policies exist for this definition: use a criteria linked to the activity level to be considered as a threshold or use a criteria linked to the origin of the waste: namely controlled area structure or building of the plant. There are of course pros and cons for each solution, but finally the decision stays with the country's authority in the frame of its policy. There is twofold impact: a) on the waste amounts to be stored, which is again the country's policy, and b) on the release of material which may travel from one country to another and may pose a problem of harmonisation of the clearance level.

Independently of the actual policies and strategies, the technologies necessary for processing the waste from dismantling are basically the same as those used during plant operation. They vary from waste minimisation at source by means of optimised management, to concentration, sorting, packaging and finally, at specific waste processing plants, nitrification, bitumisation, polymerisation, cementation, incineration, etc. All these technologies are designed for safe conditioning of the waste in order to reduce the risk of dispersion and radiation to negligible values. The only real big difference between operational waste and dismantling waste is the quantity. This means that the adequately large repositories have to be made available in one or more decades to store these waste amounts.

V. **Personnel**: particular attention should be paid to the availability of necessary plant operators and personnel in charge of plant dismantling.

The period from the time the decision to shutdown the plant has been taken, until the removal of the last nuclear fuel has been finalised, is a sensitive period for safety and for the operational staff. These issues include the moral of plant personnel and the loss of competence due to the searching of many of them for another job. This is particularly the case when there is only one unit on the site and when countries have only a small nuclear power programmes.

VI. **Public acceptance**: this important activity is not to be disregarded when preparing and implementing decommissioning-dismantling activities.

Decommissioning of nuclear facilities and the selection of a waste disposal site are activities that deserve an active communication programme. For decommissioning it is not only a continuation of the communication during plant operation but also a matter of politeness to the local population which deserves information about the process in order to demonstrate that decommissioning is harmless to them.

Another, even more important, fact is that the construction and operations of the plant had an important impact on the local economy (employment, industrial activities and source of revenues, e.g. for municipalities). Decommissioning of the plant will in most cases be related to the end of this positive impact on the local economy. This deserves that the authorities encourage well in advance the implantation of new activities and there must be communication about it.

VII. Harmonisation and other future common work identified relates to:

- Very low level waste (VLLW) release criteria that needs harmonization due to possible transboundary transportation and reuse as conventional material.

- International waste disposal: although there are legal and public concerns in some countries, the emergence of international repositories could be an economical solution for countries with small nuclear activities. But this would need harmonisation of waste definitions and transboundary waste transportation regulations.

- The adaptation of emergency plans to the different steps of plant dismantling which is not always taken into account in the different national decommissioning policies.

- Cost estimate: to continue to sharpen knowledge in this area (in co-operation with IAEA, NEA and EC).

2.2 Nuclear Power Plant's Radwaste in Perspective

The report titled "Nuclear Power Plant's Radwaste in Perspective" was published in January 2002.

- Adoption of nuclear power to generate electricity, although it helps significantly in reducing electricity-related CO_2 emissions, is nevertheless often criticised for producing radioactive waste. This is an important point and the nuclear industry needs to explain the solutions available for dealing with radioactive waste. Hence it was felt necessary to develop a concise document in order to communicate and inform on the status of radioactive waste from nuclear power plants and to illustrate the subject by a description of the real situation in different member countries. The analysis was performed together with international organisations involved in this area.

This report gives an overview of how radwaste is handled in the European Union and Switzerland and in some accession states. Its aim is to help dispel the myths and shed clarity upon an issue that is too often not well understood. The public in general and most stakeholders which are not actors of the nuclear industry are misinformed or at least not informed about the facts and realities of all technological, economical, regulatory and policy aspects of radioactive waste management.

The purpose of this report is:

- to provide clear and concise information on the different aspects of waste resulting from generation of electricity by means of nuclear energy;

- to put them in perspective with other wastes;

- to describe the related activities of some international organisations; and

- to give information on the situation in participating countries from the EU and other European countries, updating the status by country of the year 2000 report mentioned in section 2.1.

The main topics which have been scrutinised are:

- definitions of radioactive waste;
- quantities in perspective with other wastes;
- regulatory framework;
- control;
- very low level waste and exempt waste;
- low and intermediate level waste;
- high level waste;
- costs and funding;
- transportation;
- public acceptance;
- situation in EU accession candidate countries;
- recommendations for future work.

The plant operators who participated in this work represented Belgium, the Czech Republic, Finland, France, Germany, Hungary, Italy, the Netherlands, Romania, Slovakia, Spain, Sweden, Switzerland and the United Kingdom.

2.3 EURELECTRIC Position Paper on European Union Commission's "nuclear package"

In relation with the commission's proposals on "ensuring sufficient financial resources to cover decommissioning cost" contained in one of the directives of the so called "nuclear package", EURELECTRIC issued a Position Paper with the following text.

First experiences with decommissioning are taking place in the European Union (as listed in the Communication from the Commission to the Council and the European Parliament "Nuclear Safety in the European Union" COM 2002/605) without problems, proving that the industrial processes involved work well and that we can have confidence in the systems in place. This is despite differences among member states concerning the expected level of decommissioning (brown field, green field, etc.), the necessary scale of funding, the timeframe set for decommissioning, and the background for financing decommissioning, etc.

EURELECTRIC agrees with the necessity of securing, throughout their generating lifetime, adequate financial resources for the future decommissioning of nuclear installations. The money must be available as and when it is needed.

In light of the substantial differences in national circumstances, the various member states must have the ability to develop their own ways of reaching this goal. When analysing the methods of funding liability management, significant historical factors must be taken into consideration. It is not a case of “one size fits all”. Member states and nuclear companies must be allowed the freedom necessary to reach national agreements on the design and management of decommissioning financing.

Subsidiarity notwithstanding, the following aspects should be taken into account:

- The organisation held legally responsible for decommissioning should also be responsible for ensuring the necessary financial resources are accumulated, no matter what type of management scheme is chosen. Furthermore, there must be no legal ambiguity concerning the ownership of the resources accumulated for decommissioning; ownership lies with the organisation(s) responsible for providing the financing. This principle pertains where there are shortfalls, as well as where the financial resources accumulated are in excess of those needed for decommissioning.

- The decommissioning objectives, the methods used to collect the funds and the level of security of financial resources should be equivalent, while respecting the principle of subsidiarity.

EURELECTRIC shares the commission’s goal regarding the availability of the necessary financial resources. However, we find the commission’s proposed specific funding mechanism as arbitrary.

3. EUR activities

Even if no plant has been ordered in Europe since the mid 80s the major European electricity producers want to maintain the ability to build new nuclear power plants when necessary. They believe LWRs would be the most adapted technology in the first decades of this century. Producing a common European Utility Requirement (EUR) document that sets out harmonized design targets has been felt one of the basic tasks to pave the way to new standardized LWR plants.

Since late 1991, the major European electricity producers have been writing a common set of requirements that provides clear guidance to the designers. Meanwhile the main vendors have developed advanced LWR standard designs for the European market, with reference to the EUR document. The EUR document now includes all the parts that were foreseen when the EUR work started in 1991. Two sets of generic requirements have been developed: one dedicated to LWR nuclear islands (volumes 1 and 2) and the other one to power generation plants (volume 4). The volume 3 deals with the application of the EUR generic requirements to the specific designs that may be offered in Europe.

The chapter 16 of the EUR document is devoted to the decommissioning issues. The present version of the chapter (April 2001), now under revision, establishes general requirements concerning decommissioning which will become relevant to a plant at the end of its technical lifetime or earlier due to other reasons. Those requirements are aiming at demonstrating the feasibility of the decommissioning of the plant. As the decommissioning plan is a legal requirement for the owner in some countries, the fulfilment of these requirements should help to achieve these obligations, in particular the evaluation of the dismantling costs and the establishment of funds that have to be build up in order to cover the obligations.

The requirements also concern the measures that the designer has to take at the design stage to facilitate the future dismantling operations. The main design considerations for a plant are safe operation coupled with high availability. This chapter therefore addresses those aspects of decommissioning that can realistically be taken into account during the design stage of a new plant. The proposed requirements are based upon the plant layout and on experiences gained by:

- maintenance and provisions;
- evaluation of overhaul reports;
- back fitting measures combined with systems and component modifications;
- evaluation of previous decommissioning measures and studies;
- radiological measurements.

The following aspects are addressed in the chapter 16:

- feasibility study;
- levels of decommissioning;
- design features for easy dismantling;
- documentation;
- decommissioning plan.

3.1 Conclusions and recommendations

- NPP decommissioning and related waste management is at a mature industrial stage with no critical point to be solved urgently.
- The cost for future radioactive waste management including decommissioning of the plant after its useful life time has to be estimated as precisely as possible and appropriate mechanisms have to be set up to accumulate the necessary funds and have them available in due time.
- It is convenient to reduce the volume of very low level waste (VLLW) by clearing this material from regulatory control.
- Particular attention should be paid to the availability of the plant operators and personnel in charge of plant dismantling.
- The chapter 16 of the EUR includes the requirements that the new reactors designer has to take at the design stage to facilitate the future dismantling operations.
- Decommissioning is a matter deserving an appropriate communication strategy which shall start in the neighbourhood of the plant and should cdnsist in demonstrating above all technical feasibility.
- Research and Development activities are to be continued.

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STRATEGY SELECTION ANALYSIS BY PLANT TYPE

SESSION I: GAS/GRAPHITE REACTORS

VANDELLÓS, SPAIN
(SAFE ENCLOSURE)

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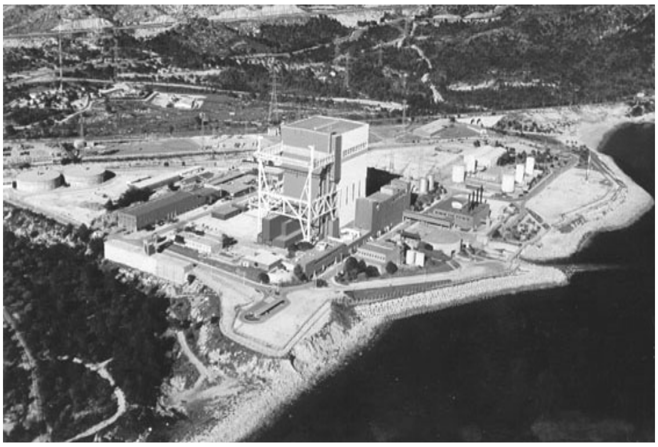
Plant description

The Vandellós-I Nuclear Power Plant (CNV1) is located on the Mediterranean coast in the province of Tarragona (Spain).

The Plant is of the European Natural Uranium Graphite-Gas type. The thermal power of the plant amounts to 1 670 MWt, its electrical output being 500 Mwe.

The Plant started-up commercial service in May 1972; its final shutdown, due to a fire in the turbines, occurred in October 1989, after 17 years of operation with an accumulated energy production of 55 647 GWh.

Figure 1. Vandellós-I NPP before start the decommissioning works in 1998



Selected decommissioning option

The option accepted by the Ministry of Industry, consists of first removing the spent fuel and conditioning the operating radioactive wastes, and then undertaking dismantling of almost all the structures and components located outside the reactor vessel, except those ensuring confinement of the vessel itself and the safety and surveillance of the facility and site. No action will be taken with respect to the vessel, in which the reactor will remain confined without nuclear fuel and with is internals intact until completion of the waiting (dormancy) period.

The site itself will be kept under surveillance during dormancy phase, following partial clearance, the remaining installations being left within the new site perimeter in a situation of monitored confinement. Following the dormancy period, which will last some 30 years, total dismantling of the remaining installations will be undertaken, this implying subsequent complete clearance of the site.

Content

The project was started in November of 1992, and the works on site began in 1998 until June of this year, when the end of level 2 was achieved. It was a new project for the Spanish Nuclear Industry, because it was the first time that dismantlement of a commercial Nuclear Power Station had been carried out in Spain. The concept that we followed was to consider this activity like an industrial process, adjusted to a time plan, to a budget and some technical specifications; it has shown significant differences with other typical processes such as the construction or the operation of nuclear plants, as much from the technical point of view as organisational, that some lessons have been learned as a result that can be applied or extrapolated to other similar projects.

The safe enclosure consist only in the reactor pressure vessel, which will be left on site, is of concrete, with 5 m thick walls and top and bottom slabs about 6-7 m thick. The activity content of the vessel is about 100 000 Ci, mostly Co-60. The residual heat equivalent is about 4-5 kW in the graphite and other materials. Part of the stage 2 concept is the total static isolation of this vessel. The vessel has 1 700 penetrations, the pipes of which were cut, seal-welded and inspected. The covers were insulated with polyurethane foam and various forms of physical protection installed. This total sealing is to avoid condensation in the core area.

The leak-tightness of the vessel was tested by subjecting the vessel to a slight over-pressure of the order of 0.5 kg/cm^2 and to evaluate the leakage over a period of time. The results were very satisfactory, about 18% of the acceptance criteria.

Figure 2. Vandellós-I, safe enclosure, at the end of the level 2 decommissioning works, May 2003

The Vandellós project is very systematically aiming to minimise the quantity of radioactive waste arising. The management of materials emerging from controlled areas is based on a rigorous process of measurement of gamma emitting nuclides and estimation of activity of difficult to measure nuclides. The procedures for this, including the campaign and using conservative judgements, was approved in the autumn of 2000.

The Vandellós-I decommissioning project has already three authorised basic possibilities for the application of clearance of residual materials: the unconditional clearance, the generic conditional clearance and the specific conditional clearance. Different sets of radionuclide specific figures for unconditional clearance levels and for generic conditional clearance levels have already been established for some generic materials, building and concrete demolition debris among them.

In order to guarantee the process a rigorous segregation and decontamination plan had put into place. The site has five controls to guarantee the complete efficiency throughout the process, which is applied to all materials. With these exhaustive controls it can be ensured that all the materials removed from the plant do not exceed the levels of activity imposed by the Spanish regulatory body.

The main part the process control consists of performing integrated measurement of the containers using a sophisticated device known as the Box Counter, which analyses the radiological charge of the material contained in the as called “Measurement and Declassification Container” by means of a gamma spectrometry measuring system.

The modularity and versatility of the auxiliary facilities, the control processes and administration of the enormous amounts of materials produced, their characterisation and their classification; the organisational structure and the administration of the bidding process and contractors, are some of the experiences that will be use as lessons learned in the future projects and can serve to other organisations that are involved in similar tasks.

UK REACTOR DECOMMISSIONING STRATEGY

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With the cessation of electricity generation, nuclear power stations move into the next stage of the overall life cycle of the facility: decommissioning. Decommissioning is defined as the process whereby a nuclear facility, at the end of its economic life, is taken permanently out of service and its site made available for other purposes. This involves the implementation of a structured and safe programme for dismantling and clearing the site and making it available for alternative use in the future. In practical terms, "decommissioning" means the systematic and progressive reduction of hazards to the point where the site could eventually be de-licensed.

The framework for decommissioning the UK Magnox power stations

Government policy

Current UK government policy on decommissioning was laid down in 1995 (Cm 2919). The key points are:

- Decommissioning should progressively reduce hazard within a framework that ensures safety of workers and the public and protects the environment;

- Decommissioning should be undertaken as soon as is reasonably practicable, taking account of all relevant factors (including the type of facility, the nature of its radioactive inventory, cost and overall financial, economic and resource issues);

- Nuclear licensees should draw up decommissioning strategies acceptable to the regulators and discussed with them in advance, including justification of the timetables proposed. These strategies should be prepared on a case by case basis for each facility, be seen as living documents and be reviewed quinquennially by the health and safety executive (HSE) consulting with the environment agencies (EAs);

- The HSE's periodic review of decommissioning strategy for those facilities in the public sector should consider, amongst other things, financial provisions.

Radioactive waste disposal

UK Nirex Ltd was formed in 1982 as the company to manage long term disposal of radioactive waste in the UK. In 1989, Nirex was asked by the then Secretary of State for the Environment to investigate the feasibility of a deep ILW/LLW disposal facility. As part of its development of that concept, it has provided the industry with specifications and advice on packaging of long lived wastes.

When Nirex's appeal against refusal of planning permission for a rock characterisation facility (RCF) was rejected in 1997, site investigation work ceased. Consequently there is at present no ILW disposal facility to take the radioactive waste arising from decommissioning UK nuclear power stations. Nirex's current mission is: "To provide the UK with safe, environmentally sound and publicly acceptable options for the long term management of radioactive materials".

Regulatory requirement for passive safety

The Regulators' requirement, and the Company's intent, is to ensure that those radioactive materials remaining on the Magnox sites for extended periods are held in a state of passive safety. Passive safety means that potentially hazardous materials and wastes have been immobilised and the site remains safe with no requirement for continuous human presence or supervision and no need for rapid human intervention.

Decommissioning options for Magnox power station sites

Options for managing used nuclear fuel

Leaving spent fuel on site for an extended period was not considered acceptable and no alternatives to transferring it to Sellafield for reprocessing have been addressed.

Options for managing operational ILW

The decision to retrieve, package and store that operational ILW which is not already passively safe was made independently of the decision as to which option should be employed for managing the rest of the site, including the reactors. This material could be safely retained in its raw form, as it has been during the electricity generation phase of the station's lifecycle, but this would not be passively safe and hence was not considered to be optimal. Retrieval and packaging allows the ILW to be stored in a passively safe condition in accordance with modern standards. It also allows raw waste storage tanks and vaults to be decontaminated and, where practicable, removed early in the decommissioning process. Retrieval and packaging is expected to satisfy HSE/NII requirements for long-term management of this material.

Options for managing the site

Having dealt with the used fuel and operational ILW, there is a need to consider the rest of the site, including the reactors. There are many detailed variations of strategies for decommissioning nuclear power station sites that are considered and applied world-wide but these fit into three main groups of options: early site clearance, deferred site clearance and "mounding". Twelve decommissioning options that fit into these three groups were considered in detail by Magnox Electric plc.

Early site clearance

This process would involve dismantling all buildings on site, including the nuclear reactors, in the years immediately following cessation of generation. Radioactivity inside the reactors would still be at sufficiently high levels at this early timescale to require the use of sophisticated, remotely operated robotic machinery for the dismantling activities to protect the employees carrying out the work. The installation and (more significantly) the maintenance of this equipment could expose employees to higher levels of radiation than would be the case under the other options considered below. Further, faults could lead to more serious harm to workers and potentially greater damage to the environment, than faults occurring during deferred dismantling.

Larger volumes of ILW would be produced from the process of dismantling the reactors at an early stage and this would have to be kept on-site, together with the packaged operational ILW, until a National repository for such ILW became available. The mass of material to be managed at this time would, on most sites, be at least an order of magnitude more than that of the operational ILW to be packaged and stored. Furthermore LLW, produced in significant quantities by reactor dismantling, might not all be accommodated in the National LLW disposal facility at Drigg in Cumbria and hence the on-site store could well need to be much larger again.

As early site clearance would not achieve the benefits associated with a period of radioactive decay (in engineering and discounted cost terms), it would have a significantly higher financial impact in net present value terms than the other options.

It can be seen that early dismantling of the reactors, without allowing for significant radioactive decay, although technically feasible, would provide a number of serious impediments and difficulties to the decommissioning process.

Deferred site clearance

Although there are a number of different options that can be grouped under the heading of deferred site clearance, the lead option that Magnox Electric plc has considered involves significant early work in dismantling all buildings on site except those housing the reactors and primary coolant circuits. These would be retained on site until the optimum time is reached for dismantling them. LLW produced by early dismantling of these buildings and the plant they contain could be accommodated at the Drigg facility in Cumbria. Such early dismantling would not create ILW.

The reactor buildings would be left *in situ* (in a configuration we have called Safestores) until the radioactivity within them had fallen to appropriate levels at which employees could safely enter the reactor pressure vessels to set up, operate and maintain the dismantling equipment. Throughout this period, the Care and Maintenance period, the reactor buildings and waste store would be continually monitored and the buildings would be maintained to retain them in a safe condition, protect them against the weather and keep them secure against intruders.

Radiation exposure levels in the reactors fall naturally through time. After about 70 to 90 years from shutdown, both the radiation exposure to workers accessing the reactor vessels inside the biological shield and the potential for releases of radioactivity to the environment under fault conditions would be greatly reduced. The reactors could be dismantled using simpler technology with personnel access into the reactors being feasible for significant periods to set up, operate and maintain dismantling machinery.

Deferring dismantling allows radioactivity to decay naturally, which reduces radiation exposure levels for workers, simplifies dismantling and reduces the potential consequences of any faults that might occur. Volumes of ILW requiring disposal and their associated radiation dose rates are also reduced.

Mounding

The most straightforward and cost-effective option would be on-site disposal, which is also known as mounding. The spent fuel would still be sent to Sellafield for reprocessing, but operational

ILW would be buried with the reactor buildings. This option would involve removing all non-radioactive buildings from the site and, possibly, partial reduction in the height of the reactor buildings. All voids within the remaining "radioactive" buildings would be filled. These buildings would then be buried under a large mound of concrete, sand and soil. This would be less expensive than the other options, as it would involve little dismantling of radioactive plant and buildings and it would provide a lower radiation exposure to workers.

Under current legislation, the site would become a radioactive waste disposal site and it could not be made available for unrestricted alternative uses in the foreseeable future. It would be difficult to monitor the state and condition of the reactor buildings under this mound and exceedingly difficult to reverse the mounding in the event that this was necessary. It is likely that the mounds would be of concern to local residents. It is thought unlikely that on-site disposal in this manner would be acceptable to the regulatory authorities.

Matters affecting the choice of decommissioning option

There are a number of factors potentially influencing the length of an appropriate reactor dismantling deferral period. Some of the more significant are discussed below. Government policy, contained in Cm 2919, requires decommissioning to be undertaken as soon as reasonably practicable, taking account of all relevant factors. *This does not mean that reactors should be dismantled as soon as technically feasible.* There is no one single deferral period that stands out as the best. The extremes of the possible range of timings are a minimum of about 30 years and a maximum of about 130 years. However, taking a balanced judgement across all relevant factors suggests that a more appropriate range is around 70 to 100 years.

Radioactive decay

For a number of decades following reactor shutdown, worker access inside the reactors is precluded because of the high radiation dose rates from cobalt-60. If reactor dismantling were to be undertaken in this period it would have to involve fully remote operations both to dismantle all reactor plant within and including the bioshield and to handle the resulting waste materials. After some decades worker access can be achieved. Calculations and measurements indicate that sustained worker access into the bioshields for dismantling purposes can be gained after about 70 to 90 years following shutdown, although further radiation dose commitment reductions will occur up to about 130 years. Radiation dose rates vary from point to point within the reactor plant because of the different materials and the differences in neutron flux within the reactors when operational. This variation in point dose rates will continue during any decay period. This means that, although sustained personnel access will be allowable to most reactor plant after 70 to 90 years decay, there will still be a few locations where dose rates are higher and access might have to be limited. However, this will not prevent general access into the bioshields or unduly constrain dismantling activities.

It is judged that the safety of the workforce and the public can be readily maintained throughout significant deferral periods. It is possible to dismantle the reactor plant safely at any time after shutdown, although early dismantling would require much more complex technology. However, it is never possible to remove totally the risk from unplanned faults. The consequences to workers, the public and the environment of such faults reduce significantly during the dismantling deferral period, bringing additional benefit.

Radioactive waste arising

Significant quantities of ILW will result from reactor dismantling but these are expected to be more than halved in terms of mass should dismantling be deferred for 50 years after shutdown and reduced to less than a tenth after 100 years deferral. The radiation dose rates and hence radiation shielding requirements associated with this residual ILW will also reduce over time thus simplifying handling and packaging requirements and reducing the hazards posed by these materials. Larger quantities of LLW than ILW result from reactor dismantling. Up to about 90 years after shutdown the quantity of LLW tends to increase with time due to the decay of ILW to LLW but after this time LLW quantities reduce as it decays below specified exemption levels.

Radioactive waste management

No disposal route for decommissioning ILW is currently available in the UK, nor are there any specific proposals for providing one. Deferring dismantling until a repository is available avoids the increased risks from double handling radioactive material and the requirement to build an exceptionally large new store on the power station site.

Passive safety

Reactor core

Material in the reactor core is essentially all activated with the radioactivity bound within the massive structural components of the reactor system. These structural components are already in a passively safe form and will be maintained in this safe state until the reactors are dismantled. The boilers and other primary circuit components on Magnox power stations are also already passively safe without the need for further work.

Cobalt and caesium radioactive plant

Radioactive plant broadly falls into two categories: cobalt-60 contaminated or activated plant such as boilers and most of the reactor structure; and caesium-137 contaminated plant such as ponds and effluent treatment plant. Either cobalt-60 or caesium-137 usually dominates the radiation dose rates on a nuclear power station.

The main factors relevant to Co and Cs radioactive plant are:

- Co plant was generally built as large robust structures having high inherent containment integrity;
- Co plant materials have experienced little corrosion in service and future corrosion is predicted to be low;
- The dose rate associated with Co plant reduces quickly over time;
- Cs plant generally is not required to have such high structural integrity as Co plant;
- Cs plant integrity is more difficult to maintain over time, with some accessible surfaces, e.g. pond surfaces, being contaminated;
- The dose rate associated with Cs plant only reduces slowly with time;

- Caesium is significantly more soluble and hence potentially more mobile than cobalt.

In general, Cs plant requires significant effort to place it and maintain it in a passively safe state without dismantling it first. Hence deferring dismantling, although technically feasible, is not favoured for this type of plant. Therefore, after de-fuelling and removal of fuel from the site, the Care and maintenance preparations phase includes the dismantling of all Cs contaminated plant and authorised disposal of resultant radioactive wastes. Co plant can be readily placed in a passively safe state and its dismantling deferred, giving rise to considerable savings in radiation exposure.

The generic decommissioning strategy for UK Magnox power stations

Selection of the preferred generic decommissioning option

The selection of the preferred decommissioning option for the Magnox power stations has involved wide-ranging assessments and studies, extensive discussions with the HSE/NII and took full account of over-arching government policy on decommissioning and waste management. The first detailed studies into decommissioning the UK's commercial gas-cooled reactor stations were undertaken about 20 years ago. The result of those studies was that the Magnox power stations could be fully decommissioned using existing technology. However this work identified that there are technical, radiological and financial benefits to be gained by deferring dismantling of the reactors by about 100 years following the shutdown of the station. Discussions with the regulatory bodies and consultation over many years with the public, local representatives and others in the nuclear industry, together with various scientific and engineering studies, helped to inform the decision-making processes. These studies included detailed assessments and measurements of the radioactive inventory and corrosion rates of a shutdown reactor. The conclusion drawn from the various studies was that the radioactive inventory of a decommissioned reactor is well known and corrosion rates are low. Multi-attribute decision analysis (MADA) assessments were also carried out. It is the function of Magnox Electric plc MADA assessments to consider a wide range of safety, environmental, technical, regulatory, political and financial factors. The outcome of the MADA was used only as a tool to help inform the Company Board's decision: the Magnox Electric plc generic reactor decommissioning strategy does not align exactly with any one of the options considered.

MADA process

The steps in the overall analysis process involved works to identify the precise nature of the strategic issue, followed by a "brainstorming" process to generate as wide a range of options as possible. This wide range of options was filtered into a short-list of only those options judged to be safe and technically feasible. An exercise was then undertaken to identify all of the relevant factors that should be taken into account to analyse and compare the short-listed options. When all of the options and relevant factors had been identified and each of the short-listed options developed, a conference was held with appropriate in-house experts at which the relevant factors for the options were scored and then weighted to reflect their relative importance. Once this had been accomplished, the options were then ranked according to their total weighted scores. There followed a sensitivity analysis, which was undertaken by analysing the effects of changes to the applied weightings: this ensured the robustness of the decision-making process and also guarded against "cliff-edge effects". The MADA analysis indicated that immediate dismantling is not optimum and site clearance or mounding should be deferred for a period of 70 years or more following shutdown.

Local consultation

Public consultation was undertaken to seek the views of those who would be most affected by the decommissioning process at Trawsfynydd. The consultation was aimed at understanding local views on how to manage the reactor buildings. Three issues emerged from the consultees' viewpoint as most important to determining the decommissioning strategy:

- maximising the number of jobs on the site for local people in the short-term;
- reducing the visual impact of the site;
- minimising the amount of radioactivity to be dealt with by workers.

Consultation also took place with the trade unions representing the employees so that their concerns could also be addressed. Meetings were held with local authorities whose concerns revolved around ensuring that the site remained safe and securing the clearance of the site as soon as reasonably practicable. These authorities were also keen to see physical improvements to the buildings that would remain on site.

National stakeholder dialogue

In order for Magnox Electric plc to be better informed about future possible changes to its generic strategy, the company is involved in a stakeholder dialogue process. This dialogue aims to:

- reach a common understanding of the issues;
- achieve a mutual understanding of the concerns of all stakeholders;
- share a common understanding of problems and solutions;
- allow Magnox Electric plc to be informed by the dialogue on the potential for strategy revision;
- reach agreement on the strategy amongst all stakeholders.

There has been substantive discussion on a wide range of topics relevant to generic decommissioning of all UK Magnox reactors, in particular the timing of final site clearance. The groups represented on the dialogue include regulators, government, anti-nuclear organisations, trade unions, local communities, academics, the company and other industry representatives. The process is ongoing.

Overview of Magnox Electric's generic decommissioning strategy

The generic decommissioning strategy will be applied to each of the Magnox power stations. This will involve three main stages: the "care and maintenance preparations" phase, the "care and maintenance" phase and final site clearance.

The first stage involves an initial intensive period of work as all buildings on the site (except the reactor buildings) are demolished. Simultaneously, operational ILW will be made passively safe. Where necessary a new purpose-built ILW store will be constructed on site for the long-term storage of ILW packages. The reactor buildings containing the reactors, reactor biological shields, heat exchangers and main gas ducts are already in a passively safe and secure state. Work will be undertaken to ensure that the buildings will remain weatherproof and secure against intrusion through the deferral period. Monitoring equipment will be installed to check continuously the conditions in the Safestores, the ILW store and on the site in general. This process results in each of the reactor buildings becoming what is known as a Safestore. At the end of this stage of the process, the aim is that the only significant buildings left on site will be the reactor buildings and the ILW store building.

Following the initial phase of works, power station sites will enter the care and maintenance period. During this phase the site will be maintained and monitored in a state of passive safety. The packaged operational ILW will be transferred to a National disposal site when such a facility is available and ready to accept the waste, in accordance with government policy.

At the end of the care and maintenance period, each site will be cleared and made available for alternative use consistent with its location. At the moment it is not possible to state exactly when the dismantling of the reactor buildings will commence. However, this decision will be regularly reviewed in the light of circumstances existing at the time. Based on present circumstances, assumptions and technical knowledge it is anticipated that the Safestores will remain in place for a period of around 100 years from reactor shutdown. The generic deferred site clearance option does not pre-empt or preclude any final disposal options for the stored ILW, nor the options for the timing or manner of final site clearance.

Magnox Electric plc has achieved and will continue to achieve during the care and maintenance preparations period, significant benefits in reducing radioactive hazards on the shutdown Magnox power station sites. This is consistent with the Company's strategy to remove and/or immobilise the most active and potentially mobile radioactivity in a short timescale, with further actions following at appropriate timescales consistent with the hazards they seek to reduce. All the radioactive material that will remain on a Magnox power station site during the care and maintenance period, either in the reactor buildings or in the new store, will be passively safe.

Nuclear regulation and safety issues

Regulatory bodies

There are three main bodies responsible for the regulation of nuclear facilities in the UK.

Health and safety executive (HSE): HSE is the statutory body responsible for the enforcement of work-related health and safety law. HSE is the licensing authority for nuclear installations and, through its Nuclear installations inspectorate (NII), regulates the nuclear, radiological and industrial safety of nuclear installations on a UK basis.

Environment agencies: The environment agencies are responsible for the enforcement of laws and regulations aimed at protecting the environment, predominantly by authorising and controlling radioactive discharges and waste disposals.

Office for civil nuclear security (OCNS): OCNS regulates security arrangements in the civil nuclear industry, including security of nuclear material in transit. This is primarily to protect against the threats of terrorism and nuclear proliferation.

Site licensing during decommissioning under the Nuclear Installations Act 1965 (as amended)

Any operations carried out on nuclear sites, including all decommissioning and radioactive waste storage works, must have secured the approval of the HSE/NII before they can be commenced. All power station sites will continue to be licensed during their entire reactor dismantling deferral period and will continue to be regulated by the HSE/NII.

The HSE/NII require that the organisation responsible for the day to day management of a site should be the licensee. It is the licensee who is responsible for site licence compliance. The site licence will remain in full force and the licensee will thereby retain full responsibility for the site and for ensuring that all conditions in the licence are complied with until the site is eventually de-licensed.

The Nuclear Installations Act provides for the delicensing of all, or part, of a nuclear licensed site when HSE is satisfied that there is no danger from ionising radiations from anything on the site. There is no established framework for delicensing or for assessing compliance with the "no danger" criterion. Delicensing completes the environmental remediation process and therefore represents the ultimate goal for Magnox Electric plc for its power station sites.

The care and maintenance period safety case

The care and maintenance period safety case is intended to be valid for 25 years, with a periodic review to be carried out every 10 years. These reviews will take full account of the data and information gathered from the ongoing decommissioning works, from the inspection and monitoring programmes which will be undertaken at the site and in the light of any relevant changes in government policy. The safety case is assessed against relevant deterministic (and where relevant probabilistic) safety and legislative criteria to assure the ongoing safety of workers and the public. If a case cannot be made by Magnox Electric plc or its successors to demonstrate the ongoing safety of a decommissioning Magnox site for a further 25-year period, then works will be carried out to rectify the situation. This could include the early dismantling of the reactors should that prove to be the only means of making the site safe at that time.

During the care and maintenance period, safety is assured by the immobility of the radioactivity within the reactors and ILW store. The greatest inventory of radioactivity is within large pieces of solid materials and is not readily available to be released to the environment. Reactor buildings will have been modified and ILW stores constructed to comply with the principles of passive safety. All of the radioactive material in the reactors is in solid form and will be multiply contained within the thick steel pressure vessel, the thick reinforced concrete shields and the reactor building weather envelope. All the radioactive material in ILW stores will be in a solid form and multiply contained within the packages, the concrete building structure and the weather envelope. There will be an inspection, monitoring and maintenance regime that will be based on the requirements of the safety case and relevant legislation.

The robust nature of the modified reactor buildings and ILW storage facilities will ensure minimal need for human intervention during this period and it is Magnox Electric's current intention that there will be no need for continuous site-based human presence or supervision. Nonetheless regular visits will be made to the sites by trained and competent personnel to confirm continuing security and safety and to perform any necessary inspection, maintenance and monitoring work. It is expected that these regular visits and inspections will be sufficient to identify maintenance requirements. In addition, it is intended that there will be appropriate security and condition monitoring equipment installed on each site which will transmit data to a permanently manned central location, to allow remote security control and to enable appropriate and timely responses to be made to any unusual occurrences. There will be an experienced team to oversee the sites, maintain site licence compliance, manage safety case production and maintenance, manage records and maintain learning from experience, in addition to deploying resources on-site as required.

Review of decommissioning strategy by HSE

UK licensees' decommissioning strategy is subject to scrutiny by the HSE (through the NII) in consultation with the environment agencies on a 5-yearly programme (the Quinquennial review). The requirement for this review is embodied in Cm 2919. This review process ensures that the decommissioning strategy is kept fully up to date in the light of any changes to government or international policy and technological advances. Magnox Electric plc's decommissioning strategy was last reviewed by the HSE/NII in a report published in February 2002. The key findings of this review show that HSE/NII regards Magnox Electric's strategy to be appropriate, largely consistent with both national and international policy statements and guidance and potentially flexible enough to accommodate lessons learned during ongoing decommissioning activities. Most technical aspects of the proposals are considered to be largely practicable and feasible. The HSE/NII found that all the tasks required fully to decommission the sites had generally been identified.

The proposed nuclear decommissioning authority (NDA)

In November 2001 the government announced its intention (Cm 5552) to make changes to current arrangements for nuclear clean up, including those for the Magnox nuclear power stations. It proposed to set up a new Liabilities management authority (now renamed Nuclear decommissioning authority) responsible to government with a specific remit to ensure that clean-up is achieved safely, securely, cost-effectively and in ways which protect the environment for the benefit of current and future generations. The NDA will be responsible to government for developing and implementing an overall strategy for discharging the nuclear legacy within policy set by government. This will include putting in place comprehensive long-term plans for the clean up of all its sites.

The creation of the NDA will involve the transfer of Magnox Electric plc assets and liabilities to the new authority. Magnox Electric plc will therefore cease to own the sites or the assets to fund decommissioning and waste management – these responsibilities will pass to the NDA. To achieve this an Act of parliament is required.

When the NDA is finally in operation it is expected that it will be accountable for determining appropriate strategies for reactor site decommissioning. The NDA will not directly manage or operate the Magnox sites. Instead, it will competitively award contracts to competent organisations to become site licensee, responsible for delivering the clean-up programme in a manner consistent with regulatory requirements.

The overall regulatory framework and the basis of the statutory relationships between the licensee and the regulators will not change. Future management arrangements for decommissioning Magnox stations will be considered by BNFL and government in consultation with regulators. Under the Nuclear Installations Act, the licensee responsible for site licence compliance must be the organisation having day to day management of the licensed site. The maintenance of a sufficient workforce of suitably qualified and experienced staff will continue to be a requirement and a matter subject to regulatory approval. The proposed NDA will not change this position.

Conclusions

Magnox Electric plc has adopted a decommissioning strategy that defers reactor dismantling. In reaching this decision the Company recognises that:

- there are no adverse safety implications to dismantling deferral;

- the UK will not have a disposal site to take decommissioning waste for many decades;
- the carbon steel construction of Magnox reactors allows in-vessel dose rates to reduce over a 70 to 90 year period such that personnel access into the bioshields to dismantle reactor plant is feasible;
- unlike LWRs, gas-cooled reactors are massive, must be dismantled on site and packaged for disposal;
- the discounted cost to the taxpayer of deferred reactor dismantling is much lower than that of immediate dismantling.

This strategy accords with government policy and is considered appropriate, practical and feasible by the UK's nuclear installations inspectorate and by the environment agencies.

TOKAI-1 DECOMMISSIONING PROJECT

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1. Introduction

A total of 53 nuclear power plants have been put into operation since 1966 when the first commercial nuclear power plant started commercial operation in Japan. Tokai-1 (Gas cooled reactor, 166 MWe) of the Japan Atomic Power Company started commercial operation in 1966 as the first commercial nuclear power plant and ceased its operation in 1998 with the 32 years successful operational history.

JAPC launched Tokai-1 decommissioning in December 2001 after the submission of the notification of decommissioning plan to the competent authority. This is the first instance of the decommissioning of a commercial nuclear power plant in Japan. As the whole project is planned to take a long term (17 years in all), the project programme is divided into three phases.

Tokai-1 decommissioning project has an important role for demonstrating that the decommissioning of commercial nuclear power plant can be executed safely and economically, and for establishing key technologies for the future LWRs decommissioning in Japan.

2. National policy on decommissioning

The Japanese AEC's statement "Long-term Programme for Research, Development and Utilization of Nuclear Energy" (Atomic Energy Commission, November 2000) says that such nuclear installations as commercial power reactors, test and research reactors and nuclear fuel cycle facilities, should be decommissioned at the responsibility of their operators when their functions terminated. The statement also says that the land after the decommissioning of commercial power reactors, will serve as sites for future nuclear power generation.

MITI (Ministry of International Trade and Industry, currently METI) recommended (June 1985) the following standard decommissioning process for a commercial power reactor; the decommissioning process subsequent to permanent shutdown and de-fuelling should be divided into three phases which are primary system decontamination, safe-store and dismantling. (The decontamination process applies to LWR and does not apply to GCR). They also recommended that 5-10 year safe-store period would be suitable for a commercial nuclear power plant.

In establishing the standard process, the following discussions were taken into account:

- The short term for the safe store would be beneficial for the future reuse of the site including a reconstruction of nuclear power plant.
- After 5 to 10 years safe store, the exposure dose of decommissioning workers could be reduced to the same level as that of operation and maintenance workers while operation stage.

- From the standpoint of public acceptance, it would not be acceptable to the local communities that a closed nuclear power plant remains for long years.
- The availability of the operating plant work force that is highly knowledgeable about the facility would be important for decommissioning.

3. Strategy of Tokai-1 decommissioning project

JAPC's strategy on Tokai-1 decommissioning project is that Tokai-1 plant would be dismantled continuously through phase (stage) and the land will be a green field for future nuclear power generation. The reactor area, i.e. reactor and biological shield envelope, will be stored in safe condition for 10 years to reduce radioactivity.

Prior to the reactor dismantling, conventional facilities outside the reactor area are to be removed for the purpose of securing a transportation route for reactor dismantling wastes, and also to get the space for waste conditioning facilities. These conventional facilities dismantling work would balance the workload through the 17 years long term decommissioning project.

The project program is divided into three phases.

The first phase is 5 years from 2001 to 2005. Conventional facilities will be removed and some preparation works will be done in this phase.

The second phase is 5 years from 2006 to 2010. Steam raising units and primary gas duct outside of safe-store area will be dismantled during this phase.

The third phase is 7 years from 2011 to 2017. All reactor structures will be dismantled and reactor building and miscellaneous buildings will be demolished after radioactive contamination survey. The decommissioning project will be completed when the land is adjusted on the ground level and all radioactive wastes are removed outside.

Relatively small scale works are carried out in the first phase and medium scale works are carried out in the second phase. Large-scale works will be carried out in the third phase utilizing know-how, technologies and experiences accumulated in the previous phase periods.

Figure 1. Decommissioning project schedule

JFY Phase	2001-2005 ▼Project commencement	2006-2010	2011-2017
First phase	Preparation work Removal of conventional facilities		
Second phase		Removal of SRUs	
Third phase	←--- Safe-store of	reactor area ---→	Reactor dismantling Building demolition

In establishing the decommissioning strategy of Tokai-1, the following key factors were considered and evaluated:

- occupational radiation exposure and radioactive waste amount;
- decommissioning cost;
- workload balance;
- availability of experienced personnel;
- managerial risk as a private company;
- conformity with national policy and guides;
- role for promoting rule-making activities and construction of waste disposal facility;
- public acceptance;
- site re-utilization.

Table 1. Strategic case study

			Safe-store period		
			10 years	30 years	135 years
Inherent to Tokai-1	Quantitative	Occupational radiation exposure	A (100%)	A+ (50%)	A+ (40%)
		Radioactive waste amount	A (100%)	A (80%)	A+ (30%)
		Decommissioning cost	A (100%)	A (95%)	A (115%)
	Qualitative	Availability of experienced personnel	A	C	C
		Managerial risk	A	B	C
Nation wide (Qualitative)		Conformity with national policy and guides	A+	C	C
		Promotion of rule making activities	A+	C	C
		Promotion of construction of waste disposal facility	A+	C	C
		Public acceptance	A	B	C
		Site re-utilization	A	B	C

4. Waste treatment and disposal

All radioactive wastes from the Tokai-1 decommissioning besides spent fuel reprocessing wastes are classified as the low level radioactive waste (LLW) in Japan, and the LLW is further categorized into three classes from the view point of disposal as shown in Table 2.

The amount of wastes arising from Tokai-1 decommissioning is estimated at 192 kt in total, and about 10% of them are estimated as radioactive wastes.

Radioactive wastes will be treated in the waste treatment facilities, which is planned to install in the second phase period. Radioactive wastes are treated (decontamination, melting, burning, compaction, segmentation) and packaged in containers. Eventually they will be disposed of to burial facilities in accordance with their radioactive level.

The amount of wastes arising in the first and the second phase is small and the wastes are stored in the existing storage facilities on Tokai site until the commencement of third phase. The burial disposal facility is expecting to be constructed before the commencement of third phase (reactor dismantling); the majority of wastes will arise in this phase. If the disposal facility is not available, the decommissioning schedule has to be changed.

Table 2. Estimated amount of waste

Unit: kilo ton

Classification		Method of disposal	First phase	Second phase	Third phase	Total
Low level waste	Comparatively high radioactive level L1	Burial disposal at 50 to 100 m underground with artificial barrier	0	0	1.55	1.6
	Comparatively low radioactive level L2	Burial disposal in near surface with concrete pit	0.01	0.56	7.84	8.5
	Very low radioactive level L3	Burial disposal in near surface without concrete pit	0.01	0.06	8.01	8.1
					Sub total	18.1
Non-radioactive waste (Including clearance waste)		**As industrial waste**	11	7	155	174
Total			11	8	173	192

Note: The amount is after decontamination.

5. Decommissioning cost

The total cost of the Tokai-1 decommissioning project is estimated at JPN 89 billion (EUR 660 million) as of year 2001, in which about JPN 35 billion (EUR 260 million) is for dismantling cost and JPN 54 billion (EUR 400 million) is for radioactive waste treatment and disposal cost. On the other hand, LWR decommissioning cost (2001 estimation) is estimated at JPN 54 billion for BWR and JPN 58 billion for PWR (1 100 MWe class). The dismantling cost is JPN 39 billion for BWR and JPN 41 billion for PWR. Radioactive waste treatment and disposal cost is JPN 15 billion for BWR and JPN 17 billion for PWR.

Tokai-1 waste treatment and disposal cost is much higher than those of LWRs, because the Tokai-1 plant has following specific design features, i.e. the reactor system is comprised of such a 1 600 tons of graphite moderator, 18 m diameter reactor pressure vessel and huge volume of biological shield.

It is very important for saving the decommissioning expense to reduce the radioactive waste volume and to reduce the cost of construction and operation of the waste burial facility.

6. Concluding remarks

Through the whole decommissioning term, safety measures for keeping the health of workers and general public should be prepared and taken place, even though the safety requirement level for the decommissioning plant is remarkably decreasing compared with the operating plant. At the same time, the decommissioning project of commercial nuclear power plant has to be managed economical to keep the expense within the reserved fund.

Tokai-1 decommissioning project has an important role for demonstrating that the decommissioning of commercial nuclear power plant can be executed safely and economically, and for establishing the key technologies for future LWR decommissioning in Japan.

SESSION II: LIGHT WATER REACTORS

THE DECOMMISSIONING STRATEGY FOR THE STADE NUCLEAR POWER PLANT

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Introduction

The first three purely privately and commercially operated plants in Germany are the KWO Obrigheim, the Würgassen nuclear power plant (KWW) and the Stade nuclear power plant (KKS). The KKS, located in the northern part of Germany close to the city of Stade at the river Elbe, was in operation from 1972 to 2003. The KKS is furnished with a pressurized water reactor with an electric gross output of about 670 MW. The plant is owned 33% by the Hamburgische Electricitätswerke AG (HEW), the utility of the city of Hamburg, and 77% by E.ON Kernkraft GmbH (EKK) in Hanover. E.ON Kernkraft GmbH is also the operator of the KKS.

EKK is currently operating 7 nuclear power plants in Germany and owns shares of some other NPPs. An additional NPP was decommissioned in 1997 and it is now being dismantled with the goal of a green field at the nuclear site. E.ON Kernkraft GmbH (EKK) is a subsidiary of E.ON AG, which is one of the biggest trusts in Europe. It is fully privately owned and its shares are widely distributed.

Conditions for the shutdown of KKS

The Stade nuclear power plant KKS has always been operating very successfully. Since first criticality in 1972 the plant almost always has operated at its maximum load with a capacity factor of more than 85%. The net electricity production during the more than 30 years of operation has been until 2002 about 143 000 TWh. In addition, the plant has accomplished an industrial steam delivery to the nearby salt mine of about 1.5 million t. During the many years of operation of the KKS, its owners have invested by far more into upgrades of the plant than the original costs for the construction. This led to a very high availability and an outstanding safety record.

A few years ago, however, two different and independent developments influenced the future of the KKS:

1) The developments on the energy market in the late 90s and the complete opening of the electricity market for competition had a deep impact on electricity distribution and generation in many parts of Europe and especially in Germany. The dramatic decrease of electricity prices, the decoupling of electricity and energy consumption from gross product and economic effectiveness as well as the increasing overcapacities on the generating side were a clear challenge for the utilities in many parts of Europe. It was a challenge especially for all utilities that were privately owned and operated. Moreover, the drop of coal prices and the associated fluctuations of prices on the oil and gas market put additional pressure on the generation structure. Utilities had to reorganize the energy production structure according to market needs and market conditions. Many coal fired, oil fired and gas fired

plants were shut down. The most cost intensive plants had to terminate their operation in due time. The KKS, one of the smallest of E.ON's nuclear plants, was not cost effective enough in the long term in order to compete with the larger units. Thus, it was decided to stop the electricity production at the best possible time.

2) In the late 90s, the nuclear operators in Germany came under increased pressure form the Federal and Länder governments. The friction between politics and the utilities increased dramatically after the red/green federal government came into power in 1998. The goal of ending the use of nuclear power became part of the coalition agreement between the Social Democrats and the Greens. In this context the idea of an agreement between utilities and government was revived. Negotiations took place in order to work out an agreement (nuclear consensus). Finally, on 11 June 2001 the major German nuclear utilities signed an agreement – or, better, a compromise – with the federal government about the further use of nuclear energy. This agreement stipulates:

   - a limit on power generation of existing reactors;
   - politically undisturbed operation during remaining lifetime;
   - a ban on reprocessing starting mid-2005;
   - the building of fuel storage facilities at the reactor sites.

Later, this agreement became an integral part of the Nuclear Act in Germany. The motivation for the utilities to agree to such a compromise was manifold. Reaching a maximum of political stability for the operation of the existing nuclear power stations was the main motivation. Of course, it is very difficult to communicate such an agreement to the public, in particular to the public in favour of nuclear energy. From today's point of view the motivation for such an agreement has been largely confirmed. The German nuclear power stations have generated 171 TWh last year, contributing one third of the public electricity supply in Germany. This was a new production record. It was due to the exceptionally high plant availability associated with an outstanding performance and safety record. The operation was never or rarely disturbed by idealistically or politically driven discussions.

According to the agreement and, now, the Nuclear Act, the operation limit for KKS would have been the middle of 2004.

The shutdown decision

During the negotiations of the nuclear consensus, it became quickly clear that, for EKK, the Stade nuclear power plant was an issue to be discussed and decided fairly quickly. On the one hand the agreement under discussion did not allow a longer operation than mid-2004; on the other hand the pressure was increasing to cut electricity generation prices and, thus, shutdown the less effective plants.

In order to find the right strategy for the termination of its operation and for the decommissioning of the plant, a group of experts was put together to assess all different aspects of a possible shutdown. In particular the following aspects were considered in detail:

- production costs for the electricity and costs for replacement energy after shutdown;

- fuel strategy for the last years of operation: reshuffling of fuel assemblies, minimisation of new waste fuel assemblies, maximising burnup;

- medium- and long-term contracts on outages, fuel production, fuel reprocessing, transports, services etc;

- timing of fuel transports in order to minimise the time of post operation;

- decay time for fuel with respect to heat production for transport, radioactive decay of waste, radioactive decay of the inventory of the plant and its cost effects;

- different strategies for decommissioning and dismantling, their timing and duration, costs and effects on personnel;

- personnel issues, possible personnel reduction programmes, requalification programmes;

- licensing issues like acceptance by the competent authorities, licensing time scale and possible hindrance factors from an independent assessment;

- acceptance of the public and the communities in the surroundings of the plant;

- long term development of electricity prices, electricity production structure, energy consumption and, in particular, developments within the E.ON trust;

- availability of a final repository.

Some of the above aspects led to well-defined figures, which were fairly simple to compare which each other. Nevertheless, these figures were based on many assumptions, especially in context with long term predictions. Also, many of the arguments and aspects can be considered as to be rather “soft”. For instance, personnel, political and social acceptance are influenced more by the company culture than by hard figures. The discussion and assessments of all aspects, the combination of the many different ideas made the group work extremely interesting and challenging. It was not always possible to exactly derive clear conclusions. Nevertheless, the final result was clear: the shutdown of the KKS at the end of 2003 with subsequent post operation and immediate dismantling.

Preparation of the decommissioning plan

After the final decision was taken to shut down the plant, another group of expert was put together in order to develop the decommissioning strategy for the plant. The process for this development was subdivided into three stages:

1) brainstorming;

2) identifying decommissioning plans (idea phase);

3) selection a preferred decommissioning plan (conception phase).

In the first phase, all experts contributing to this process where asked to give their ideas, which could be part of the overall decommissioning plan. In the second phase, the idea phase, these many ideas were sorted and assessed if they were feasible or not. The result of the second phase was a list of several decommissioning plans for KKS. Finally in the third phase, these different plans were compared and the final decision was taken for one decommissioning plan. This plan was the basis for licensing and further planning of the decommissioning. It took about 9 month to work out the preferred decommissioning plan.

How does the overall decommissioning plan for KKS look like? The goal of the decommissioning plan is the green or brown field at the site of KKS. The plan is divided into 5 phases, 4 under nuclear licensing and supervision, and one under conventional supervision:

The dismantling of the nuclear part of the plant will be performed in four stages.

1) The first stage will consist, mainly, of the dismantling of contaminated material, mostly those outside the secondary containment. Right after the removal of this material the decommissioning infrastructure will be installed in this area. The decommissioning infrastructure will contain all equipment necessary for dismantling, cutting, cleaning and decontamination as well as clearance measurements. The infrastructure will be able to deal with the many categories of material such as concrete, metal, insulation and others.

2) Within the second phase of the dismantling, we are going to tackle the large components such as the steam generators. The steam generators need special attention, because of their complexity, weight and inner construction. Especially the large internal surface, which is highly contaminated, will be in the focus when planning for decontamination techniques.

3) During the third phase of dismantling, all activated components including the reactor pressure vessel, its internals and the biological shielding will be removed. In this phase a large fraction of the radioactive waste will need to be transported into the intermediate storage facility.

4) The fourth phase of dismantling will cover all residual systems and components inside the controlled area. The controlled area will eventually be cleaned and released.

5) According to the decommissioning plan the whole site can be cleared by around 2013. The conventional pull down of the buildings at the end (phase 5) will lead to a green field.

A final repository for low- and medium-level radioactive waste has been licensed in Germany but it not yet accessible. The operator of Stade has thus decided to construct a facility for intermediate storage. The waste will be packed in casks that will be later suitable for the national repository. As soon as the final repository will be receiving waste, the Stade waste will be moved to the repository.

Nuclear licensing

The decommissioning activities need to be licensed by the competent authority of the Land. The plan can be subdivided in several licensing steps. However, according to the German Nuclear Act the full decommissioning plan has to be presented to both the authorities and the public.

The first license for KKS will cover the following items:

1) The decommissioning of the plant and the residual operation until final removal of all components of the nuclear plant.

2) The dismantling of contaminated parts of the plant (phase 1).

3) Construction and operation of an intermediate storage facility for low- and medium-level radioactive waste.

In addition to the nuclear licensing, an environmental impact assessment needs to be performed according to both European and German law. Within this impact assessment the whole process, namely the full decommissioning plan, needs to be considered and assessed as to what effects are expected on the environment.

Both, the nuclear licence and the environmental impact assessment will be communicated to the public within a formal public information and public hearing process. In the case of KKS, the safety report, the environmental impact assessment, a short description of the project and the application for nuclear license will be openly accessible for the public. For a period of two months, every citizen will have the opportunity to read all documents, either in the city of Stade or at the Environment Ministry in Hanover. Everybody will have the chance to submit questions or comments on the decommissioning plan.

Finally, a public hearing will take place in late autumn this year. The public hearing is a platform for all citizens concerned to discuss the questions that they have submitted during the months before.

Besides the formal public involvement, the competent authorities contracted independent experts in order to assess all the details of the decommissioning plan. According to the time schedule, this assessment will be accomplished in due time before issuing the license. The licence is expected for early 2004.

Preparation for decommissioning

Besides preparing the licensing procedures, all the detailed planning needs to be done. A fairly large team of engineers and technicians has already started right after the conception phase with the detailed planning of especially the first dismantling phase. Soon the planning of the second phase will start.

The team of engineers consists mainly of people from the plant and some from the central administration. External experts are also involved. People from the central administration will make sure that all experience will be transferred from one plant to the other, that is between KWW and KKS in the case of EKK. Especially for E.ON Kernkraft, it is necessary to combine forces from the two ongoing decommissioning projects in Würgassen and Stade. The evaluation of all experience will be an ideal starting point for an effective future decommissioning projects.

NPP DECOMMISSIONING DOCUMENTATION PREPARATION

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Summary

The presentation deals with the V1-NPP decommissioning documentation preparation. History of the V1-NPP decommissioning documentation preparation is described first of all. Last decommissioning plan of the V1-NPP is described in more detail. Determination of the decommissioning scope, basic assumptions for decommissioning and analysed three decommissioning options are given. Breakdown of the decommissioning process used for the decommissioning options analysis is shown. Main decommissioning parameters for chosen options resulting from the analysis are given. Comparison of the decommissioning options by multicriterial analysis is presented and some conclusions are given.

A new software product being developed in DECOM Slovakia Ltd, which inherently implements the standardised list of decommissioning cost items issued commonly by EU, OECD and IAEA will be used for future updating the conceptual decommissioning plan and for detailed decommissioning planning the V1-NPP. The description, basic properties and development status of the software product are given.

History

Based on the ČSFR Government Decree No. 21 dated on 10 January 1991 the "Project study on the V1-NPP decommissioning" was elaborated already at the end of year 1991. Immediate decommissioning option of the V1-NPP was analyzed in detail in the study.

Subsequently others four decommissioning options of the V1-NPP have been analyzed in the year 1992 with the aim at their mutual comparison and the choice of preferred option which would become a base for future procedure of the V1-NPP decommissioning. So, five basic decommissioning options of V1-NPP have been chosen:

1) immediate decommissioning option;

2) deferred decommissioning option with the hermetic areas safe enclosure for 70-80 years;

3) deferred decommissioning option with the reactor safe enclosure in the reactor shaft for 70-80 years;

4) deferred decommissioning option with the reactor building safe enclosure for 70-80 years;

5) deferred decommissioning option with the nuclear island safe enclosure for 70-80 years.

These options have been chosen so that they represent the limiting cases of the decommissioning procedure (namely options 1 and 5) and so they enable to estimate the decommissioning procedure influence on the main decommissioning parameters. The chosen options represent a sufficient spectrum of mutually different decommissioning procedures so that quantitatively justified choice of a preferred decommissioning option can be reached by their mutual comparison.

All analyzed options have the same beginning – the operation termination phase and also the same end – the releasing the site for unrestricted use while the releasing the site for unrestricted use for option 1 is realized immediately after final shutdown and for other options after elapsing the safe enclosure period (i.e. after 70-80 years).

Based on the multicriterial comparison of all five options the option 2 was chosen as a preferred one on the level of SE-EBO and SE, joint-stock company. This preferred option was not reviewed and approved in the sense of the presently valid legislation.

In connection with the Decree of Government of the Slovak Republic No. 801/1999 and No. 974/2000 the basic and necessary step in intensive preparation of V1-NPP decommissioning documentation had to be, with regard to its principal importance, "The V1-NPP conceptual decommissioning plan" in the sense of the law No. 130/1998 and the appropriate performing decree No. 246/1999. Main technico-economic reasons for necessity of actualization of the "Project study on the V1-NPP decommissioning" by the form of "The V1-NPP conceptual decommissioning plan" are as follows:

- Project study elaborated in the years 1991-92 does not correspond by its structure and in certain extent by its contents to requirements on The NPP conceptual decommissioning plan in the sense of the law No. 130/1998 and decree No. 246/1999.

- In comparison with assumptions in the years 1991-92 the strategy of RAW treatment and conditioning together with technical equipment in the Jaslovské Bohunice site was changed.
- It is necessary to re-evaluate the considered V1-NPP decommissioning options taking into account the actual state of knowledge and approaches to NPP decommissioning in the world (period and extent of safe enclosure).
- Specific costs have been changed in a very important extent not only as a consequence of much higher general cost level but also in connection with substantial and differentiated re-evaluation of unit costs of considered technological procedures and working activities.
- Necessity to take into account the technical changes raised by V1-NPP refurbishment.
- Necessity to accord the V1-NPP decommissioning with the actual A1-NPP decommissioning process.
- Possibility and purposefulness to actualize the anticipated initial state of V1-NPP after its final shutdown based on the course and results of operation during the last 10 years.

The V1-NPP conceptual decommissioning plan will be reviewed/complemented step by step till the year 2006 to reach "The V1-NPP final decommissioning plan".

Basic assumptions for decommissioning

Design and operational data are the basic information source for elaboration of the decommissioning plan. In addition to this, the formulation of basic assumptions and conditions is essential in order to specify unambiguously the conditions from which the process of decommissioning will come out:

- Operation of the V1-NPP will be terminated after the period of normal power operation. It is assumed that during operation there was no relevant accidental situation and no accidental situation caused the abort of operation.
- Both V1-NPP units are subjected to decommissioning and the order of operation termination will be the same as it was for commissioning the units.
- According to the Slovak Republic government Decree No. 801/1999 the 1st unit will be finally shutdown at the end of the year 2006 and the 2nd unit in the year 2008.
- Costs of treatment and conditioning of the rest of operational RAW are not included into decommissioning costs.
- Initial state of V1-NPP at the beginning of decommissioning as for the extent of operated and non-operated systems and equipment was determined and approved by the customer.
- V1-NPP decommissioning shall be analyzed in relation to the supposed state of A1-NPP, V2-NPP, ISFSF and RAW treatment and conditioning facilities during the V1-NPP decommissioning period when:
  - A1-NPP will be in second phase of decommissioning;

– V2-NPP will be in normal operation;

– ISFSF will be in normal operation;

– Bohunice RAW treatment and conditioning centre will be in normal operation as well as other equipment for treatment and conditioning the RAW in building 34 of A1-NPP.

- Three V1-NPP decommissioning options, which have been approved by the customer, will be analyzed.

- The substantial part of radioactive wastes from the V1-NPP decommissioning will be treatable and the final form will be acceptable for disposal in RAW repository at Mochovce. The technological procedures and technical facilities ordinarily used in the course of normal V1-NPP operation will be utilized at maximum extent for treatment and conditioning of mentioned radioactive wastes.

- The radioactive wastes not meeting the criteria for disposal in above mentioned near-surface disposal facility at Mochovce will be transported and disposed in deep geological repository located approximately 200 km from the V1-NPP. Beginning of deep geological repository operation is supposed after 2037. In case the deep geological repository will not be available (e.g. for option 1), these RAW will be temporarily disposed in the integral store of RAW built at Bohunice site.

- The criteria for release of materials into the environment for the purposes of this study are supposed as follows:

– metallic materials from dismantling will be released without limitations into the environment in case of following criteria fulfilment:

i) surface beta and gamma contamination < 0.3 Bq/cm^2;

ii) surface alfa contamination < 0.03 Bq/cm^2;

iii) weight beta and gamma activity < 100 Bq/cm^2.

– non-metallic waste from demolition will be released for unlimited use at value of weight beta and gamma activity < 100 Bq/kg.

- Spent fuel rests in the decay pool for 3 years. The spent fuel management, including its removal from unit into ISFSF and its further handling, is not the subject of this decommissioning plan.

- All buildings and facilities to be decommissioned are agreed and approved by the customer.

- Calculation of resulting parameters is based on input and financial data provided or approved by the customer. Other data are determined by expert estimation.

- Demolition of non-radioactive parts of constructions and buildings is considered up to the depth – 1 m.

- Decommissioning costs appraisal is based on December 2001 price level and a discount is not considered.

Basic approach to the analysis

The basic approach to elaboration of the “V1-NPP conceptual decommissioning plan” is possible to define by following steps:

- Determination of starting basic conditions and assumptions for decommissioning.
- Determination of expected initial state of NPP after operation final shutdown.
- Selection of NPP decommissioning basic options to be analyzed.
- Determination of “scenario” of expected decommissioning procedure for each considered option.
- Determination of time sequence of constructions and buildings decommissioning for each considered option.
- Detail breakdown of decommissioning procedure in accordance with determined scenario to individual partial activities.
- Analysis of each partial activity and its evaluation by the following characteristic parameters:
  - duration;
  - labour demand (expressed in man-hours needed);
  - need of technical means;
  - amount of arisen radioactive wastes;
  - amount of arisen non-radioactive wastes;
  - collective dose equivalent of personnel;
  - expected influence to environment;
  - costs.
- Summarization of characteristic parameters for each decommissioning option.
- Comparison of evaluated decommissioning options on the base of characteristic parameters and other criteria.
- Proposal of preferred NPP decommissioning option.

Analyzed options of the V1-NPP decommissioning

Three basic decommissioning options, linking up immediately to operation termination phase, have been analyzed in the frame of the V1-NPP conceptual decommissioning plan:

1. immediate decommissioning option;
2. deferred decommissioning option with reactor safe enclosure for 30 years;
3. deferred decommissioning option with nuclear island safe enclosure for 30 years.

The basic decommissioning options are characterized in Figure 1.

Breakdown of decommissioning process

For the purposes of the analysis of each options the decommissioning process was broken-down into the following parts:

- preparation activities for decommissioning (passage from operation to decommissioning, documentation, etc.);
- decommissioning phase I;
- decommissioning phase II;
- decommissioning phase III (if any);
- time dependent activities;
- investments needed for decommissioning;
- completion work for decommissioning.

Main decommissioning parameters for chosen options

There are given in Tables 1 and 2.

Figure 1. Basic V1-NPP decommissioning options

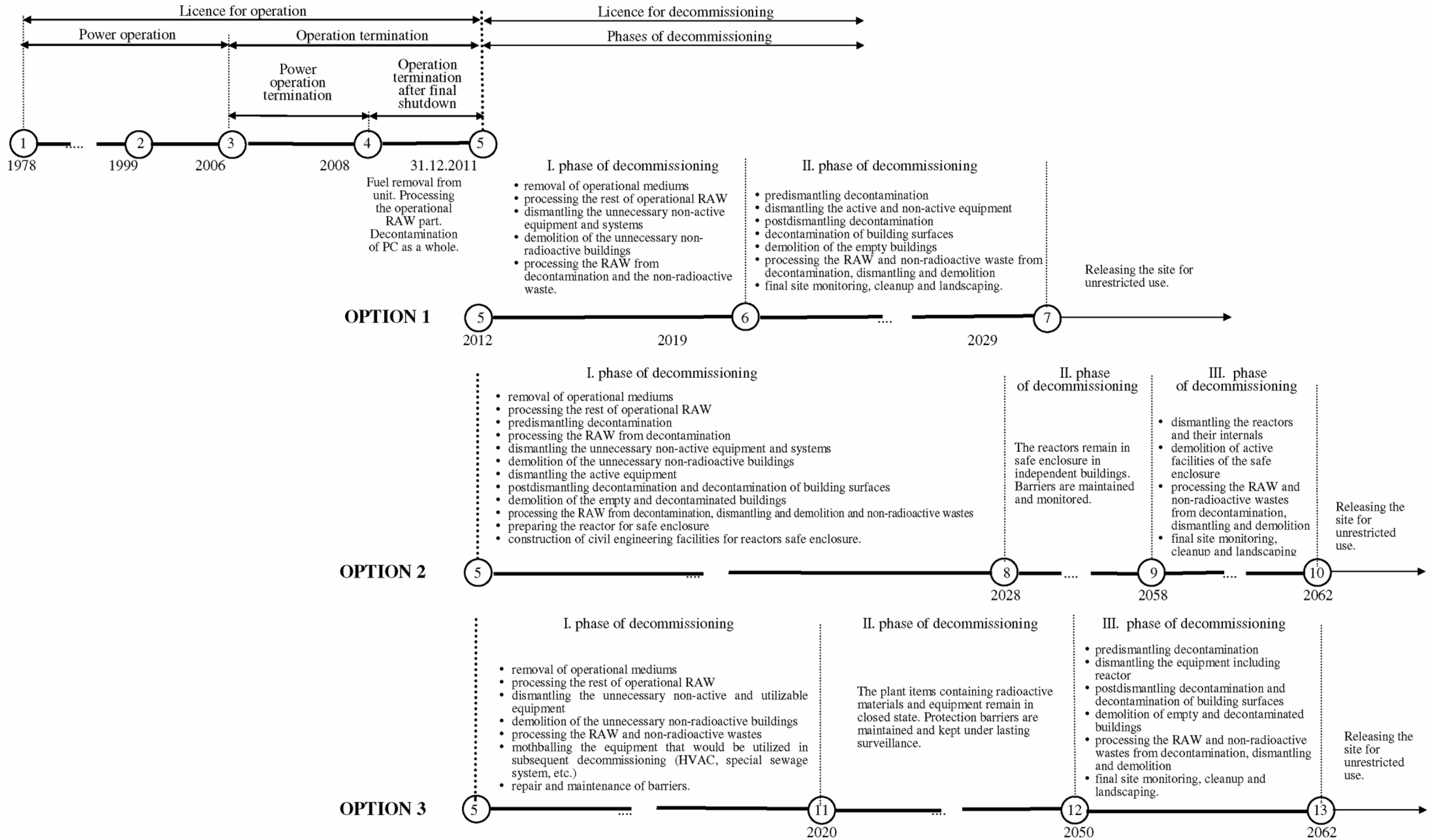


Table 1. Main resulting parameters of the analysis of chosen V1-NPP decommissioning options

No.	Characteristic decommissioning parameter	Unit	Value for option		
			1	2	3
1	Total costs	mil. Sk	13 611	13 823	14 668
2	Collective dose equivalent	man.Sv	18,81	17,01	2,82
3	Duration of decommissioning process	months	216	612	612
4	Total labour hours needed	thousands of hours	12 125	12 386	13 470
5	Amount of liquid RAW (before processing) with salinity of 200 g/dm^3	m^3	3 776	3 777	2 440
6	Activity of liquid effluents	Bq	1,58 x 10^{13}	1,59 x 10^{13}	1,10 x 10^{13}
7	Activity of gaseous effluents	Bq	3 x 10^7	2,9 x 10^7	0,9 x 10^7
8	Amount of non-active metals	t	62 711	62 712	63 663
9	Amount of high radioactive metals	t	930	930	930
10	Amount of recycable building waste	t	370 725	371 506	371 109
11	Amount of communal waste	t	12 555	12 562	12 600
12	Number of fibre reinforced concrete (FRC) containers for near-surface repository	FRC	3 215	3 216	1 970
13	Number of fibre reinforced concrete (FRC) containers for deep geological repository	FRC	38	38	38
14	Time loading the site by radioactivity	months	210	607	606

Table 2. Distribution of costs for main activities for chosen V1-NPP decommissioning options

No.	Specification of costs	Costs for options [mil. Sk]		
		1	2	3
1	Costs for preparation activities for decommissioning (passage from operation to decommissioning, documentation, ...)	835 870	841 840	866 836
2	Costs for decommissioning phase I	1 730 678	8 540 754	2 056 624
3	Costs for decommissioning phase II	7 626 019	92 760	2 235
4	Costs for decommissioning phase III	0	864 054	5 935 182
5	Costs for time dependent activities	2 147 100	2 169 600	2 197 400
6	Costs for investments needed for decommissioning	507 000	536 000	558 500
7	Costs for completion work for decommissioning	86 100	90 100	90 100
8	Contingency	678 233	687 892	728 358
9	**Total costs**	**13 611**	**13 823**	**14 668**

For better review and illustration when comparing and evaluating the V1-NPP decommissioning options the part of resulting decommissioning parameters is shown in a graphical form in the following figures.

Figure 2. Total decommissioning costs

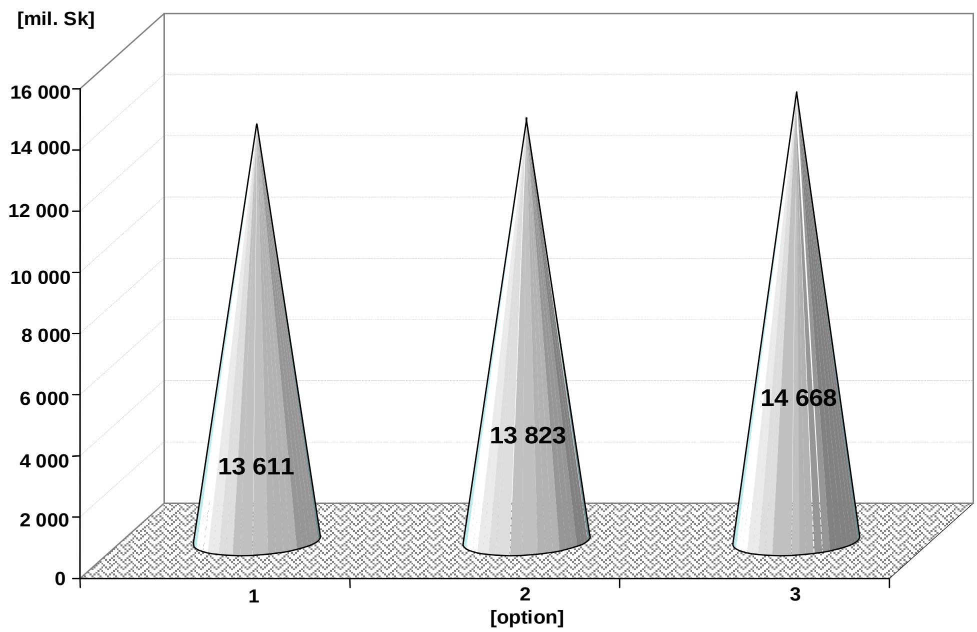


Figure 3. Collective dose equivalent

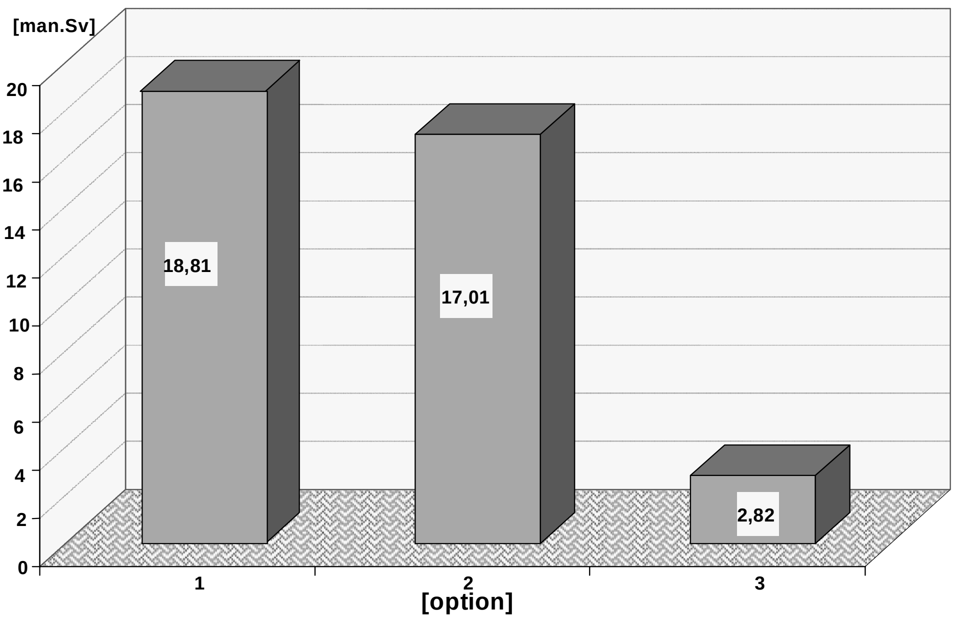


Figure 4. Labour hours needed

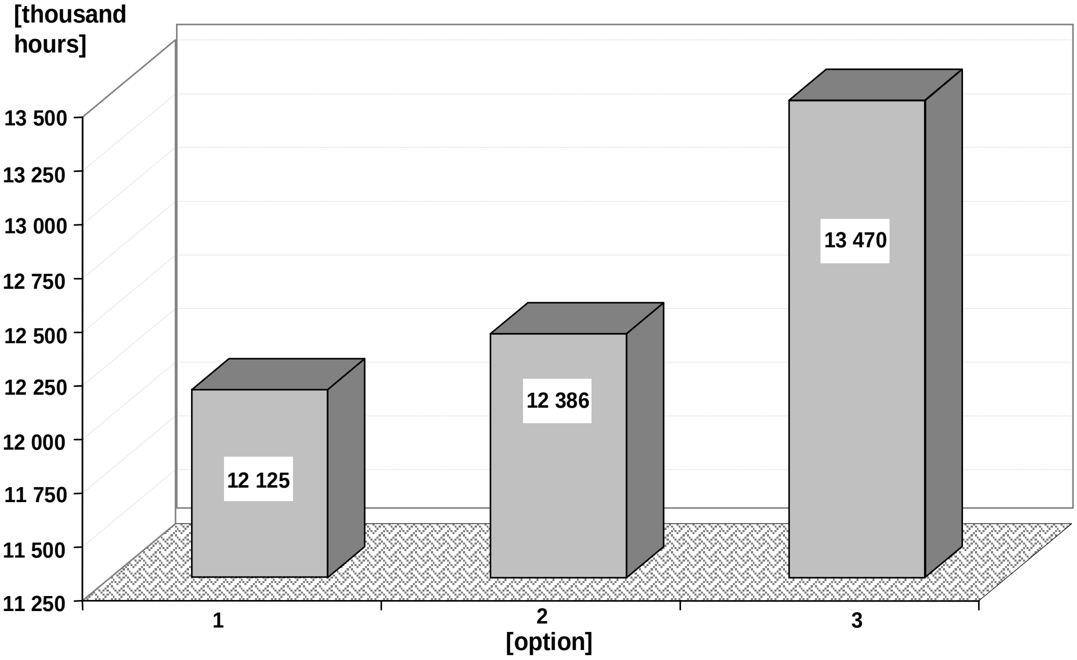


Figure 5. Amount of liquid RAW before processing at salinity of 200 kg/m^3

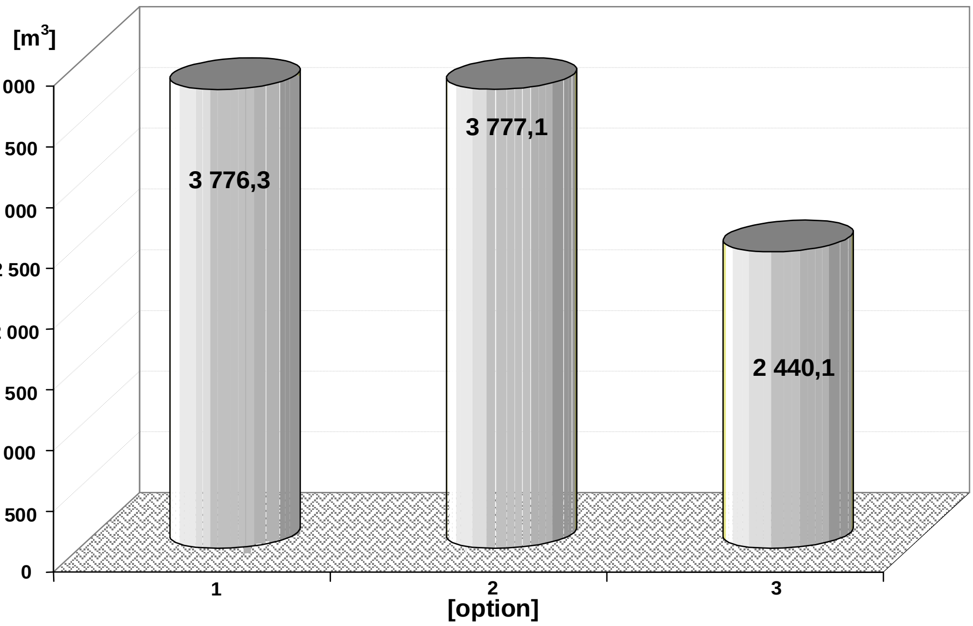


Figure 6. Time dependence of annual total costs for various options of V1-NPP decommissioning

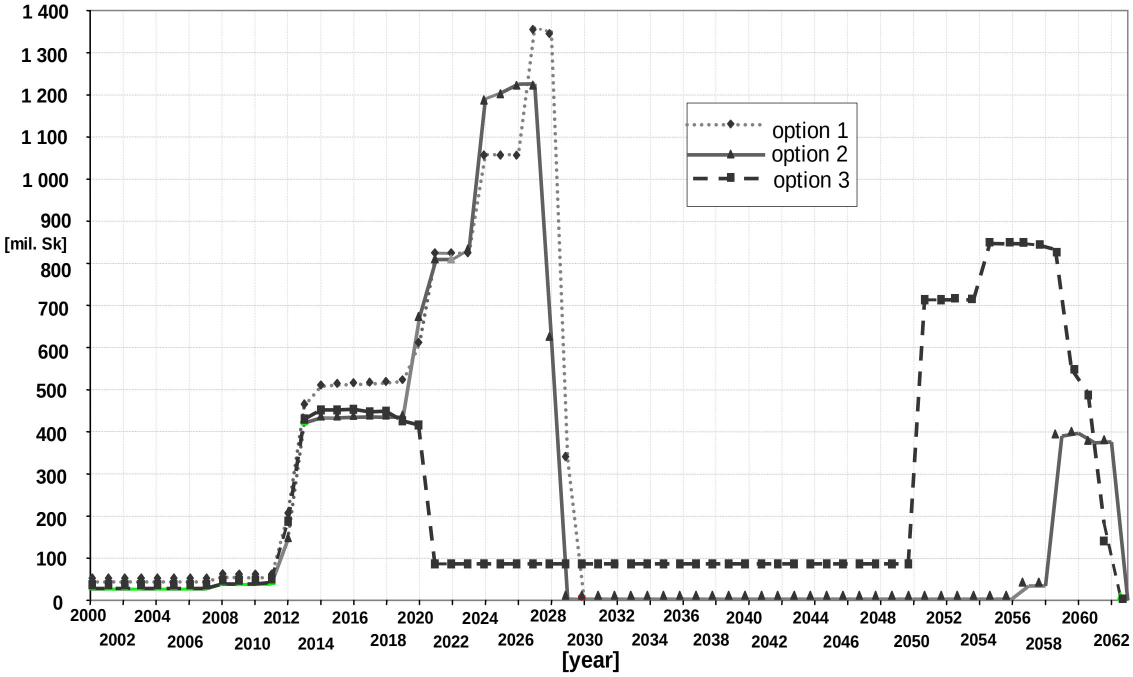
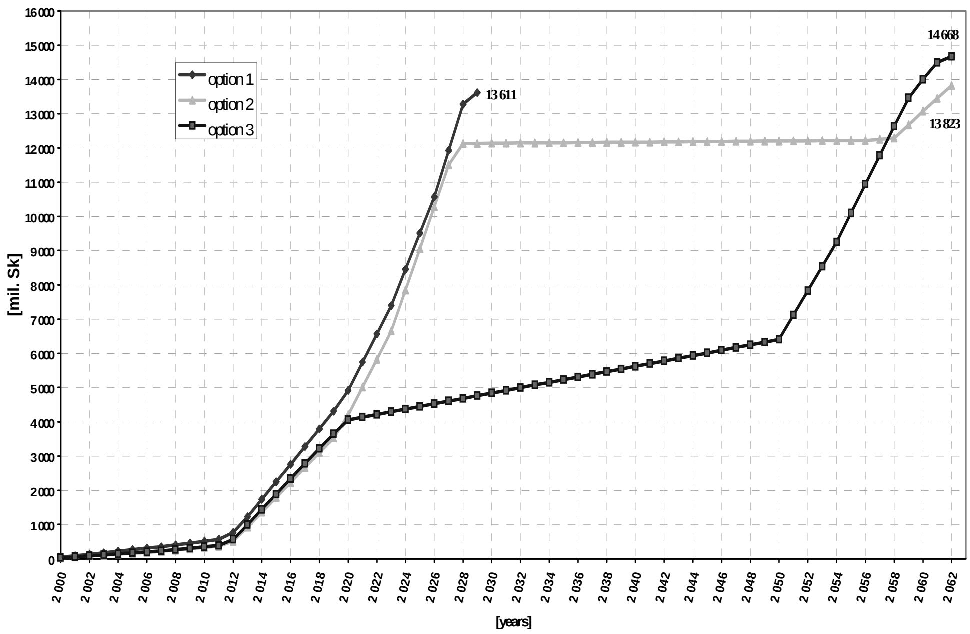


Figure 7. Time dependence of cumulative total costs for various options of VI-NPP decommissioning



Multicriterial comparison of decommissioning options

Twenty criteria given in Table 3 divided into 6 groups according their nature have been defined for selection of the preferred V1-NPP decommissioning option. The criteria were further divided into the classes:

- Objective:
  - objective 1 (O1);
  - objective 2 (O2).
- Subjective (S).

A criterion weight interval was assigned and a criterion weight was determined for our specific case to each of criteria. Higher numerical value of the criterion weight was assigned to the criteria with higher importance from the point of view of preferred decommissioning option selection. A criterion rate number for option was assigned to each of 21 criteria by the following way:

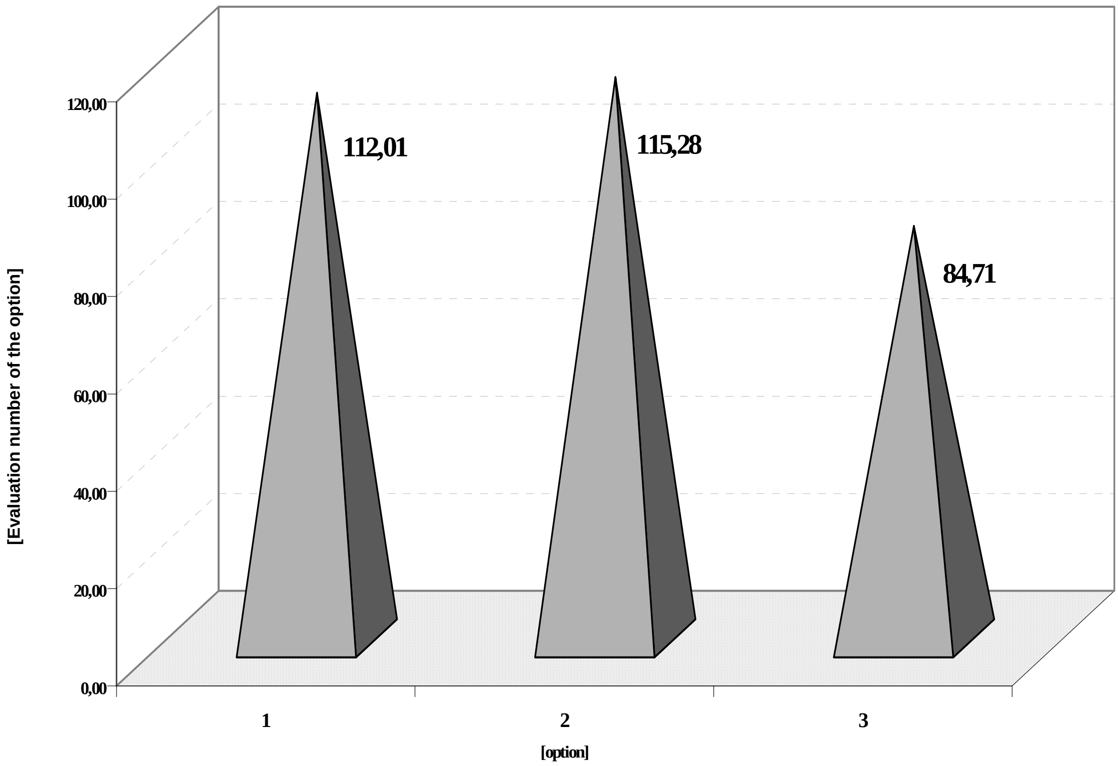
- Criterion rate number for option for objective criteria (O1, O2) was used as a value of appropriate resulting decommissioning parameter obtained from the analysis (calculation).
- Subjective criteria are a special class. They are the supplementing criteria materializing the evaluation of each of options, which are not a result of analysis (calculation), but the value of criterion rate number for option was determined by group of experts on the base of the analysis results, of personal evaluation of the criterion, of experience acquired up to now in the field of decommissioning while an objectivity and expertness of experts were markedly reflected. Criterion rate numbers for option were expressed by a real number from 1 to 100. The best evaluation is expressed by the smallest criterion rate number for option.

Mathematical processing the criterion weights and the criterion rate numbers for option given in Table 3 results in evaluation number of options illustrated in Figure 8. It can be seen from Figure 8 that option 3 has the smallest evaluation number of option (S_3=84.71), what means, according the used mathematical algorithm, that the option 3 can be considered as preferred one for V1-NPP decommissioning. It is necessary to underline a relativity of this conclusion regarding its relation on input conditions, assumptions and on subjective opinions of experts participated in the comparative process of decommissioning options.

Table 3. Criteria for comparison of options, their division into groups and classes, determination of criterion weight and criterion rate number for option

Criterion No.	Criterion name	Criterion weight	Criterion class	Criterion rate number for option		
				1	2	3
	Safety criteria					
1	CDE	10	O 1	18,81	17,01	2,82
2	Risk of maximal IDE	6	S	100,00	90,00	10,00
3	Risk of fire rise	5	S	70,00	75,00	100,00
4	Risk of work in hard working environment (without radiation risk)	2	S	90,00	100,00	80,00
5	Risk resulted from workers number	2	S	100,00	90,00	80,00
6	Risk of radiation accidents rise	6	S	100,00	90,00	50,00
	Ecological criteria					
7	Radiation impact of gas effluents of normal course of decommissioning on the environment	6	O 1	3,00E+07	2,90E+07	9,30E+06
8	Radiation impact of liquid effluents of normal course of decommissioning on the environment	6	O 1	1,58E+13	1,59E+13	1,10E+13
9	Other waste - amount	2	O 2	445 991,00	446 779,00	447 372,00
10	Time loading the site by radioactivity	4	O 2	17,50	50,60	50,50
	Technical criteria					
11	Technical means for decontamination	2	S	100,00	90,00	80,00
12	Technical means for dismantling	2	S	100,00	90,00	70,00
13	Technical means for demolition	2	S	100,00	90,00	70,00
14	Technical means for RAW management	2	S	100,00	90,00	70,00
	Economic criteria					
15	Total costs	10	O 1	13 611,00	13 823,00	14 668,00
16	Time distribution of costs	5	S	100,00	90,00	60,00
17	Labour hours needed	8	O 1	12 125,00	12 386,00	13 470,00
	Realization criteria					
18	Utilization of workforce	5	S	50,00	60,00	100,00
19	Duration of decommissioning process	3	O 2	18,00	51,00	51,00
	Criteria of demands on RAW repositories					
20	FRC number to near-surface repository	8	O 2	3 215,00	3 216,00	1 970,00
21	FRC number to deep geological repository	8	O 2	38,00	38,00	38,00

Figure 8. Results of comparison of decommissioning options by multicriterial analysis



Conclusions from the V1-NPP analysis

Main results of the described evaluation of the V1-NPP decommissioning and corresponding conclusions and recommendations can be summarized as follows:

1) Each of analysed options of the V1-NPP decommissioning will require, besides corresponding technical means, a considerable **labour hour demands**. Maximum labour demand 13.47 mil. man-hours is for the decommissioning option 3.

2) With regard to the extent of decommissioned technological equipment and buildings and to specific conditions of decommissioning, the activities related to the V1-NPP decommissioning will be considerably **time demanding**. Even when utilizing all available technical means for decontamination, dismantling, demolition and RAW management and at optimal way of their use, the full decommissioning will require time period **18 to 21 years** (i.e. "net time" spent on decommissioning besides the safe enclosure time period). This time period is influenced in a certain measure by chosen option: the lowest time period is for decommissioning option 1 (18 years) and the higher time period is for decommissioning options 2 and 3 (21 years).

3) Substantial difference among considered options is in **collective dose equivalent** values, while the lowest value will be reached in case of decommissioning option 3 (2.82 man. Sv) and the highest value (18.81 man. Sv) will be reached in case of decommissioning option 1.

Because a further progress can be expected in the radiation protection field in the future, it is possible to consider the estimated values of collective dose equivalent for all three options as the maximum ones.

4) All three options of the V1-NPP decommissioning are accompanied by production of considerable amount of RAW. Decommissioning the V1-NPP according to option 3 substantially reduces **the total amount of RAW arisen from decommissioning. Volume requirement for LILW disposal in the near surface disposal facility Mochovce** is in case of decommissioning option 1 appr. 3 215 FRC containers, while in case of decommissioning option 3 this amount is decreased to 1 970 FRC containers.

5) Besides the low and intermediate level RAW arisen from decommissioning and disposable at Mochovce repository, an amount **of high level RAW**, containing long half-time radionuclides, will arise. These high level RAW will be finally disposed at deep geological repository. Volume requirements for high level RAW disposal in the deep geological repository for the decommissioning options do not differ.

6) **Technical means for non-active waste** (metallic waste, building materials) are to be provided for decommissioning needs. A recycling facility for treating the concrete, reinforced concrete and other building materials, transport containers for transporting the non-active metallic materials to metallurgical works and so on are in question. Amount of non-active waste will be considerably high only for building materials (it makes up appr. 371 000 tons). Amount of non-active metallic materials to metallurgical works reaches the value about 64 000 tons.

7) **Mutual ratio between amount of RAW and non-active waste** will considerably depend, besides other factors, also on approved limits (criteria) for unrestricted release of materials from NPP into the environment.

8) Performing any of considered decommissioning options will require considerable financial expenses. Performed evaluation of expected **total decommissioning costs** shows that at assumed unit prices the differences among the individual evaluated options are interesting. Difference between the lowest value of the total decommissioning costs (decommissioning option 1: 13 611 mil. Sk) and the highest value (decommissioning option 3: 14 668 mil. Sk) is approximately 7.8 % from the value of the lowest total decommissioning costs.

9) From the point of view of the operating organization which is also responsible for the V1-NPP decommissioning **the time dependence of use of annual and cumulative decommissioning costs** (see Figure 6 and Figure 7) is very important. More convenient time dependence of use of annual and cumulative decommissioning costs is for the decommissioning options 2 and 3 in comparison with the decommissioning option 1.

10) **Mutual comparison of evaluated three basic options** of the V1-NPP decommissioning and a recommendation of the preferred option resulting from such a comparison and based on evaluated main and auxiliary parameters (see Table 1) depends on priority of separate points of view which will be applied during considerations. If main emphasis will be put on the total decommissioning costs, the most suitable will be the decommissioning option 1, the most unsuitable will be the decommissioning option 3. If main emphasis will be put on the total collective dose equivalent, and on amount of RAW, the most suitable will be in the contrary the decommissioning option 3 and the most unsuitable will be option 1.

11) Results of multicriterial analysis (see Table 3), which takes into account not only the importance of individual objective criteria based on calculated quantitative resulting parameters of the analysis of each option, but also other subjective criteria, prefer the decommissioning option 3. The most unsuitable is option 2. It is necessary to underline that a final result of this way of comparison of options is influenced in certain measure by criterion weight assigned to considered criteria and by criterion numbers for option assigned to various subjective criteria by experts.

12) Final selection of the V1-NPP decommissioning preferred option can be only done on the base of V1-NPP decommissioning environmental impact assessment report prepared in accordance with the law No. 127/1994, its submission and review and position of the Ministry of Environment of the Slovak Republic and appropriate involved authorities and organizations.

Computer calculation code OMEGA

Introduction

Cost estimates of decommissioning up till now provide results in different cost item structures. The comparison of cost of various decommissioning projects is then difficult, if possible in some cases. Three dominant European organisations in the field of decommissioning – OECD/NEA, IAEA, EU, agreed on common effort in definition of decommissioning cost items. The main reason for this step were significant inconsistencies in costs of various decommissioning projects caused by different definition of extent of decommissioning activities, technical factors, time structure, waste management systems, local factors, financial factors, etc. The result of this common effort is a document “A Proposed Standardised List of Items for Decommissioning Purposes” (1999), which represents a structure of categorized decommissioning activities. The main purpose of the Proposed Standardised List is:

- to facilitate communication;
- to promote uniformity;
- to encourage common usage;
- to avoid inconsistency or contradiction of results of costs evaluations;
- to be of world wide interests to all decommissioners.

A new computer code “Omega” (**O**racle **M**ulticriterial **G**eneral **A**ssessment of Decommissioning) is under developing in Decom Slovakia, Ltd., which implements the Proposed Standardised List. The resulting costs and other parameters are fully compatible with the structure of cost items of the Proposed Standardised List. The main intended use of this computer code is in the phase of detailed cost calculation and decommissioning planning. The code can be used also for less detailed cost estimations for example for the decommissioning feasibility study level.

The computer code has its own database of unit factors and other parameters needed for calculation. The calculation structure is constructed based on the structure of the Proposed Standardised List and on the inventory database of the nuclear facility to be decommissioned. The basic working phases when using the code are following:

- Assembling of decommissioning calculation options for the nuclear facility. The extent and number of options should cover the whole range of possible or intended ways of decommissioning.

- Calculation of costs and other decommissioning parameters for individual decommissioning options. Wide range of decommissioning parameters can be calculated.

- Time and parametric optimisation of individual options of decommissioning.

- Comparison of optimised options of decommissioning and choice of the most suitable option based on multi-criterial analysis.

Basic properties of the code

Activity based costing principle was applied. Individual decommissioning activities of decommissioning option are identified and are sorted according to the structure of the Proposed Standardised List. A set of default master hierarchical structures of decommissioning activities according to Proposed Standardised List is available, which are modified by the user in the individual options. The master hierarchical structures have additional lower levels compared to Proposed Standardised List. This enables large variability in assembling the individual options.

Automatic generation of the calculation structure. Based on hierarchical decommissioning activity structure selected and modified by the user, on technology, building and radiological inventory database and prescribed conditions introduced by the user, the calculation structure is generated, which is the used for calculation of costs and other decommissioning parameters. The generated structure on the level of individual calculation item has wide range of local input parameters with default values, which can be modified by user. The calculation procedures are either those defined by the user in the hierarchical activity structure or are automatically selected during the generation of the calculation structure according to the category of the item to be dismantled.

Nuclide resolved calculation process. The inherent calculation process is nuclide resolved and respects the time decay of individual radionuclides before and during decommissioning and nuclide resolved technological limits for waste processing, for releasing of materials and acceptance limits for disposal of the radioactive waste. The results of calculation are also nuclide resolved.

Working breakdown structure. The working breakdown structure, which corresponds to the real sequence of decommissioning activities is constructed over the calculation structure by the user on the base of default master working breakdown structures. The standard Microsoft Project planning software is used for optimisation of assembled working breakdown structures.

Configuration. The calculation configuration is Client (Visual Basic) – Server (Oracle). Oracle database enables to introduce large amounts of input facility inventory data and calculated data. Software of the client is user friendly and multi-user work in a network is possible. Excel and Microsoft Project user-friendly software is used for processing and visualising of calculated data and for multicriterial analysis.

Calculated parameters. The main types of calculated parameters are:

- Costs with the structure defined in Proposed Standardised List. Each calculated cost item has prescribed inner structure: labour costs, capital costs, material costs and contingency.

- Personnel parameters – professions needed and number of workers for each profession.

- Duration of process in individual calculation items and duration of grouped items in the working breakdown structures.

- Profession resolved exposure – internal and external exposure.

- Items of material and activity flow, nuclide resolved, including the resulting forms of waste for disposal, material for releasing and gaseous and liquid effluents to the environment.

- Material consumption items entering the technological processes of dismantling, decommissioning, treatment of waste and other decommissioning activities.

- Equipment planning items.

Development status of the code

The development of the computer code is planned to be finished at the end of the year 2002. At present time the code is already available and is under testing. The model calculations based on real inventory of a nuclear power plant are being performed. Beside the calculating parameters of decommissioning, the code is at present time further expanded for calculating the parameters of more simultaneous decommissioning projects and for calculation of spent fuel cycle parameters.

An internet-based version of the computer code is planned to be developed in next step. This version will enable a wide encrypted access to the results of calculation or to the definition and calculation of options of decommissioning.

THE GREIFSWALD WWER DECOMMISSIONING PROJECT: STRATEGY SELECTION

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Abstract

At the Greifswald site, 8 units of Russian pressurized water reactors type WWER 440 are located, including several facilities to handle and store fuel and radwaste. After the reunification of Germany in 1990, the operating units 1-5 were switched off and the construction work at the units 6-8 was stopped. After serious considerations to refit and restart some reactors, in 1990/91 the decision was taken finally to decommission all reactors. Due to this decision, the Energiewerke Nord GmbH was faced with a major and multi-facetted decommissioning task. This paper outlines the strategic approach taken and offers some key lessons which have been learnt to-date.

Greifswald site and initial situation

At the Greifswald site, there are in total 8 reactors of the Russian pressurized water reactor type WWER 440. The units 1-4 are of the model 230 and the units 5-8 of the more recent model 213. There are also a wet storage pool for spent fuel, a warm workshop (a workshop for maintenance work of slightly contaminated components) and additional buildings for the treatment and storage of radioactive waste.

Immediately after the reunification of Germany in 1990, the 4 operating units 1-4 were switched off, the trial run of unit 5 and the construction work at the units 6-8 were stopped. Investigations in view of the reconstruction of some units showed no acceptable economic solution. Finally, in 1990 the decision was taken to decommission the units 1-4, followed by the same decision for unit 5 in 1991. The Energiewerke Nord GmbH (EWN) was created as a new owner to replace the former GDR-collective combine "Bruno Leuschner". The sole shareholder is the German state (Ministry of Finance).

In 1991 there were on site ca. 5 000 employees and a further ca. 1 000 in research groups in Berlin, Rossendorf and Leipzig. The ca. 8 000 construction workers had already left the site. This amount of employees can only be understood within the context of the previous socio-economic system. The site is also located in a basically agricultural region without any major industries, which made job relocation very difficult if not impossible.

After the reunification the local society had to be transformed from a command-driven planned economy to a free-market economy. The complete legal system had to be changed, i.e. also the nuclear licensing authority and authorized expert system had to be renewed. Obviously also the inhabitants and employees had to get adjusted to the new social environment. Furthermore, it was necessary to introduce "Western" planning and management methods. Thus, it can be understood it was a challenging task to perform this major project within such boundary conditions.

Situation analysis and key decisions

As it can be understood from the initial conditions mentioned, this decommissioning project is multi-facetted and must cover the following key areas:

- personnel;
- decommissioning/dismantling;
- waste/material management;
- licensing;
- site reuse;
- project management.

These issues are interrelated and had to be solved in an integrated and iterative manner. The financing of the overall project is secured by the German state, and EWN, as a legally normal private company, has to apply the usual financial practises and is audited consequently by the sole owner, the German Ministry of Finance.

Due to the unexpected shut-down, there had been no preparatory decommissioning planning, so that it was absolutely necessary to establish the planning basis for the overall project and to define the company objectives. First of all, a strategic analysis of the company was performed, considering all prevailing boundary conditions – technical, legal, economical, political and social – in order to:

- establish and evaluate all possible alternative company developments;
- evaluate personnel needs and qualifications;
- transfer the company structure from operational to decommissioning tasks.

As a result of this analysis, the following key decisions were taken:

- complete direct dismantling – no safe enclosure period;
- construction of a large interim storage for all waste and fuel arising from the decommissioning of all reactor units to achieve independence;
- change of the operating license into decommissioning license;
- perform as much as possible of the relevant work with the existing personnel;
- reuse of the site.

On the basis of these decisions the project objectives and the company tasks were clearly defined, and it was possible to introduce an adequate project structure and to begin with the decommissioning planning work in a well defined manner.

Basic strategies

Personnel

First of all measures had to be taken to reduce the number of employees. Due to the decision to use own personnel as far as possible, major contractors were excluded. A retirement scheme had been installed and after careful evaluation all possibilities of privatisation and outsourcing were performed. Furthermore, EWN tried to improve the chances of a number of employees on the free labour market through training and education, others received economical support by their dismissal.

In this way EWN successfully reduced the personnel from ca. 5 000 to only ca. 1 800, which was still high, but justifiable. This number is slowly reducing due to the natural fluctuations over a project life-time and is today ca. 1 250. Thus, the remaining personnel has clear perspectives and the bases exist for an effective project with a motivated workforce.

Decommissioning/dismantling

The second major decision to take was to decide on the decommissioning strategy, i.e. direct or deferred dismantling after a safe enclosure phase. In order to resolve this main issue with its major implications, a complete project planning and calculation for both alternatives had to be performed. The result showed that the direct dismantling is ca. 20% cheaper, produces less radioactive waste and a less dose commitment, which is due mainly to the limited lifetime especially of the buildings of these early Russian-designed reactors, which they have no containment. Obviously, the direct dismantling option also had a positive influence on the job situation on site and the valuable knowledge of the personnel can be used.

In order to reduce the overall project time, and the dose commitment for the personnel as well, the plant parts are to be dismantled in as large parts as possible and transported into the Interim Storage North (ISN) for decay storage. Thus, further dismantling and treatment can be performed later and is independent from the dismantling activities in the units.

Waste/material management

Timely planning, on the basis of a thorough technical and radiological review of the plant, and the organisation of the overall waste management are absolutely necessary preconditions for a successful project.

Due to the present lack of access to a final disposal facility in Germany for the near future, the Interim Storage North (ISN) was planned and erected on site. It serves as an independent, integrated treatment and storage centre for radioactive waste and dismantled material, as well as a storage for spent fuel in CASTOR casks. In this way, sufficient buffer and intermediate storage capacities were created and a high flexibility in logistics and waste management was achieved. The capacity of the final disposal facility ERAM, in Morsleben, was used as far as possible until its closure in 1998.

To obtain easier boundary conditions for the dismantling activities, the spent fuel was removed from the reactors and the cooling ponds into the wet interim storage on site. Later the fuel will be loaded in dry CASTOR casks and transported to the ISN.

Licensing

Since the provisional license ended 30 June 1995 – as a result of the transition agreement on laws between both German states in 1989/90 – it was tried to obtain an as large as possible license first and then to complement this with license applications for dismantling parts. In this way, the consistent use of personnel capacities, a continuous planning work and the continuity in the licensing procedures and in-process control could be guaranteed.

It was furthermore agreed that no public hearing was required, since there is no real public concern. However, the importance of informing the public of progress and development on the project is well recognised and is achieved through a liaison committee with representatives from politics, NGO’s and the public who meet regularly.

Site reuse

During the initial phase of personnel reduction it was possible to establish a number of small- and medium-sized enterprises on site. In total, ca. 1 000 work places were created. After the initial decisions, all efforts have been taken to keep the site as an industrial and energy producing site and recently, 2 preliminary contracts could be closed on the construction of gas fired power plants [total capacity 2 400 MW (e)], including a guarantee for the creation of 400 new jobs. Thus, despite the rather isolated location of the site, it has been possible to create new industrial possibilities. The efforts in this area are continuing and the infrastructure is being improved. A major part here is the creation of a harbour area at the cooling-water outlet channel allowing the entry of normal Baltic transport and container ships.

Project management

To cover all necessary activities, a project management structure has been introduced in a timely fashion. On the basis of the company analysis, a technical concept was worked out and the overall project was broken down to working package level. The project was optimised from the cost and personnel point of view in order to obtain a constant personnel number. For the project management, special software tools have been developed, allowing to perform technical planning, work preparation, tracking and control of the flux of dismantled material and radioactive waste, etc. Actual data from the dismantling operations are recorded, evaluated and fed back into the system.

International activities

EWN is trying to convert the know-how from the presently ongoing decommissioning activities into new long-term jobs. Especially in the engineering area, there is today a very well founded engineering know-how, which now has been mixed with Western experience, rules etc. In this framework EWN is involved in several decommissioning projects in Eastern Europe, e.g. Chernobyl (Ukrania), Kozloduy (Bulgaria) and Ignalina (Lithuania).

Concluding remarks

After initial difficulties connected to massive personnel reduction combined with the introduction of a market economy and West German laws and procedures, EWN has succeeded in restructuring the company to arrive at a size suited to the task of decommissioning. The decommissioning and dismantling of the Russian WWER type reactors do not pose specific problems. However, the size of the project and the resulting mass flow is extraordinary. It can be concluded that dismantling of nuclear facilities is basically not a technical problem but a challenge to project management and logistics, once the legal and economical boundary conditions have been clarified. In order to achieve a safe and cost effective project, it is necessary that all stakeholders, i.e. operator/owner (EWN), authority and authorised experts, and public achieve a positive co-operation. To sum up, the lessons learned are:

- development of comprehensive inventory is a necessary prerequisite for all planning;
- social aspects and psychological effects must be taken into account;
- clear licensing structure – one license better if not too large project;
- clear and realistic requirements from licensing authority (related to real safety risk);
- the overall project must be planned, i.e. from shut down to disposal;
- establish a project structure and integrate all site activities;
- the dissemination of open public information is a key activity;
- simple and sturdy tools/equipment; mock-up tests if new or complicated technology;
- ALARA-principle must be strictly applied from the planning phase.

SESSION III: NATIONAL STRATEGY(IES)

LESSONS LEARNT IN ESTABLISHING A FIRST NATIONAL INVENTORY OF DECOMMISSIONING LIABILITIES IN BELGIUM

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Like all countries that use nuclear power for producing electricity or have other nuclear activities for peaceful purposes, Belgium is faced with an important challenge: the safe management of all the radioactive materials present in these industries and activities, in both the short and long term. Of course there is a price to pay for this management, which in accordance with the ethical principle of intergenerational fairness should be borne mainly by the generations which benefit from these activities, in other words by current generations. However, it is possible – as has been the case for a number of "historic" cases – that when the moment has come, the financial resources to cover the costs of decommissioning and remediation of these installations, so that they no longer need to be subject to institutional control, prove to be insufficient or even completely non-existent: this then results in a *nuclear liability*. This kind of situation can have several causes, such as an underestimation of the actual costs by the operator or the owner of the nuclear installation or by the holder or the owner of the radioactive materials, negligence, transfer of ownership of the nuclear installation or the nuclear site without transfer of the corresponding provisions, a reduction in the operating time, a bankruptcy, as well as ignorance.

Because it wishes to avoid the occurrence of new nuclear liabilities, the Belgian legislator, by virtue of article 9 of the programme law of 12 December 1997, charged the "*Nationale instelling voor radioactief afval and verrijkte splijtstoffen*" (ONDRAF/NIRAS) [Belgian Agency for Radioactive Waste and Enriched Fissile Materials] with collecting all the elements that are necessary in order to examine to which degree the decommissioning and remediation costs can be actually covered when the time comes. ONDRAF/NIRAS was specifically charged with ascertaining all facts of a technical and financial nature which should enable the government – in this case its competent minister (the minister who is responsible for energy) – to verify whether every operator or owner of a nuclear installation and every holder or owner of radioactive materials (e.g. radioactive sources) have provided in time for the requisite financial resources to cover the future costs of decommissioning and remediation. This evaluation of course also serves to enable the government to take the necessary corrective measures in time in order to deal with any shortcomings and thus avoid the occurrence of new nuclear liabilities.

This new assignment, *the inventory of the nuclear liabilities*, its official legal name, consists of locating and recording the installations and sites where radioactive materials are present, and evaluating the situation in order to develop a policy that offers the requisite financial guarantees for safety in the long term. More specifically, the legislator asks ONDRAF/NIRAS to:

- establish a register of the localisation and the state of all nuclear installations and all sites that contain radioactive materials;

- estimate the costs of their dismantling and remediation;
- to evaluate the existence and adequacy of the provisions for financing these future or current operations;
- to update this register on a five-yearly basis.

The programme law of 12 December 1997 anticipated the approval by Belgium, in August 2002 (Belgian Statute Book of 25 December 2002), of the Joint convention of the *International Atomic Energy Agency* of 5 September 1997 concerning the safety of the management of irradiated nuclear fuel and radioactive waste, which states in article 22 that "*Each Contracting Party shall take the appropriate steps to ensure that [...] adequate financial resources are available to support the safety of facilities for spent fuel and radioactive waste management during their operating lifetime and for decommissioning.*"

The inventory is not a purpose in itself but a means that will benefit every citizen. It concerns a task of public importance that makes better management in the long term possible. The monitoring by ONDRAF/NIRAS of Belgian territory fits in with an active prevention policy, an essential part of sustainable management. It can thus be prevented that society would have to bear in future the financial burden of potential nuclear financial liabilities.

To carry out this assignment, ONDRAF/NIRAS has developed a flexible evaluation methodology. The inventory, provided by a nuclear operator, of the present radioactive materials and the installations and sites that contain radioactive materials is used as input for a cost calculation model. This model is based on a number of management scenarios which generate the costs on the output side for the management of the present radioactive materials and for dismantling and remediation of installations and sites that contain radioactive materials. This is subsequently compared with an evaluation of the availability and adequacy of the financial resources to cover the costs in question.

Lessons learned

In addition to the costs that are not currently covered, the inventory exercise has highlighted a number of weak points that may threaten the availability and sufficiency of the financial means built up. To fill these gaps, the following corrective measures are required for which the initiative should be taken by the minister in charge:

- *Determination of the financial responsible(s) of some sites.* In most cases the legal situation is simple, because the operator and owner of the installations are the same. For some sites the legal situation is more complicated however. Is the financial manager the operator of the site, the owner of the installations, the owner of the site on which the installations are present, the lessee of the installations or the manager stipulated in a contract concluded between the parties? The division of the obligations amongst the owners and the operators must be defined in accessible agreements.
- *Difference in accounting obligations.* The accounting obligations for organisations (universities, non profit associations, etc.) are specific and different from companies that have to submit a balance sheet to the National Bank. Even the analysis of the balance sheets that are submitted to the National Bank by companies that are subject to this obligation, may prove difficult and should be more detailed.

- *Availability of the financial means built up.* The financial means hidden behind accounting provisions recorded in the annual accounts of the companies are generally rebuilt up in the operation of these companies. This may threaten their availability in the long term taking the uncertainties of economic life into account.

- *Sufficiency of the financial means.* Covering the nuclear costs using a financing mechanism presupposes that this mechanism is maintained for the entire, originally planned duration of operations of the installations concerned. The risks of an early shutdown of the installations or an insufficiency of the mechanisms raise the issue of the solidarity between the actors in the nuclear sector.

- *Uncertainty regarding real costs.* The calculation of the real costs is linked to a number of uncertainties that relate to the work hypotheses used, specifically in relation to the planned management scenarios, and with the development of the laws, standards and techniques. These uncertainties are partially covered by a margin that is included in the calculation of the provisions. Once this reserve is depleted, the State is the sole guarantee for long-term financing for making the radioactive substances safe.

- *Fiscal deductibility of the provisions.* The non-fiscal deductibility of the nuclear provisions, with the exception of the provisions built up by the nuclear power plants, is a disincentive for many companies to create provisions.

Conclusions and outlook

After five years collaboration between ONDRAF/NIRAS and the operators of nuclear installations and holders of radioactive substances, the government today has at its disposal a first general overview available of the financing mechanisms intended to cover the future costs of the decommissioning and remediation in Belgium, including the costs of long-term management of radioactive waste. The report on the inventory of the nuclear liabilities contains all useful elements that should make it possible for the government to take a number of necessary measures to consolidate the means acquired and to fill those gaps identified. In this way it will guarantee the Belgian citizen that the necessary financial means will be available to manage the radioactive substances present in Belgium safely, both in the short and long term.

During the inventory exercise of 2003-2007 the knowledge and experience acquired will be broadened and the case of the sites that are not currently subject to a license but do contain radioactive substances and which will have to be registered to the Federal Agency for Nuclear Control (FANC/AFCN) from 1 September 2003 will be specifically investigated. Some of these sites will probably be included in the existing register by means of a decision taken by the agency.

DECOMMISSIONING STRATEGY FOR NPPS AND OTHER NUCLEAR FACILITIES IN ITALY

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In Italy the issue of decommissioning become real suddenly when, after a government decision, all operating NPP's have been definitely shutdown in 1987. At that time, in the absence of a government policy, the Italian electric utility ENEL decided to proceed on the basis of the safe storage strategy. Several reasons were behind the decision. Among them the unavailability of a national repository, the potential reduction in occupational doses and the financial advantage in delaying major costs. Therefore, the programmes considered the completion of all decommissioning activities and the elimination of all radiological constraints on the sites around the year 2050.

Decommissioning activities for safe storage, however, did not start at the pace that was initially planned, since many other boundary conditions continued to be not fully clarified (regulatory, financial, technical, etc.). In addition the main mission of ENEL was to generate and sell electrical energy and there was no real pressure to start the activities before the situation was totally clear. In parallel to the partial privatization of ENEL, in this climate of slow progress in the way to safe storage, SOGIN was created in 1999 as a separate share Company in the ENEL holding to carry out the decommissioning of the NPPs. In 2000 SOGIN became property of the Ministry of Treasury and was completely separated from ENEL. Therefore, SOGIN became the reference company in Italy for decommissioning.

It was also decided, since 2000, that SOGIN should take the responsibility for the decommissioning of other nuclear installations in Italy, namely those of the Nuclear Fuel Cycle operated by ENEA, the state owned R&D organization, and *Fabbricazioni Nucleari* (FN), an industrial fuel fabrication plant, formerly owned by *Agip Nucleare*. In August 2003 all licenses of the fuel cycle facilities were also transferred to SOGIN, which became responsible for their decommissioning.

At the same date the financial mechanism was also defined through the electrical bills to complement the funds already accumulated specifically by ENEL and those very limited available from ENEA and FN.

At the beginning of the year 2003, through the nomination of a special government Commissioner, SOGIN became also responsible for the technical identification and engineering of the national centralized repository for radioactive wastes.

1. Director of Nuclear Power Plants Decommissioning Department.
2. Director of Nuclear Fuel Cycle Installations Department.

Concerning the decommissioning strategy evolution, the Italian government, on the basis of a strategy document which has been presented to the parliament, at the end of 1999 requested SOGIN to complete the decommissioning of all NPPs[3] before the year 2020. The main reasons for the decision were:

- The consideration that in a country where nuclear power has been abandoned (at least for the time being) it would be impossible to maintain all knowledge and skills necessary to carry out decommissioning activities.
- Each NPP was based on a single unit site and safe storage expenses could not be shared among other operating or shutdown plants, increasing total costs.
- At the time of the decision all plants were already shutdown since more than 12 years, reducing the interest in further waiting radioactive decay.
- In the Italian social and industrial context plant personnel could not be either recycled in other jobs or laid out. Therefore it was of crucial interest to maintain them operative in the decommissioning area.
- A proper planning at the national level would have permitted to maintain constant the occupational levels and to share personnel and experiences between sites. Therefore, timing has been accelerated, but not reduced to the really shortest possible one on purely technical bases.
- The accumulation of the experiences in a reasonable period would have facilitated the expansion of the company in the international market of decommissioning.
- The sites could be reutilized for new industrial applications, including electrical power stations.

In developing the new strategic objectives the government recognized that they had to solve two additional issues: a technical problem and an economical problem.

The technical problem refers to the construction of a national waste repository. The dismantling and the waste treatment activities can be fully implemented but, in the lack of the national repository, the conditioned wastes should be kept on site in an interim store, preventing its total release and producing additional running costs. As a consequence the national strategy plan calls for the sitting of the repository by the year 2005 and for its operation by the year 2009. As we will discuss later, the decommissioning programs of the four plants assume the availability of the national repository as a reference to start major dismantling.

The second problem refers to the fact that at the time of the closure of all NPPs the funds for decommissioning were not totally available and the government had to take a decision. In the 80s ENEL, even without any legal obligation, had created a decommissioning fund based on the USNRC rules and assuming a safe storage strategy. This fund was subdivided in two parts, one for the dismantling and waste management and one for fuel cycle closure. The change of strategy indicated by the government associated with the premature closure of all plants clearly implied that the accumulated funds were insufficient. As a consequence, based on the rationale that the decision to

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3. The list of Italian NPP's to be decommissioned in included in Attachment 1.

build and to shutdown the NPPs were decisions taken by the country through government acts, the government itself decided that the complementary costs of decommissioning had to be covered through the electrical bill in the form of a levy. The responsibility of defining the amount of the levy, on the basis of the presented programs and of the project advancements, has been given to the National Authority for Electricity and Gas that is an independent technical body with the necessary competences.

Consequently SOGIN developed in parallel the new licensing documentation, the new schedules and technical descriptions as well as the corresponding financial requirements. Those documents were submitted to the authority on September 2001, allowing them to define the amount of the levy on the kWh's sold; the fee for the NPPs is currently in the order of EUR 0,036 per kWh sold. Each year in September SOGIN presents a status report and, if necessary, minor revisions to the documents; major changes are expected only at the end of a three year period.

Figure one presents the last overall time schedule for NPP's decommissioning submitted to the authority in September 2002.

The history of fuel cycle (FC) decommissioning strategy is somewhat different. In parallel to the closure of NPP's in 1987, also the FC facilities (research, pilot laboratories and fuel fabrication facilities) were closed and put in safe conditions.[4] Situation was at that time more complicated by the fact that ENEA, the main owner and operator of these facilities, did not accumulated the funds required for decommissioning and the government did not identify a financing mechanism until the year 2000. The only activity that was carried out until 2000 was to treat and condition the most dangerous wastes and to prepare for decommissioning.

In the 1999 document mentioned above, the government decided that all FC facilities also shall be decommissioned before 2020. This timescale responds basically to the same issues mentioned above with the following notable additions and differences:

- The most urgent issue is the conditioning of a large variety of radioactive wastes, including liquids from fuel reprocessing, which will take several years;
- No funds were accumulated yet at the time of the decision for these facilities;
- Completion of detailed radioactive characterization and plant documentation for decommissioning planning will require additional efforts.

The programme presented to the authority at September 2002 for FC facilities is shown in Figure 2. This programme requires to be funded by an additional levy of about EUR 0,026 per kWh sold.

In the overall picture described above, at the beginning of this year, also with regard to the increase in the international threats of terrorism, a decision was taken by the government to speed up at least those activities, which could have a greater impact on the increase of safety and security levels of all installations. In fact on 14 February the "emergency state" for nuclear installations was declared until the end of this year and, through the Ordinance 3267/2003 of 7 March of the Civil Protection signed by the Prime Minister, a special Commissioner was nominated to manage the emergency in the person of Gen. Carlo Jean, at that time already Chairman of the Board of SOGIN. In the same

4. The list of Italian FC facilities that were transferred to SOGIN for decommissioning is included in Attachment 2.

Ordinance SOGIN was indicated as the operating arm of the Special Commissioner. The basis for this decision was the consideration that in new international scenarios the nuclear installation security shall be enforced and that all processes for waste treatment and conditioning and installation decommissioning should be streamlined. Special powers were given to the Commissioner in terms of decision making processes and licensing processes.

One of the first actions of the Commissioner was to ask SOGIN to review the decommissioning schedules of all plants and installations with the aim of reducing their total duration. taking of course advantage of the possibility of shortening the approval time for licensing processes.

The updating of the decommissioning schedules is underway. It is currently expected that for NPP's the schedule reduction will not exceed 2 or 3 years, while for the FC facilities this reduction will be even shorter. This conclusion clearly is a consequence also of other conditions, such as the need of not increasing significantly the levy on the electrical bills and to optimize resources and competences at the national level.

Another very important factor that has been taken into consideration is the link between the availability of the national repository and the decommissioning programs. Since the time required to have the national repository operating is still subject to uncertainties, on each NPPs and nuclear installation some storage facilities have to be used or built, if necessary. Therefore an appropriate technical and economical balance shall be reached between the need to accelerate the decommissioning and the need to reduce the costs on the electrical energy users.

In this analysis a better definition of the amount of conditioned wastes to be stored plays a major role. The initially estimated amount has dramatically decreased in the last years due to a better characterization of the plants, to a better evaluation of the decontamination technique efficiency and last, but not least, to the expected harmonization of the Italian release limits to those recommended by the European Union.

In our view, the acceleration of the decommissioning for NPP's and FC facilities, after having considered all above, is totally justified, not only on moral grounds, but also in terms of consequences of a prolonged post-operational phase, namely additional wastes and doses to the operators related to maintenance and inspection activities.

Another aspect related to the current effort of schedule revision refers to the increase in their confidence. The aspects being refined refers to procurement policies and to the definition, with the agreement of the Safety Authority, of technical solutions and technical procedures valid for all plants. In this perspective since, for many reasons, although the activities are the same in all plants, their technical sequence is different, site by site, each plant has been identified as the lead plant for some activity. For instance, since Garigliano had the problems of a more refined environmental consequences analysis of airborne releases in order to demolish the old stack, the site has been assigned the duty of demonstrating new codes. Again, for other reasons, the Caorso site has been assigned the responsibility of developing general design criteria for the waste management facility and to demonstrate the viability, in the Italian licensing context, of the Phadec decontamination technology.

The same approach is more difficult to pursue for the FC installations, because the variability of the situations is much greater. However a similar effort will be put by SOGIN in the standardization of approaches and technologies. A rationalization could be achieved transporting and accumulating similar wastes, present even in very small quantities in various installations, on the same site, where the most appropriate treatment system could be built and operated. However this approach seems to face a strong local authority's opposition and will likely fail.

Above all, a major standardization effort has been conducted by SOGIN directly through the definition of technical guidelines and indirectly by strongly supporting the definition of national standards for all the most sensitive area of decommissioning. Figure 3 provides an overview of the standardisation effort.

The evolution of the decommissioning policy in Italy confirms that there is not an optimum strategy for all cases, but that it may evolve even in the same country and for the same plant when the boundary conditions change.

Figure 1. Current overall decommissioning schedule for all Italian NPP's

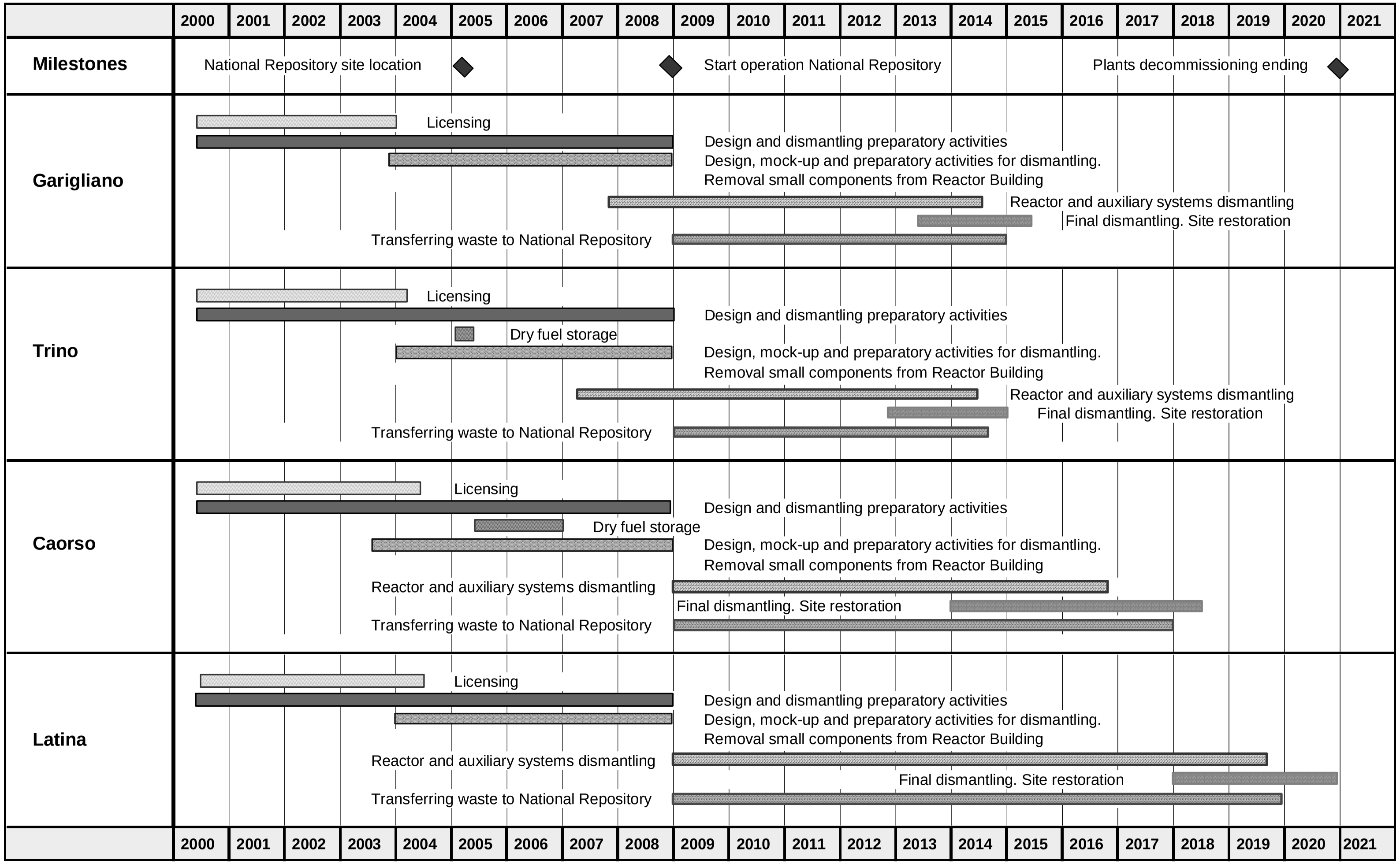


Figure 2. Current overall decommissioning schedule for all Italian FC facilities

EUREX

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Mantenimento in sicurezza e interventi conservativi															
Gestione rifiuti radioattivi di esercizio															
Gestione combustibile irraggiato e materie nucleari															
Piano Globale di Disattivazione															
Smantellamenti e gestione relativi rifiuti															
Conferimenti al deposito nazionale e rilascio del sito															

ITREC

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Mantenimento in sicurezza e interventi conservativi															
Gestione rifiuti radioattivi di esercizio															
Gestione combustibile irraggiato e materie nucleari															
Piano Globale di Disattivazione															
Smantellamenti e gestione relativi rifiuti															
Conferimenti al deposito nazionale e rilascio del sito															

PLUTONIO

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Mantenimento in sicurezza e interventi conservativi															
Gestione rifiuti radioattivi di esercizio															
Gestione combustibile irraggiato e materie nucleari															
Piano Globale di Disattivazione															
Smantellamenti e gestione relativi rifiuti															
Conferimenti al deposito nazionale e rilascio del sito															

CELLE CALDE

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Mantenimento in sicurezza e interventi conservativi															
Gestione rifiuti radioattivi di esercizio															
Gestione combustibile irraggiato e materie nucleari															
Piano Globale di Disattivazione															
Smantellamenti e gestione relativi rifiuti															
Conferimenti al deposito nazionale e rilascio del sito															

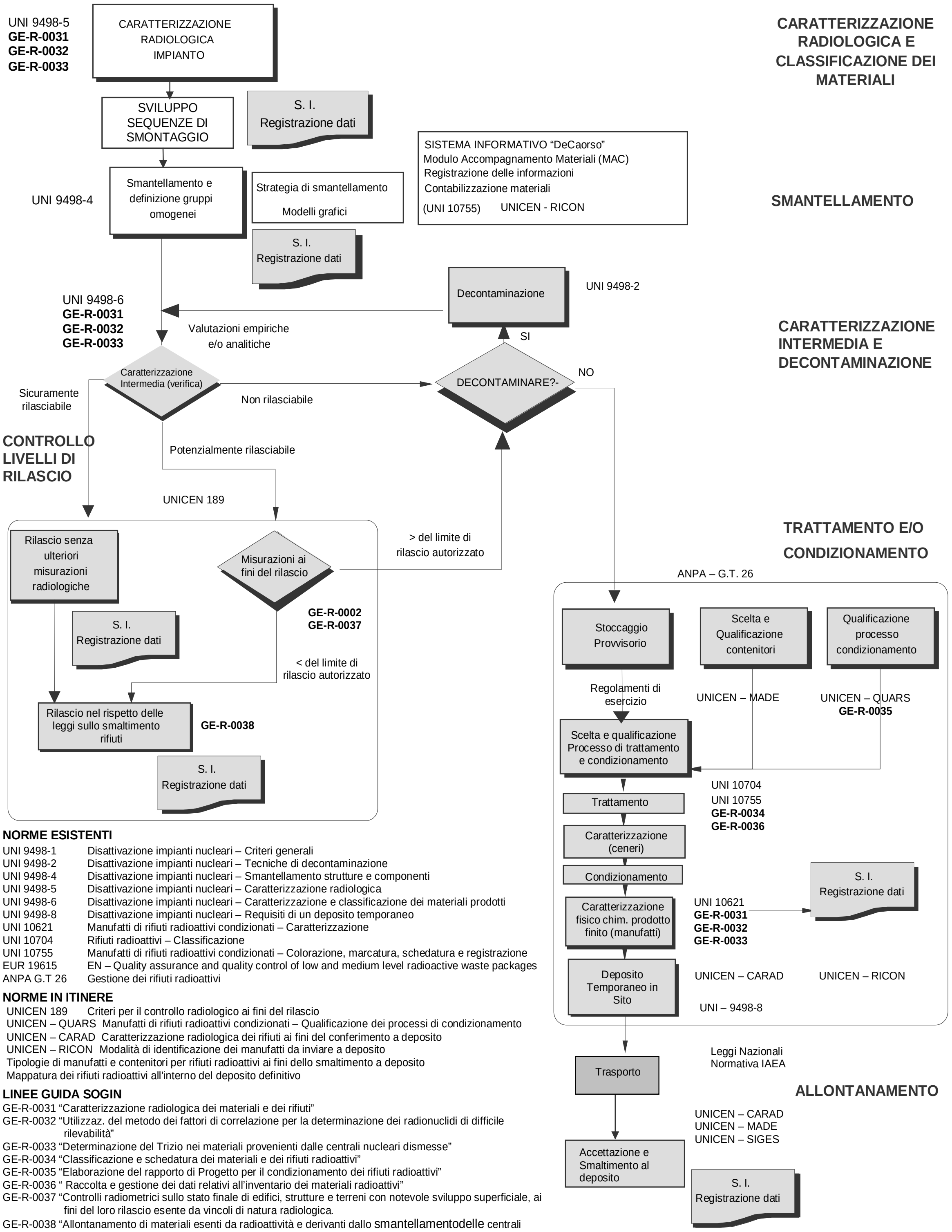
FN

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Mantenimento in sicurezza e interventi conservativi															
Gestione rifiuti radioattivi di esercizio															
Gestione combustibile irraggiato e materie nucleari															
Piano Globale di Disattivazione															
Smantellamenti e gestione relativi rifiuti															
Conferimenti al deposito nazionale e rilascio del sito															

LABORATORIO

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Mantenimento in sicurezza e interventi conservativi															
Analisi e caratterizzazioni															
Smantellamenti e gestione relativi rifiuti															
Conferimenti al deposito nazionale e rilascio del sito															

Figure 3. Overall standardization process



NORME ESISTENTI

UNI 9498-1 Disattivazione impianti nucleari – Criteri generali
UNI 9498-2 Disattivazione impianti nucleari – Tecniche di decontaminazione
UNI 9498-4 Disattivazione impianti nucleari – Smantellamento strutture e componenti
UNI 9498-5 Disattivazione impianti nucleari – Caratterizzazione radiologica
UNI 9498-6 Disattivazione impianti nucleari – Caratterizzazione e classificazione dei materiali prodotti
UNI 9498-8 Disattivazione impianti nucleari – Requisiti di un deposito temporaneo
UNI 10621 Manufatti di rifiuti radioattivi condizionati – Caratterizzazione
UNI 10704 Rifiuti radioattivi – Classificazione
UNI 10755 Manufatti di rifiuti radioattivi condizionati – Colorazione, marcatura, schedatura e registrazione
EUR 19615 EN – Quality assurance and quality control of low and medium level radioactive waste packages
ANPA G.T 26 Gestione dei rifiuti radioattivi

NORME IN ITINERE

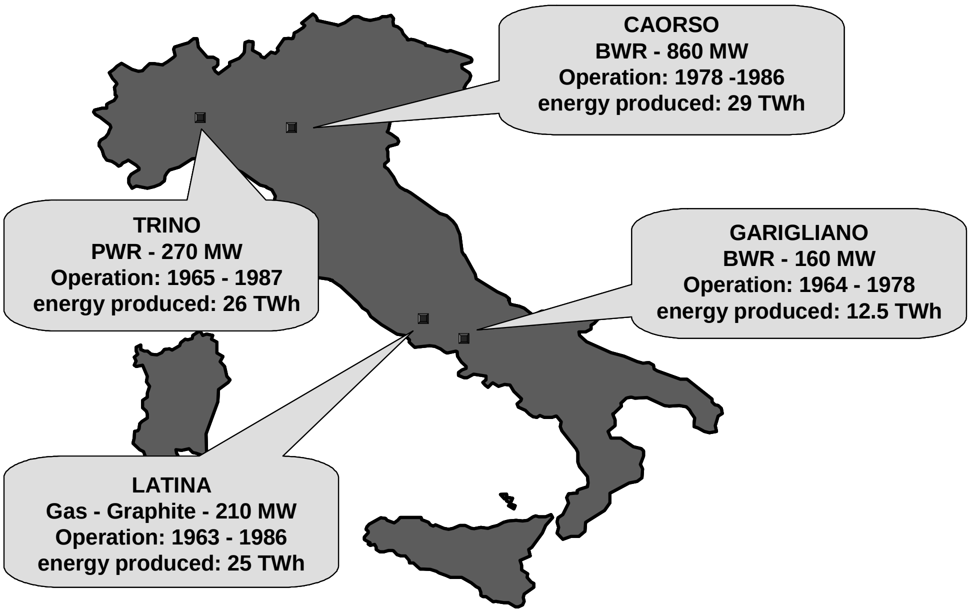
UNICEN 189 Criteri per il controllo radiologico ai fini del rilascio
UNICEN – QUARS Manufatti di rifiuti radioattivi condizionati – Qualificazione dei processi di condizionamento
UNICEN – CARAD Caratterizzazione radiologica dei rifiuti ai fini del conferimento a deposito
UNICEN – RICON Modalità di identificazione dei manufatti da inviare a deposito
Tipologie di manufatti e contenitori per rifiuti radioattivi ai fini dello smaltimento a deposito
Mappatura dei rifiuti radioattivi all'interno del deposito definitivo

LINEE GUIDA SOGIN

GE-R-0031 "Caratterizzazione radiologica dei materiali e dei rifiuti"
GE-R-0032 "Utilizzaz. del metodo dei fattori di correlazione per la determinazione dei radionuclidi di difficile rilevabilità"
GE-R-0033 "Determinazione del Trizio nei materiali provenienti dalle centrali nucleari dismesse"
GE-R-0034 "Classificazione e schedatura dei materiali e dei rifiuti radioattivi"
GE-R-0035 "Elaborazione del rapporto di Progetto per il condizionamento dei rifiuti radioattivi"
GE-R-0036 " Raccolta e gestione dei dati relativi all'inventario dei materiali radioattivi"
GE-R-0037 "Controlli radiometrici sullo stato finale di edifici, strutture e terreni con notevole sviluppo superficiale, ai fini del loro rilascio esente da vincoli di natura radiologica.
GE-R-0038 "Allontanamento di materiali esenti da radioattività e derivanti dallo smantellamentodelle centrali nucleari dismesse"

Attachment 1

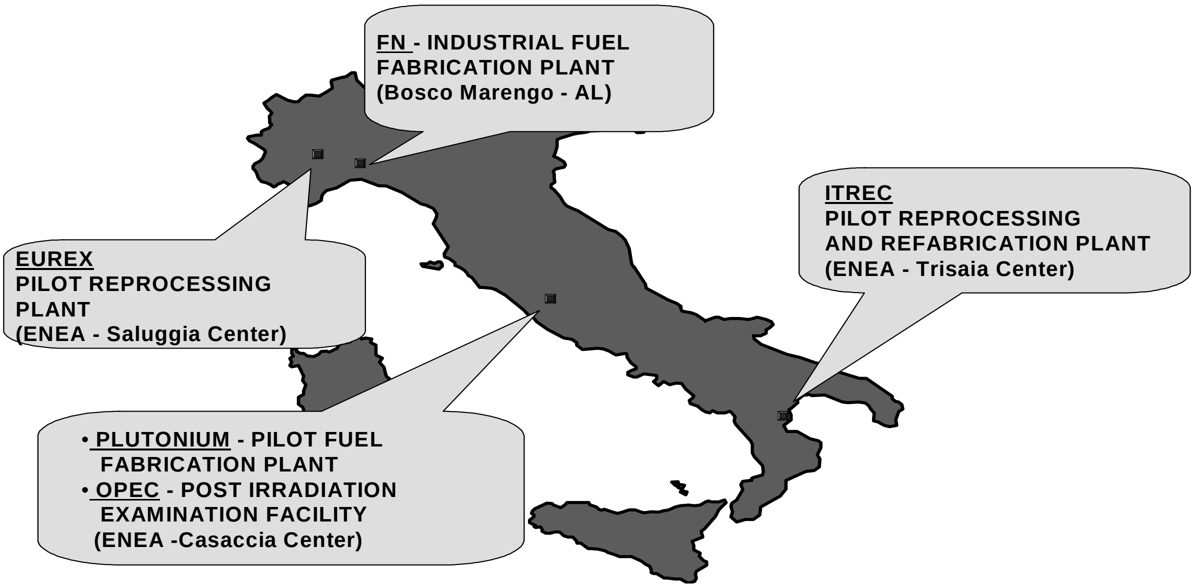
List of Italian NPP'S to be decommissioned by SOGIN



Plant	**Latina**	**Garigliano**	**Trino**	**Caorso**
Type	GCR	BWR	PWR	BWR
Capacity (MWe) *Gross* *Net*	 160 153	 160 150	 270 260	 882 860
NSSS supplier	TNPG	General Electric	Westinghouse	AMN-GETSCO
Construction start	1958	1959	1961	1970
Grid connection	1963	1964	1964	1978
Commercial operation	1964	1964	1965	1981
Shutdown	1986	1978	1987	1986
Electric energy produced (GWh) *Gross* *Net*	 26 082 196 24 840 356	 12 478 060 11 699 418	 25 027 636 23 843 767	 29 030 978 27 945 235

Attachment 2

List of Italian nuclear fuel cycle facilities to be decommissioned by SOGIN



EUREX

EUREX was a pilot reprocessing plant located at the ENEA R&D Centre of Saluggia.

Main past activities:

- 1970-1975: MTR (HEU) spent fuel reprocessing;
- 1980-1983: CANDU spent fuel reprocessing;
- 1988-1991: Pu nitrate-oxide conversion (via sol-gel);

Main decommissioning milestones:

- within 2010: safe management of all radioactive waste produced during the past activities;
- within 2016: decontamination and dismantling of the plant, safe management of the resulting material, free release of the site.

Main decommissioning issues:

- solidification of all liquid radioactive waste;
- dry storage of residual spent fuel in dual purpose casks.

FABBRICAZIONI NUCLEARI (FN)

FN is an industrial fuel fabrication plant located in Bosco Marengo.

Main past activities:

- 1973-1995: fabrication of fuel assemblies for Italian and foreign LWR;
- 1996-2001: preparatory works for decommissioning.

Main decommissioning milestones:

- within 2004: decontamination and dismantling of equipment, safe management of the resulting material;
- within 2011: controlled temporary storage "*in situ*" of radioactive waste, transfer to the national repository, free release of the site.

Main decommissioning issues:

- residual nuclear material removal.

PLUTONIUM

The "Plutonium Plant" (IPU) was a pilot fuel fabrication plant located at the ENEA R&D Centre of Casaccia.

Main past activities:

- 1968-1974: process development (sol-gel);
- 1977-1980: fuel fabrication for AECL Chalk River reactor;
- 1990-1996: liquid radioactive waste management.

Main decommissioning milestones:

- within 2010: management of all radioactive waste and nuclear material produced during the past activities;
- within 2016: decontamination and dismantling of the plant, safe management of the resulting material, free release of the site.

Main decommissioning issues:

- removal of residual nuclear material;
- decontamination and dismantling of glove-boxes.

OPEC

OPEC was a post irradiation examination facility located at the ENEA R&D Centre of Casaccia.

Main past activities:

- 1962-1990: post-irradiation examination of metal uranium and uranium oxide spent fuels (up to 2000 Ci-74 TBq);
- 1992-1998: spent fuel scraps encapsulation, hot cells decontamination.

Main decommissioning milestones:

- within 2010: safe management of all radioactive waste and nuclear material produced during the past activities;
- within 2016: decontamination and dismantling of the plant, safe management of the resulting material, free release of the site.

Main decommissioning issues:

- removal of spent fuel scraps;
- management of residual radioactive waste.

ITREC

ITREC was a pilot reprocessing and re-fabrication plant (U-Th fuel cycle) located at the ENEA R&D Centre of Trisaia.

Main past activities:

- 1975-1978: reprocessing of Elk River spent fuel (U-Th);
- 1995-2000: solidification of liquid radioactive waste.

Main decommissioning milestones:

- within 2010: management of all radioactive waste produced during the past activities;
- within 2016: decontamination and dismantling of the plant, management of the resulting material, free release of the site.

Main decommissioning issues:

- solidification of U-Th highly radioactive solution (reprocessing “final product”);
- dry storage of residual spent fuel in dual purpose casks.

DECOMMISSIONING STRATEGIES BEING IMPLEMENTED IN THE USA

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USNRC, USA

Background

Decommission is defined in the US Nuclear Regulatory Commission's (USNRC's) regulations at 10 CFR 20.1003 as "to remove a facility or site safely from service and reduce residual radioactivity to a level that permits: 1) release of the property for unrestricted use and termination of the license; or, 2) release of the property under restricted conditions and the termination of the license."

On 21 July 1997, the USNRC published the final rule on Radiological Criteria for License Termination (the License Termination Rule or LTR) as Subpart E to 10 CFR Part 20. This rule authorized two different sets of cleanup criteria – a concentration-based criteria (referred to as the Site Decommissioning Management Plan criteria or SDMP Action Plan criteria), and a dose-based criteria. In addition, the rule provided for the remediation of sites and license termination for unrestricted use and for release with restrictions on future site uses.

USNRC'S decommissioning approaches and criteria

Under the provisions of 10 CFR 20.1401(b), any licensee that submitted its decommissioning plan (DP) before 20 August 1998, and received NRC approval of that DP before 20 August 1999, could use the SDMP Action Plan criteria for site remediation. In 1999, the Commission granted an extension of the DP approval deadline, for 12 sites, to 20 August 2000. In September 2000, the staff notified the Commission that all 12 DPs were approved by the deadline. All other sites must use the dose-based criteria of the LTR. In addition, Agreement States were expected to adopt equivalent dose criteria by 20 August 2000. As of 30 June 2002, 25 states had adopted the LTR, or other legally binding requirements, and 7 states had not.

Unrestricted use

The current USNRC dosed-based unrestricted release limit is 0.25 milliSieverts per year (0.25 mSv/a) (total effective dose equivalent) to the average member of the critical group from all exposure pathways and demonstration that the residual contamination levels are As Low as Reasonably Achievable (ALARA).

Restricted use

Prior to the promulgation of the LTR, USNRC regulations did not contain a provision for releasing sites for other than unrestricted use. Experience with decommissioning facilities has indicated that for certain sites, achieving the unrestricted use criterion might not be appropriate because: 1) there may be net public or environmental harm in achieving unrestricted use; 2) expected future use of the site likely would preclude unrestricted use; or, 3) the cost of cleanup and waste disposal to achieve the unrestricted use criterion would be excessive compared with achieving the same dose criterion by restricting the use of the site and eliminating exposure pathways.

Similarly, for certain difficult sites with unique decommissioning problems, 10 CFR 20.1404 includes a provision by which the USNRC may terminate a license using alternative dose criteria. The USNRC expects the use of alternative criteria to be confined to rare situations. This provision was included in 10 CFR 20.1404 because the USNRC considered it is preferable to codify provisions for these difficult sites in the rule rather than require licensees to seek an exemption process outside the rule.

The USNRC still considers unrestricted use to be the preferable method to decommission licensed facilities and terminate radioactive materials licenses. However, in recognition that there may be a limited number of sites where license termination with restrictions may be appropriate, the USNRC included provisions for terminating the licenses for these few sites in the LTR.

License termination under restricted conditions will be permitted pursuant to 10 CFR 20.1403 if all the following requirements are met:

1. The licensee can demonstrate that further reductions in residual radioactivity necessary to release the site for unrestricted use: 1) would result in net public or environmental harm; or, 2) were not being made because the residual levels are ALARA [10 CFR 20.1403(a)].

2. The licensee has made provisions for legally enforceable institutional controls that would limit dose to the average member of the critical group to 0.25 mSv/a [10 CFR 20.1403(b)].

3. The licensee has provided sufficient financial assurance to enable an independent third party to assume and carry out responsibilities for any necessary control and maintenance of the site [10 CFR 20.1403(c)].

4. The licensee has submitted a decommissioning plan or a license termination plan to the USNRC that indicates the licensee’s intent to release the site under restricted conditions and describes how advice from individuals and institutions in the community who may be affected by the decommissioning has been sought and incorporated, as appropriate, following analysis of that advice [10 CFR 20.1403(d)]. In seeking this advice, the licensee would have conducted the activities for seeking advice required by 10 CFR 20.1403(d)(2), including providing for participation by a broad cross-section of community interests who may be affected by decommissioning; providing an opportunity for a comprehensive collective discussion of the institutional controls and financial assurance specified in 10 CFR 20.1403(d)(1) by the affected parties; and providing a publicly available summary of all such discussions.

5. The residual radioactivity levels have been reduced so that, if the institutional controls were no longer in effect, the annual dose to the average member of the critical group would not exceed either 1 mSv/a or, under certain conditions, 5 mSv/a. If the 5 mSv/a value is used, the licensee must: 1) demonstrate that achieving 1 mSv/a is prohibitively expensive, not technically achievable, or would result in net harm, 2) make provisions for durable institutional controls, and 3) provide sufficient financial assurance to allow an independent third party to carry out rechecks of the controls and maintenance at least every 5 years and carry out any necessary controls and maintenance [10 CFR 20.1403(e)].

The USNRC staff review and evaluate the DP and solicit public input to determine whether the above requirements are satisfied, pursuant to 10 CFR 20.1405. Once the USNRC determines that they have been met, the USNRC license is terminated and the USNRC no longer regulates or oversees the site, except in the circumstances indicated in 10 CFR 20.1401(c). Specifically, 10 CFR 20.1401(c) indicates that the USNRC could require additional cleanup after license termination if it determines that, based on new information, the criteria in Subpart E of 10 CFR Part 20 for release of a site were not met *and* residual radioactivity remaining at the site could result in a significant threat to public health and safety. The Commission has explicitly chosen not to define what constitutes "new information" or "significant public risk", because this determination will be made on a case-by-case basis.

In some instances a licensee planning license termination with restricted conditions under an approved decommissioning plan or license termination plan may find, during remediation, that the site can be cleaned up to a level that would not require restricted conditions. Additionally, a licensee that had planned unrestricted release may find during remediation that unrestricted release is not practical. In these instances, the licensee would be expected to submit an amended decommissioning plan or license termination plan to USNRC as soon as possible.

The restricted conditions would be expected to be limited to the smallest portion of the site that is appropriate. However, all areas that will be subject to restricted conditions would be expected to be contained within one or occasionally two areas. Complicated checkerboard patterns of areas with restricted conditions would be avoided.

Alternate criteria

Under 10 CFR 20.1404, the USNRC may consider terminating a license using alternate criteria that are greater than 0.25 mSv/a with restrictions in place found at 10 CFR 20.1403. However, licensees requesting license termination under the alternate criteria provisions of 10 CFR 20.1404 would still need to ensure that potential doses from residual radioactivity are less than 1 mSv/a with restrictions in place. In addition, the USNRC will limit the conditions under which a licensee could apply to the USNRC for, or be granted use of, alternative criteria to unusual site-specific circumstances subject to the following provisions:

1. The licensee has provided assurance that public health and safety will continue to be protected and that it is unlikely that the dose from all man-made sources combined, other than medical, would be more than 1 mSv/a. A licensee proposing to use alternative criteria would have to provide a complete and comprehensive analysis of such possible sources of exposure.

2. The licensee has employed, to the extent practical, restrictions on site use for minimizing exposure at the site, using the provisions for institutional controls and financial assurance in 10 CFR 20.1403.

3. The licensee has reduced doses to ALARA levels, based on a comprehensive analysis of risks and benefits of all viable alternatives.

4. The licensee has sought advice from affected parties regarding the use of alternative criteria at the site. In seeking this advice, the licensee would have conducted the activities for seeking advice required by 10 CFR 20.1404(a)(4), including providing for participation by a broad cross-section of community interests that may be affected by decommissioning; providing an opportunity for a comprehensive collective discussion of the issues related to the alternative criteria by the affected parties; and providing a publicly available summary of all such discussions. As part of this process, the licensee would submit a decommissioning plan indicating how advice of individuals and institutions in the community that may be affected by the decommissioning has been sought and addressed.

5. The licensee has obtained the specific approval of the Commission for the use of alternative criteria. The Commission will make its decision after considering the USNRC staff's recommendations that would address any comments provided by the EPA and any public comments submitted regarding the decommissioning plan pursuant to 10 CFR 20.1405.

USNRC'S decommissioning process

Materials sites

USNRC regulations at 10 CFR Parts 30, 40, 70, and 72 require that a DP be submitted by a materials licensee to support the decommissioning of its facility when it is required by license condition, or if the procedures and activities necessary to carry out the decommissioning have not been approved by the USNRC and these procedures could increase the potential health and safety impacts to the workers or the public. The objective of the DP is to describe the activities and procedures that the licensee intends to undertake to remove residual radioactive material at the facility to levels that meet USNRC criteria for release of the site and termination of the radioactive materials license.

For materials sites proposing unrestricted release, a full technical review of the DP will be initiated after the successful conclusion of the acceptance review. The staff's review is guided by NUREG-1757, "Consolidated NMSS Decommissioning Guidance", and its supporting references. The results of the staff's review will be documented in an Environmental Assessment (EA) and a Safety Evaluation Report (SER). The EA will be shared with the State where the site is located and State comments will be considered in finalizing the EA. The final EA must be summarized in the Federal Register in the form of a Finding Of No Significant Impact (FONSI). If the proposed decommissioning could result in environmental impacts an Environmental Impact Statement (EIS) must be prepared describing these impacts, as well as any mitigation factors.

For materials sites proposing restricted release, the review will be conducted in two phases. The first phase of the review will focus on the financial assurance (FA) and institutional control (IC) provisions of the DP. The review of the remainder of the DP will be initiated only after the staff is satisfied that the licensee's proposed IC & FA provisions will comply with the requirements of the License Termination Rule (LTR) (10 CFR 20 Subpart E). The applicable portions of NUREG-1757 will be used to guide this phase of the review. Phase II of the review will address all other sections of the technical review as guided by NUREG-1757 and will include the development of an EIS. In parallel with the development of the EIS, the staff will develop a draft and final SER. The development of the draft SER will be coordinated with the development of the DEIS so that any requests for additional information (RAIs) can be consolidated. Following publication of the FONSI (for a DP involving an EA) or the ROD (for a DP involving an EIS), a license amendment will be issued approving the DP along with any additional license conditions found to be necessary as a result of the EA/EIS and/or the SER. Following approval of the DP, the licensee must complete decommissioning in accordance with the approved DP within 24 months or apply for an alternate schedule. USNRC staff will inspect the licensee during decommissioning operations to ensure compliance with the DP. These inspections will normally include in-process confirmatory radiological surveys.

Currently one materials site has elected to decommission pursuant to 10 CFR 20.1403, and two additional sites have indicated that they are considering this option.

Power reactors

USNRC regulations at 10 CFR Part 50 require that, prior to, or within 2 years following permanent cessation of operations, reactor licensees provide USNRC with a post-shutdown decommissioning activities report (PSDAR). The purpose of the PSDAR is to provide USNRC and the public with a general overview of the proposed decommissioning activities. 10 CFR Part 50 also requires that nuclear power reactor licensees submit a license termination plan (LTP) at least 2 years before termination of the license. The purpose of the LTP is to describe the radiological condition of the site, provide a dose assessment for the site, identify the remaining decommissioning activities, and provide the final survey plan for the site.

Power reactors undergoing decommissioning may elect to use one of three different alternatives: DECON, SAFSTOR, or ENTOMB.

Under DECON (immediate dismantlement), soon after the nuclear facility closes, equipment, structures, and portions of the facility containing radioactive contaminants are removed or decontaminated to a level that permits release of the property and termination of the USNRC license.

Under SAFSTOR, often considered "delayed DECON", a nuclear facility is maintained and monitored in a condition that allows radioactivity to decay; afterwards, it is dismantled.

Under ENTOMB, radioactive contaminants are encased in a structurally sound material such as concrete and appropriately maintained and monitored until the radioactivity decays to a level permitting release of the property.

The plant owner may also choose to adopt a combination of the first two choices in which some portions of the facility are dismantled or decontaminated while other parts of the facility are left in SAFSTOR. The decision may be based on factors other than radioactive decay such as availability of waste disposal sites.

To be acceptable, decommissioning must be completed within 60 years. A time beyond that would be considered only when necessary to protect public health and safety in accordance with USNRC regulations.

Currently, 11 power reactors have indicated their intent to use or elected to use the DECON option (2 of the 11 are proceeding with limited DECON), 9 have indicated their intent to use or elected to use the SAFSTOR option. An informal survey of reactor licensees (NRC does not require licensees to demonstrate why they chose a particular decommissioning strategy) indicated that the principal rational for choosing the DECON option are concerns with potential access to waste disposal facilities in the US and the need to reduce/avoid potential future decommissioning costs. For one site, the licensee needed to build an ISFSI on site to house fuel from two other co-located sites and needed to remove one reactor from the site to build the ISFSI

The licensees had different rationale for choosing SAFSTOR. Three licensees indicated that they chose SAFSTOR because the decommissioning unit was co-located with continuing operational units and the licensee intended to decommission all reactors at the site at the same time. Two licensees indicated that they did not wish to build an ISFSI on site as it would deplete decommissioning funds and one indicated that they wished to stage the decommissioning of all of its nuclear facilities (the licensee owns several NPPs), to take advantage of the expertise that would be developed to support the decommissioning of the first facility.

Issues affecting decommissioning strategy selection

As discussed below the staff experience using the LTR since it was finalized in 1997 has revealed some important implementation issues.

USNRC licensees are having difficulties arranging the institutional controls required by the restricted release and alternate criteria provisions of the LTR that ensure long-term effectiveness. Governments and Tribes are unwilling to accept transfer of ownership of private sites, because of long-term liability and funding concerns (e.g. potential future additional cleanup, potential failure of engineered barriers, and one-time payment to US Treasury for Federal ownership). Lack of independent third party to ensure long-term effectiveness of ICs and, if needed, to provide control and maintenance if current owner/licensee abandons the site, goes bankrupt, or if a subsequent owner does not provide control and maintenance. Also, there is a concern over long-term continuity of an independent third party. Licensees are also having difficulties establishing legally enforceable ICs involving various types of "deed restrictions" that "run with the land" to ensure effectiveness over long periods of time and if property ownership changes. The LTR has limited flexibility of the existing LTR graded approach to IC requirements for providing degrees of effectiveness based on dose levels and half-life. This includes the meaning of "enforceable" and "durable" controls, as well as use of engineered barriers, role of independent third party, and degree of public involvement.

In addition, there appears to be potential inconsistencies between the doses allowed by the LTR and other NRC regulations such as 10 CFR 40.13(a), 10 CFR Part 40, Appendix A, and 10 CFR 20.2002. In addition, the relationship is unclear between the LTR's dose constraint of 0.25 mSv/a and ALARA for unrestricted release of a site, and existing guidance for controlling solid materials on a case-by-case basis, particularly for instances where residual contamination might be removed from an unrestricted release site after license termination.

Clear direction and guidance are needed for selecting more realistic exposure scenarios for both unrestricted release and restricted release that appropriately considers IC effectiveness and radiological risk. Specifically, what justifications are adequate to use scenarios other than the generic screening scenario of a resident farmer, in light of the 1 000 year dose modelling time period.

Staff experience has also identified a number of financial assurance risks including initial underestimation of costs; increased costs after certain events (e.g. groundwater contamination); unavailability of funds in bankruptcy; inadequate financial disclosure; and corporate reorganization. A number of legacy sites have substantial contamination including subsurface soil and groundwater contamination. These sites were operating long before the current decommissioning regulatory infrastructure existed. While much has been done to prevent such future sites, staff is evaluating whether more could be done through rulemaking, guidance development, or in changes to existing operating licensees

On 18 June 2002, the Commission directed the staff to evaluate the status of the implementation of the LTR [Staff Requirements Memorandum (SRM)-SECY-01-0194]. The staff provided its analysis and recommendations in May 2003 in SECY-03-0069. The staff proposes a variety of actions to address these issues including: 1) a rulemaking for measures to prevent future legacy sites; 2) revised guidance to support the rulemaking and to clarify restricted release, on-site burials, and realistic exposure scenarios; 3) revised inspection procedures and enforcement policy to enhance monitoring, reporting, and remediation to prevent future legacy sites; and 4) a regulatory issue summary (RIS) to inform a wide range of stakeholders about the LTR analysis of each issue, Commission direction, and actions planned to resolve each issue.

EDF DECOMMISSIONING PROGRAMME:
A GLOBAL COMMITMENT TO SAFETY, ENVIRONMENT
AND COST EFFICIENCY OF NUCLEAR ENERGY

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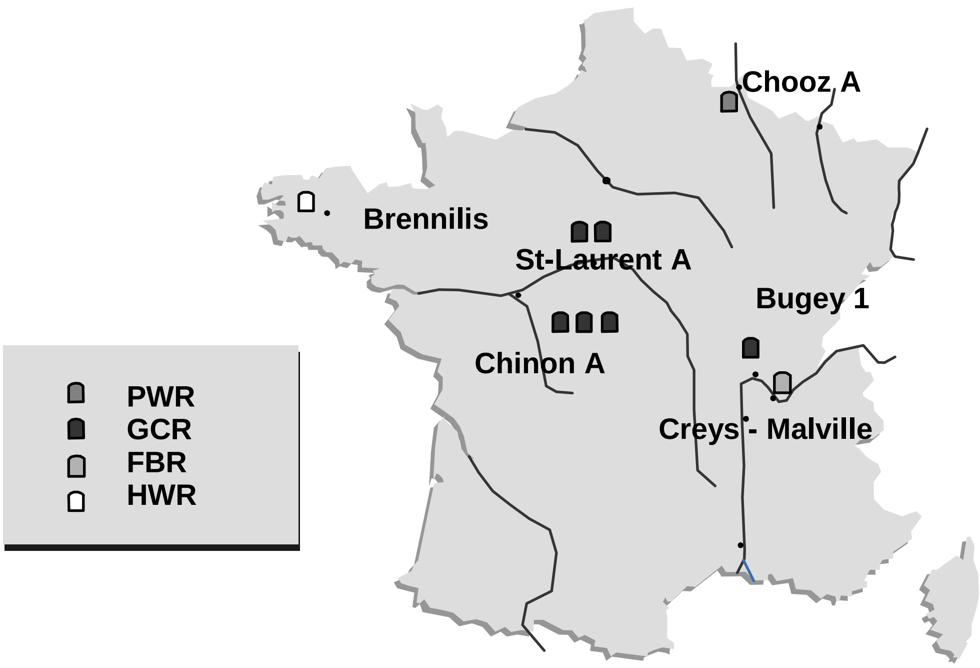
In France nuclear energy is considered as a safe, cost-effective and environment friendly energy source, and EDF is working on the development of a new generation of reactors to replace the existing ones and construction of a new nuclear power plant could start in the next few years. Nevertheless, to achieve this objective, it will be necessary to get the support of political decision-makers and acceptance by the public. Due to the growing concern of these stakeholders on environmental issues, their support can only be obtained if it is demonstrated that nuclear energy industry will not leave behind unresolved issues that will be a burden to the next generations. In this context decommissioning and dismantling of the first generation of EDF NPPs constitutes a prerequisite for the construction of a new type of nuclear power plant.

Introduction

EDF has 9 of its nuclear power plants that have been definitively shutdown and are currently under decommissioning.



Most of them are first generation units that started operating in the 60s and were definitively shutdown at the end of the 80s or at the beginning of the 90s mainly for economic reasons. They were not competitive against the new type of reactors under construction at that time (PWR 1300 MW and N4 series).

Unit	Reactor type	Capacity	Operation life
Brennilis	HWR	70 MW	1967/1985
Chinon A1	GCR	70 MW	1963/1973
Chinon A2	GCR	200 MW	1965/1985
Chinon A3	GCR	480 MW	1966/1990
Saint-Laurent A1	GCR	480 MW	1971/1992
Saint-Laurent A2	GCR	515 MW	1972/1994
Bugey 1	GCR	540 MW	1971/1992
Chooz A	PWR	300 MW	1967/1991
Creys-Malville (Superphenix)	FBR	1240 MW	1986/1996

EDF decommissioning and dismantling strategy

Until January 2001, EDF's policy regarding the dismantling of its decommissioned nuclear power plants was to reach "level 2" (release of non-nuclear facilities) about 10 years after final shutdown and to postpone final dismantling for another 30-40 years to take advantage of radioactive decay. This strategy was satisfying 3 categories of stakeholders:

- the owner, because expenses were deferred;
- the operator, because there is still some activity on site;
- the regulatory body because decision about final storage solutions could be postponed.

Only public opinion was suspicious about the real possibility to return to green field in a reasonable timeframe.

Today, EDF considers that, if the nuclear option is to remain open, it is necessary to deal pro-actively with increasing public opinion concerns on environmental and waste management issues. EDF and the nuclear industry have thus to demonstrate their ability to control the back end of nuclear power plants life cycle. Therefore, EDF decided one year ago **to achieve total dismantling of all nine already shutdown reactors in the next 25 years**. This new strategy will provide tangible demonstration of the feasibility of dismantling, from the industrial, waste disposal and financial (adequate funding) points of view.

There are several benefits to this more aggressive strategy:

- it will allow addressing safety- and environment-related issues as yet unresolved;
- the cost of dismantling first generation units will have been met already when the time will come to invest in the renewal of the operating PWR park;
- the released sites can be used to build new power plants (fossile or nuclear); and last

- it will also provide the opportunity for putting in place and develop the industrial organization and preparedness (engineering and industrial) on which to rely for the final dismantling of the whole existing PWR park of 32 units after 2020.

To implement this strategy, EDF decided in 2001 to set up a new Engineering Department, CIDEN (French acronym for Decommissioning and Environment Engineering Department), with 2/3 of the activity of its 400 employees dedicated to decommissioning.

EDF decommissioning and dismantling programme

The programme for the decommissioning and dismantling of the 9 EDF units already shutdown has to be completed in 2025. It will be organised in two stages:

1) The first stage includes:

   – Final dismantling of Brennilis (green field) in 2015.

   – A dismantling demonstration of a PWR reactor building (Chooz A) before starting replacing the population of PWRs currently in operation.

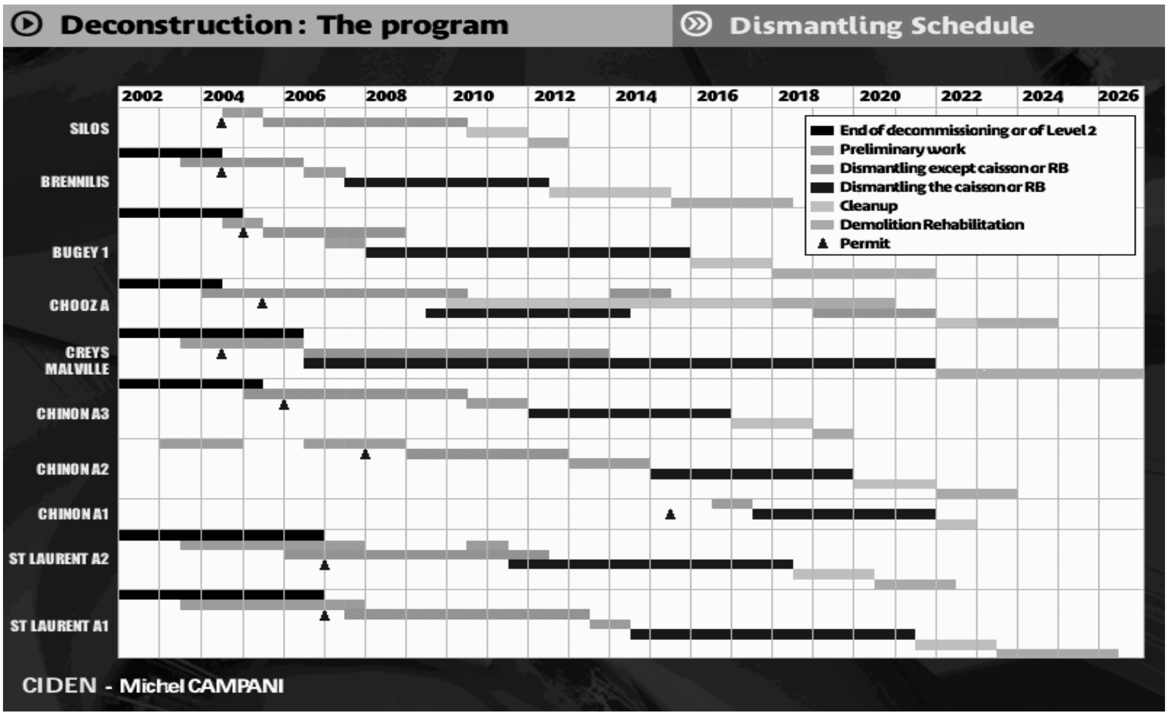
   – Final dismantling of reactor containment of a GCR (Bugey 1) as a first of its kind.

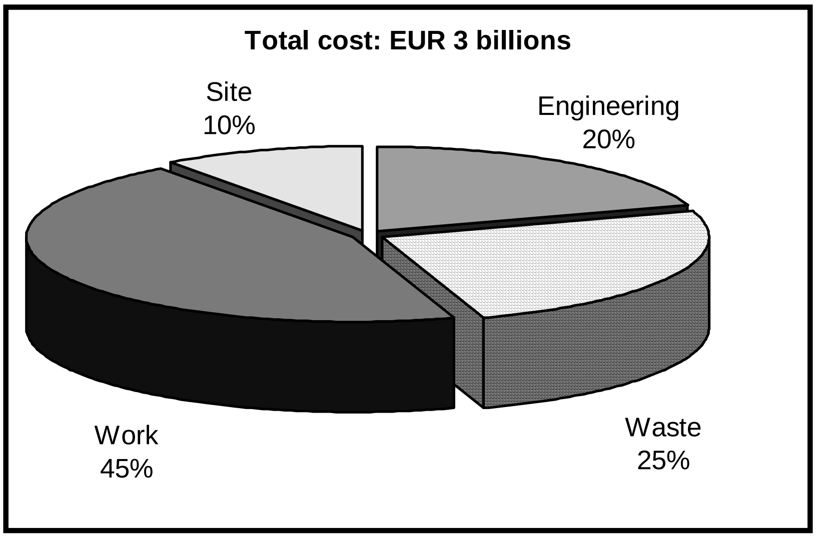
2) The second stage includes:

   – Dismantling of 5 GCR units: Saint-Laurent A1 and A2, Chinon A1, A2 and A3.

   – Final dismantling of Chooz A and Bugey 1 in 2025.

Figure 1. Programme cost breakdown





The successful implementation of this programme relies on:

- The simplification of regulatory processes and procedures (3 authorisations were recently needed to cover all the decommissioning and dismantling process).
- The availability of treatment, conditioning and disposal facilities for specific categories of wastes (graphite, sodium, long-lived, etc.).
- An effective nuclear industry (contractors and suppliers) that will guarantee the technical, cost and schedule aspects of this programme will be met.

Availability of waste management solutions on time is of the utmost importance. Among them, the main, critical issues are:

- Opening of a very low level wastes disposal in 2003 (130 000 tons).
- Opening of a new disposal site for graphite and radiferous wastes (17 000 tons) in 2010.
- Opening in 2007-2008 of a centralised interim storage facility for long-lived medium level wastes (500 tons including filters, control rods, reactor internals for example).

In order to secure the execution of the decommissioning and dismantling programme EDF is considering the possibility to construct "buffer" storage facilities on site to mitigate the impact of potential delays in the licensing and commissioning of the new facilities.

Regarding the closely concerned and related issue, namely disposal of high-level radioactive waste (HLW), the so-called "1991 Bataille" Law identified three prospective avenues that are to be investigated by 2006. Waste transmutation (CEA lead with assistance from EDF), sub-surface storage (CEA lead), and deep geological disposal (under ANDRA responsibility). These possibilities are all open and under investigation, at present. EDF intends to be active in all issues.

Because its responsibility as nuclear operator is at stakes, but also because *in fine* it will have to bear the cost of waste disposal, EDF is becoming more and more involved in all these projects.

The regulatory process for de-licensing has recently been simplified. Whereas, until recently, 3 authorisations were needed to cover all the decommissioning and dismantling process, now only one decree is required. To obtain this decree, a safety case has to be elaborated and submitted to the Safety Authority. It comprises the following documents:

- Justification of final state of the site and main steps of the dismantling process;
- Safety analysis report;
- Operating rules for monitoring and maintenance;
- Emergency plan;
- Environmental impact assessment;
- Waste management studies.

To avoid to apply for a new decree when minor modifications are required, which will undoubtedly occur within such a long and complex process, an internal organisation has been set up by EDF and accepted by the French regulatory body to deliver internal authorisations for modification of the safety analysis report and the operating rules as far as they remain in accordance with the safety case submitted for the issuance of the dismantling decree. For each modification a safety analysis has to be documented and reviewed by an internal committee whose members are not involved in the operation of the plant. The authorisation is delivered by the operator of the plant taking into account the recommendations of the committee. French safety authorities have to be informed after the authorisation has been delivered and they can audit this committee.

Conclusion

With its new strategy for the decommissioning and dismantling of its first generation of nuclear power plants and with its subsequent implementation, EDF will demonstrate its ability to manage the technical aspects of dismantling and its associated wastes as well as its financial aspects by funding all dismantling costs. It will thus prove its competence for an efficient management of the life cycle of nuclear power plants.

SESSION IV: OTHER FUEL CYCLE FACILITIES

THE UP1 DECOMMISSIONING PROGRAMME AT THE COGEMA-MARCOULE SITE STRATEGIC APPROACH

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Abstract

Commissioned in 1958, UP1 plant is located on COGEMA Marcoule site in southern France along the Rhone River. It reprocessed first spent fuels from plutonium producing reactors for Ministry of Defence and later, spent fuels from commercial GCR gas cooled-graphite reactors for the CEA, EDF and others COGEMA clients such as Hifrensa for a total of about 18 600 metric tons. The plant production was officially stopped by the end of 1997 and followed immediately by a major decommissioning project which is still now underway. In this presentation we will first provide an overview of the activities on the site before targeting on some key issues to illustrate the choice of the decommissioning strategy.

1. Introduction

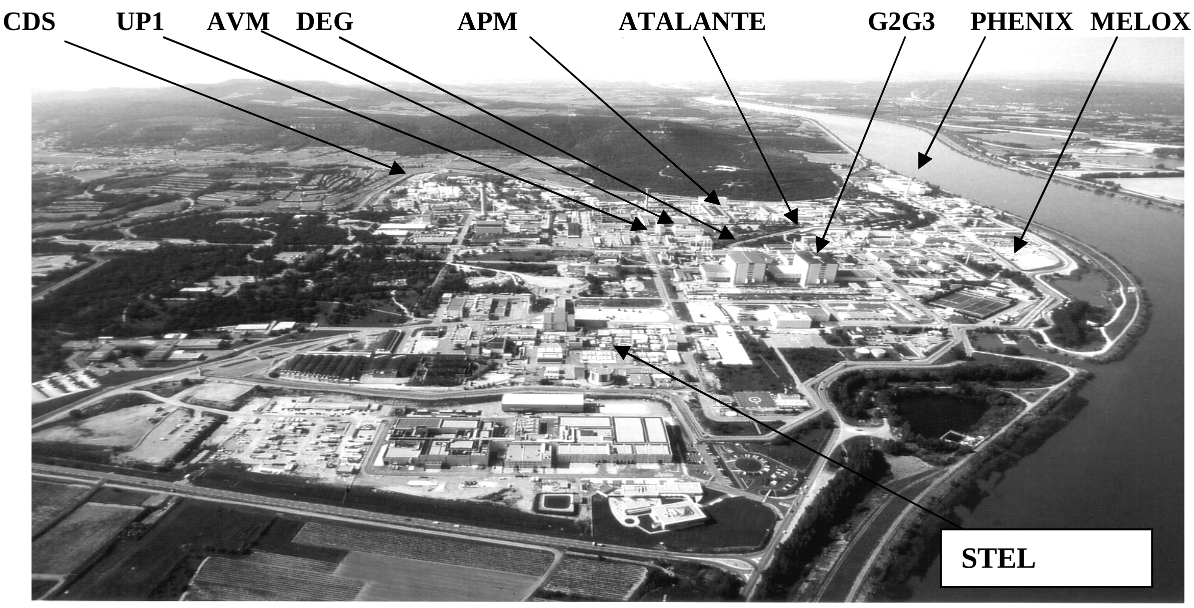
Marcoule site (Figure 1) includes mainly CEA (ATALANTE laboratories, APM pilot reprocessing plant, G reactors and Phenix FBR) as well as COGEMA facilities (UP1 reprocessing plant, MELOX fuel fabrication plant, solid and liquid waste treatment installation). In 1996, CODEM (a joint venture 45% CEA – 45% EDF – 10% COGEMA) was created to manage the decommissioning operations engaged after the end of production of UP1. It is the decision making, funding and supervising entity. The facilities within the scope of the decommissioning operations are:

- The production facilities such as decladding facilities (DEG), (MAR400) and the UP1 reprocessing plant.
- The support facilities such as a solid waste treatment facility called (CDS), liquid waste treatment facilities (STEL) and a fission product vitrification facility (AVM).
- The interim storages.

The decommissioning operations cover two major programmes:

- The final shutdown and dismantling of the production and support facilities.
- The retrieval and repackaging of historical onsite waste.

Figure 1. Marcoule site



2. Overview of the decommissioning operations

2.1 The final shutdown and dismantling programme

The final shutdown operations consist in rinsing by conventional and specific reactants process circuitry, if necessary using mechanical processes and even sometimes in evacuating the equipments. The main objectives of this phase are to reduce the residual activity level, in order to limit the collective dose during the dismantling phase, to optimise waste management and reduce surveillance requirements and associated costs to place under safe conditions the installations.

The current status mid-2003 is illustrated below by some key numbers:

- 1 500 TBq (β,γ) and 20 kg of plutonium removed (around 85% of the total estimated activity);
- 2 000 tons of equipments evacuated (over a total of 5 000 tons of equipments and 20 000 tons of structures);
- 11 000 m^3 of effluents;
- 5 400 m^3 of waste (90% LLW to ANDRA surface disposal, 5% ILW, 5% VLLW);
- 335 000 working hours.

Some examples will be shown during the presentation.

The dismantling programme covers all the decontamination and evacuation material operations for all kinds of facilities to lower the residual activity at a level compatible with the elimination of radio logically restricted access zones and then putting in place the adequate surveillance means.

2.2 The retrieval and repackaging of historical onsite waste

This programme involves the retrieval, sorting, treatment and conditioning of historical waste. In addition with the waste issued from the final shutdown and dismantling operations, the UP1 plant processed from 1958 till 1997 numerous types of fuel and generated a large variety of waste, most of which are still temporarily stored on the site. The waste can be classified in different families:

- 60 000 bitumen drums;
- 500 m^3 of process waste stored under water (resins, diatoms, zeolites, powdered graphite and sludge);
- 2 900 tons of structural waste in dry interim storages (magnesium, graphite core, metallic structural material);
- 26 tons of technological alpha waste (resins, ashes, technological waste).

The waste is stored in multiple areas and configurations. Activities and degree of knowledge are very variable and characterization is the preliminary step, before either conditioning and sending them to the right outlet. This programme is planned to last at least 20 years. As a priority the pits of the North West zone, where 6 000 bitumen drums produced between 1966 and 1978 are temporally stored, have been selected and the operation is underway to be planned to be finished in 2007. Another important retrieval operation that should start in 2004 is the transfer of process waste (mixture of 120 m^3 of graphite, zeolites and sludge) from two pits of the old decladding facility (DEG) to pits of the newer one (MAR400).

3. Main issues concerning the UP1 decommissioning strategic approach

Reference scenario

The decontamination and dismantling operations will last more than 30-40 years. The selected strategy is an immediate dismantling due to the fact that radio nuclides are long-life types (Cs, Pu) compared with deferred strategy (reactor case with Co). The final shutdown of the production facilities is the predominant aspect in the first years and will be followed by dismantling phase till 2020. Then after 2020, the final shutdown and dismantling of the support facilities will occur. The waste retrieval and conditioning programme is beginning with few limited operations and should increase over the next decade and last over the end of the project.

Organization and funding

CODEM, as the client, is the decision-making, financing and supervising entity for the decommissioning operations and the implementation of the programme is assigned to COGEMA as the nuclear operator and also industrial contractor. COGEMA set up the appropriate organizational structure needed for the decommissioning task force by dedicating a decommissioning team gathering complementary cultures with sufficient resources. The forecast total cost of the decommissioning project is EUR 5.6 billion shared in 53% for the final shutdown and dismantling operations and 47% for waste retrieval and conditioning.

Waste and effluent management

The main objectives are to transfer the waste as soon as possible to the ANDRA disposal site in order to minimize interim storage requirements and costs. Effluents and waste generated during the UP1 decommissioning will be processed and conditioned in the existing facilities:

- Vitrification facility and Liquid treatment station (evaporation, bitumization) for the effluents;
- Different treatment and conditioning for the solid waste following the nature (steel, concrete, lead, induced waste, etc.) and activity (ILW, LLW, VLLW, conventional).

Processes and techniques

Process equipment are first rinsed with conventional reactants (HNO3, NaOH), generally followed by specific ones such as potassium permanganate, oxalic acid and HF or cerium (IV). For dismantling, on shelf techniques are commonly used (saw, grinder, shear, etc.). In case of severe environment, remote operating techniques are implemented such as carriers, dexterous arms and telescoping masts.

Safety case issues

Till end of 2002, from a regulatory point of view a decommissioning project was mainly composed of two phases called the final shutdown and dismantling. For Marcoule site, there was the necessity to get two authorizations (one for final shutdown and one for dismantling) and a lot of authorizations to cover the different jobsites. The consequences were delays in the dismantling operations. To day the French safety authority wants to integrate the feed-back of several French decommissioning projects and published in early 2003 new regulatory procedures. It is planned to cover all the decommissioning operations in a unique dismantling decree for civil basic nuclear installations, thus simplifying the regulatory framework.

4. Conclusions

UP1 decommissioning programme is an important industrial operation undergoing in France, due to its size, duration and cost. The complexity of the operations is due to the diversity of nature of the cells, to the presence of alpha contamination and areas with high residual radioactivity levels and to the great variety of waste to be treated and conditioned. The rinsing phase is now close to be over and results concerning the removal of fissile material are better than expected. Even if some difficult jobsites are still there, the current status of the decommissioning operations are in coherence with the global planning.

DECONTAMINATION AND DECOMMISSIONING AT THE WEST VALLEY DEMONSTRATION PROJECT

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Introduction

The West Valley Demonstration Project (WVDP, or Project), in accordance with the WVDP Act of 1980 (Public Law 96-368), was established to demonstrate the solidification of high-level waste (HLW). The Project is on the site of the only commercial spent nuclear fuel reprocessing facility ever to operate in the United States. It was operated by Nuclear Fuel Services (NFS) from 1966 to 1972 under a US Nuclear Regulatory Commission (NRC) license. During that time approximately 640 metric tons of spent fuel were reprocessed, generating approximately 600 000 gallons of liquid HLW, which was placed into two underground storage tanks. In 1972, NFS stopped operations to complete plant modifications. Four years later, NFS decided to cease operations permanently and return the site to the State of New York, in accordance with the lease agreement for the site. The 3 300 acre site is owned by New York State Energy Research and Development Authority (NYSERDA) and includes an NRC-licensed burial ground and a state-licensed (as an agreement state) burial ground.

The WVDP Act states that the Secretary of the US Department of Energy (DOE) shall carry out the following activities:

- Solidify, in a form suitable for transportation and disposal, the HLW by vitrification or by such other technology which the Secretary determines to be the most effective for solidification.
- Develop containers suitable for the permanent disposal of the solidified HLW.
- As soon as feasible, transport, in accordance with applicable provisions of law, the waste solidified at the Western New York Nuclear Service Center (WNYNSC) to an appropriate Federal repository for permanent disposal.

* The views expressed by the authors are their own and do not necessarily represent the views of the US Government, the US Department of Energy, the State of New York, or any of its agencies. This document has undergone Export Control Review and has been approved for general release.

- In accordance with applicable licensing requirements, dispose of low-level radioactive waste (LLW) and transuranic (TRU) waste produced by the solidification of the HLW under the Project.

- Decontaminate and decommission the tanks and other facilities of the WNYNSC in which the HLW was stored, the facilities used in the solidification of the waste, and any material and hardware used in connection with the Project, in accordance with such requirements as the (Nuclear Regulatory) Commission may prescribe.

DOE assumed operational control of the approximately 200 acre Project Premises on 26 February 1982, including the NRC licensed burial ground (for which NYSERDA, and not DOE, remains responsible). The Project Premises exclude the state licensed burial ground for which NYSERDA is fully responsible.

The development of containers for the permanent disposal of HLW and solidification of the liquid HLW have been completed. Efforts are now focused on transitioning to the decontamination, waste management, and decommissioning phases of the Project. Several critical activities are in progress to support this important transition.

The final end-state of the Project will be decided following completion of a National Environmental Policy Act (NEPA) process being jointly conducted by the DOE and NYSERDA regarding decommissioning and/or long-term stewardship of the WVDP and the WNYNSC.

The Project work scope is now directed toward reducing the highest long-term radiological risks at the WVDP by completing decontamination work aimed at eventually meeting the NRC's long-term peak dose License Termination Rule (LTR) criteria for the WVDP while final decommissioning options are evaluated. This will position the WVDP at the initial conditions for proceeding with final decommissioning in terms of the minimal amount of source term that requires removal. The curie inventory characterization effort now in progress will provide a basis for future decontamination and decommissioning decisions.

Regulatory strategy

The US commercial nuclear industry's activities are regulated by the US NRC, US Environmental Protection Agency (EPA), US Department of Transportation (DOT) and the State governments. However, in general, the NRC does not have regulatory jurisdiction at DOE sites.

The DOE is self regulating and has established a series of DOE Orders for the production, use and management of radioactive materials, some of which have been codified under Title 10 of the Code of Federal Regulations. Operations at the WVDP are conducted in accordance with DOE Orders and regulations. For the duration of the Demonstration Project, DOE, EPA and the State (through the New York State Department of Environmental Conservation, New York State Department of Health, and New York State Department of Labor) have primary regulatory authority at the site, with NRC having a consultative role.

The NRC's role at the WVDP stems from its regulation of the former reprocessing plant at West Valley under Operating License CSF-1. Under the provision of the WVDP Act, the NRC has an informal review and consultation role at the WVDP. Currently the technical specifications of the NRC license are held in abeyance while DOE conducts the WVDP. Upon completion of the DOE project NYSERDA's NRC license will be reactivated and operational responsibility returned to NYSERDA.

In accordance with NEPA, on 2 July 1982, DOE issued a Final Environmental Impact Statement (EIS) to assess alternatives for solidifying the liquid HLW. DOE issued a Record of Decision (ROD) on 9 September 1982, to solidify the HLW. An EIS for Waste Management has been prepared and is in the final stages of review. Another EIS for evaluating decommissioning alternatives for the WVDP is under preparation.

A brief summary of the regulatory and stakeholder agreements relating to WVDP activities is as follows:

1) **Cooperative Agreement between DOE and NYSERDA**: Signed in October 1980 and amended in September 1981, this agreement allows DOE exclusive use and control of the WVDP Project Premises and facilities for the purposes and duration of the Project. In addition, this agreement sets forth specific definitions, roles, and responsibilities applicable to the Project, use of facilities and Project completion.

2) **Memorandum of Understanding (MOU) between DOE and NRC**: Published in the Federal Register in September 1981, this memorandum defines roles, responsibilities, terms and conditions agreed to by the DOE and NRC regarding NRC's review and consultation role during the course of the Project.

3) **Stipulation of Compromise Settlement**: Reached in May 1987, this settlement represents the out-of-court settlement reached between the Coalition on West Valley Nuclear Waste and Radioactive Waste Campaign and the DOE regarding preparation and issuance of a comprehensive EIS for the Project prior to on and off-site disposal of certain low-level waste (LLW).

4) **Supplemental Agreement to the Cooperative Agreement**: Signed in February 1991, this supplemental agreement sets forth special provisions for the preparation of a joint EIS between the DOE and New York State for the site as a whole, including areas for which NYSERDA retains responsibility.

5) **Resource Conservation and Recovery Act (RCRA) 3008(h) Administrative Order on Consent**: Expanded and signed in March 1992, this four-party agreement between the US EPA, New York State Department of Environmental Conservation (NYSDEC), DOE and NYSERDA includes a requirement for DOE to complete RCRA facility investigations and conduct RCRA corrective measures/studies for RCRA-regulated solid waste management units (SWMUs) on the Project Premises.

6) **Federal and State Facility Compliance Agreement (FSFCA) and Addendum**: This legal agreement was entered into by DOE, EPA, WVNSCO, NYSERDA and NYSDEC in March 1993 to plan and schedule activities to meet RCRA requirements for storage and characterization analyses of mixed wastes at the WVDP. The original five-year agreement was extended one year by addendum and was fully executed and terminated by March 1999.

7) **Cooperative Agreement between the Seneca Nation of Indians and OH/WVDP**: Signed in June 1996, this agreement establishes a framework for inter-governmental relationships between the Seneca Nation of Indians and the DOE with respect to Project activities.

8) **DOE-HQ Waste Management Programmatic Environmental Impact Statement Record of Decision (WM PEIS, DOE/EIS-0200-F)**: Issued in May 1997, this Complex-

wide ROD for disposal of DOE waste allows for the disposition of Project LLW at disposal sites within the DOE Complex, off the Project Premises.

Decontamination project strategy

In January 2002, the NRC issued its Final Policy Statement on "Decommissioning Criteria for the West Valley Demonstration Project at the West Valley Site". These criteria are based upon established LTR criteria applied to NRC licensees.

Activities mandated in the Act that pertain to HLW solidification were completed in September 2002. Activities that remain to be carried out involve dispositioning LLW and TRU generated by solidifying HLW, and decontaminating and decommissioning tanks, facilities, material and hardware used to conduct the Project.

The project strategy is to perform decontamination activities necessary to meet NRC's long-term peak dose LTR criteria for WVDP without biasing the potential EIS decommissioning alternatives. Existing characterization data (curie estimates) were used for identifying cells/areas containing the highest curie inventory of long-lived radioisotopes which also represent the highest long-term radiological risks remaining at the WVDP. These data enabled selection and prioritization of decontamination scopes that would be necessary and sufficient for meeting the NRC's long term peak dose LTR criteria for these facilities. The adequacy of the decontamination effort will be demonstrated through characterization and performance assessment modelling of the site. In addition to risk reduction, this strategy will provide a basis for any future decontamination decisions through the curie inventory characterization efforts now in progress.

The DOE defines TRU waste as that which contains greater than 100nCi/g of alpha emitting isotopes with atomic numbers greater than 92 and half lives greater than 20 years. It can be considered analogous with the European plutonium contaminated material (PCM) waste category. A Remote-Handled Waste Facility is under construction for processing TRU and high-activity wastes.

In implementing this strategy, the single most important aspect of the WVDP is safety and the protection of the public, workforce, and environment. The Integrated Safety Management System (ISMS) at the WVDP provides the necessary structure to ensure that any work activity that could potentially affect the public, workforce, or environment is completed safely in compliance with DOE Orders.

The strategy is being carried out successfully by accomplishing the following objectives:

- Completing the safe lay-up of the HLW Waste Tank Farm and Vitrification Facility following the completion of Vitrification of HLW.

- Completing the confirmatory curie-inventory characterization of the reprocessing plant, vitrification facility and the waste tank farm.

- Decontaminating Project facilities to the extent necessary to eventually meet NRC's long-term peak dose LTR criteria for WVDP and disposing Project-generated LLW and TRU waste.

- Completing construction of and obtaining approval to operate the Remote-Handled Waste Facility (RHWF) needed for the safe processing of Project TRU waste and high-activity waste.

- Completing the preparation and issuance of an EIS/ROD for Waste Management at the WVDP and dispositioning LLW consistent with the ROD.

- Completing the preparation and issuance of an EIS/ROD for Decommissioning and/or Long-Term Stewardship at the WVDP and WNYNSC.

- Completing the remaining DOE scopes consistent with the ROD for Decommissioning and/or Long-Term Stewardship at the WVDP and WNYNSC.

Decontamination project delivery

Successful completion of the WVDP is directly related to eliminating or reducing long-term radiological hazards and risks at the WVDP to the extent needed to ensure the health and safety of the public and the environment. Completion of the solidification of HLW into a waste form that can be transported to a Federal Repository (for long-term deep geological disposal) marks a point of considerable progress towards completing the WVDP. Decontamination activities are now being performed to eliminate or reduce the most significant long-term hazards and risks remaining at the WVDP. This is being accomplished by decontaminating facility areas that have the highest inventory of long-lived radionuclides and thus pose the greatest potential risk to the public and the environment. Attention is also given to preparing current and future LLW and TRU waste inventories for shipping and disposal; disposing legacy waste inventories consistent with storage capacity; and managing facilities and resources needed to conduct work and maintain the site in a safe and stable condition.

Work scopes have been developed to accomplish the objectives directly related to radiological hazard and risk reduction. Decontamination of portions of the former PUREX plant and associated facilities included removal of:

- 21 000 linear feet of pipe.

- 70 tons of tanks and equipment.

- 20 major vessels.

- 144 pipe connectors, a remotely operated crane, two 22.5-ton concrete pedestals, plutonium product tanks and a plutonium evaporator.

Reduction of long-term radiological risks and peak dose by removal of long-lived radionuclides has been achieved or is in progress in the following areas:

- Head End Cells (HEC) has been 80% cleared of spent fuel debris and major contaminated equipment.

- Chemical Process Cell (CPC), which housed the former fuel dissolution equipment, has been cleared of equipment, vessels and pipe work, decontaminated and is now used to house the vitrified waste canisters pending transportation to a Federal repository.

- Uranium and Plutonium product cells have been cleared of equipment, vessels and pipe, and the surfaces have been decontaminated.

- Spent fuel has been removed from the spent fuel pool, and the pool drained and decontaminated.

- Primary separation cells are undergoing equipment, vessel and pipe removal activities.

- Construction of the Remote-Handled Waste Facility for remote packaging of LLW, Contact-Handled and Remote-Handled TRU waste (CH-TRU and RH-TRU) including Non-Destructive Assay and Destructive Assay in the form of confirmatory sampling, video logging, data tracking and computer modelling of waste forms. This will facilitate off-site disposal of long-lived curies.

Conclusion

A major milestone related to the WVDP mission has been the completion of the solidification of the liquid HLW resultant from former reprocessing operations. Activities are now focused on reducing the remaining long-term radiological hazards and risks at the WVDP. This is being accomplished primarily by removing the radionuclide source term from the host facilities in the former PUREX reprocessing plant, to the extent required in order to eventually meet the long-term peak dose LTR criteria for the WVDP through a performance-based model. This will position the WVDP to the initial conditions for proceeding with final decommissioning in terms of the minimal amount of source term that requires removal (restricted release) or further decontamination towards an unrestricted release option.

To date, 600 000 gallons of HLW have been solidified into 275 HLW canisters and about 20 000 LLW cement drums, currently in interim storage onsite. The HLW canisters are awaiting availability of the Federal Repository. The LLW drums will be disposed of in accordance with the Waste Management EIS/ROD currently in preparation. The bulk of the Head End and Separation and Product Cells have been decontaminated and a new Remote-Handled Waste Facility is near completion for the assay, size reduction and packaging for shipment of all solid wastes generated. This includes LLW (inclusive of the European ILW classification) and TRU waste.

Acronyms and abbreviations

CH-TRU	Contact Handled Transuranic
DOE	United States Department of Energy
EPA	United States Environmental Protection Agency
EIS	Environmental Impact Statement
HEC	Head End Cells
HLW	High-Level Waste
ISMS	Integrated Safety Management System
LLW	Low-Level Waste
LTR	License Termination Rule
NEPA	National Environmental Policy Act
NFS	Nuclear Fuel Services
NRC	United States Nuclear Regulatory Commission
NYSDEC	New York State Department of Environmental Conservation
NYSERDA	New York State Energy Research and Development Authority
NYSDOH	New York State Department of Health
NYSDOL	New York State Department of Labor
RCRA	Resource Conservation and Recovery Act
RH-TRU	Remote Handled Transuranic
RHWF	Remote-Handled Waste Facility
ROD	Record of Decision
TRU	Transuranic
WNYNSC	Western New York Nuclear Service Center
WVDP	West Valley Demonstration Project
WVNSCO	West Valley Nuclear Services Company

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[3] Stipulation of Compromise Settlement, Civil No. 86-1052-C, United States District Court, Western District of New York, 27 May 1987.

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DECOMMISSIONING STRATEGY FOR BRENNILIS FRANCE

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Brennilis is a heavy water moderated – gas cooled reactor with a capacity of 70 MWe. It is located in Brittany and has been jointly operated from 1967 to 1985 by EDF and CEA as an industrial prototype.

The reactor was definitely shutdown in 1985. At that time, the decommissioning strategy was to reach the level 2 defined by IAEA for the decommissioning of nuclear facilities, i.e. partial and conditional release of the installation, about ten years after final shutdown and then leave the reactor building in safestore condition for about 30 to 40 years to benefit from radioactive decay.

Final shutdown activities

The final shutdown activities, including unloading of the fuel and drainage of the circuits, started immediately after shutdown and by 1992, the IAEA defined level 1 of decommissioning, i.e. final closure, was reached.

Heavy water was evacuated in 1994 and spent fuel was removed from the site and sent to Marcoule UP1 reprocessing plant. Now, all the spent fuel has been reprocessed, solving the issue of spent fuel storage.

Partial dismantling activities

In 1996 EDF and CEA got the authorization to start the partial dismantling of the plant with the objective to reach IAEA defined level 2 of decommissioning in 2003. The activities performed during this period included dismantling of auxiliary buildings as well as the confinement and surveillance of the part of the installations surrounding the reactor.

For this decommissioning stage the basic steps were the following:

1) electrical and mechanical equipment dismantling;

2) concrete decontamination;

3) demolition.

For the dismantling of electrical and mechanical equipment, a specific approach was developed in order to minimise risks and workers exposition during dismantling activities. The electromechanical equipment was characterised into several categories: very low level wastes, low level waste, non-contaminated. Then each category was identified and painted in different colours in order to facilitate the sorting of the dismantling wastes.

Regarding concrete decontamination, a new methodology was developed and tested in Brennilis as a pilot work site. The required decontamination, i.e. concrete thickness to be removed by scrabbling techniques, was defined on the basis of expert appraisal, taking into consideration the design of the installations, the operating history including in particular identification of possible incidents as well as radiological inspections and observations made or experts appraisals carried out on the state of the concrete. This analysis then leads to a classification of the surfaces according to their potential contamination level, in several categories corresponding to suitable processing. If necessary, a preliminary cleanup is carried out beforehand in order to allow a more reliable expert appraisal and to define the depths to which contamination has penetrated.

After cleanup, radiological inspections are performed in order to verify the conventional nature of the remaining sections. They consist in very low level activity measurements to to check the absence of surface contamination or residual mass activity with target values of 0.4 Bq/cm^2 or 0.4 Bq/g respectively.

This methodology was implemented for the decontamination of the solid waste storage building at Brennilis site. After removal of contamination and, further to the approval of its declassification by safety authority, the building was demolished in spring 2002 using conventional techniques.

The cleanup of other facilities at Brennilis like the liquid wastes treatment plant and spent fuel storage was carried out in 2003.

Final dismantling activities

Because the plant is located in a place that is now a regional natural park, as early as 1999, both the CEA and EDF announced their decision to proceed to stage 3 of decommissioning without waiting for a 30-40 years safestore period. This last dismantling stage should be reached by 2015. At that time, Brennilis will be the first commercial reactor in France to be fully dismantled.

Due to this new strategy, the completion of level 2 decommissioning activities has been delayed to 2006, giving the priority to the anticipation of final dismantling studies.

The preparatory works for the final dismantling will start by the end of 2003. They include the dismantling of heavy components like CO_2 heat exchangers and miscellaneous circuits and structures surrounding the reactor vessel. The objective is to get access to the reactor vessel and to provide room for the logistics that will be necessary to dismantle the reactor vessel and to package the generated wastes.

The studies for the dismantling of the reactor vessel have started and the works are planned to start in 2007 for completion by 2012. Then the reactor building will be decontaminated and by 2015 the site will be release from regulatory control.

DECOMMISSIONING OF SIX GERMAN FUEL CYCLE FACILITIES

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Abstract introduction

The decommissioning of six fuel cycle facilities from Siemens AG and Nukem Hanau GmbH located at Hanau and Karlstein, Germany, provides a unique platform of experience. Five fuel fabrication plants, which had supplied fuel for research and pilot reactors as well as to commercial nuclear power plants, are in various stages of decommissioning. The fuel processed in the relevant facility, had either been Thorium, low and high enriched Uranium or even Plutonium. A hot cell research complex complemented these fuel facilities, where post-irradiation examinations on all kind of fuel had been performed.

Research on plutonium-bearing fuel started as early as in 1965 and since then about 9 000 kg Plutonium has been processed. In the late sixties fuel fabrication commenced on a commercial basis under license agreement with US-based companies General Electric and Westinghouse.

The pilot fuel fabrication plants of Nukem were mainly involved in the fabrication of fuel for research reactors, including of coated particles for spherical HTR fuel. Late Eighties, beginning Nineties, the facilities were shut, partly due to political reasons and cleaned out, and decommissioning started immediately thereafter. No advantage can be gained by mothballing fuel cycle facilities because of the long-lived fissile isotopes. More than 2 000 highly specialized engineers and workers as well as a similar number of employees in the supporting industries lost their job. In total more than EUR 1 billion will be spent for obtaining “green meadow” including disposition of radioactive waste in deep underground disposal.

Except for the hot cell complex, where local dose rate could be as high as several hundreds of Sv/h the major challenge in decommissioning of nuclear fuel facilities, is the predominance of α-particle contamination rather than high radiation fields. All effort has to be focused on preventing α-particles leaking outside their foreseen containment and thus, reducing the risk of incorporation. To a lesser extent, special criticality precautions may be required also during the decommissioning phase. Another tricky item is the procedure of free release measurement. Free release applications of buildings, concrete rubble, metals and other material belonging to a nuclear facility has not only to step over high technological thresholds, but also over public acceptance hurdles.

Strategic factors

The following decommissioning strategy selection is based on the perspective of an implementer. The selection is not based on priority consideration nor does it claim completeness. It should be understood as a box full of notes and ideas collected during the process of decommissioning. Careful and systematic analysis of safety and protections aspects of decommissioning techniques has been documented already earlier, for example in the IAEA-technical reports. It is the conviction of the authors of this paper that useful lessons can be drawn from such reports, however an ongoing decommissioning project can confront the decommissioning team with situation, which need individual strategies and tailor-made solutions.

List of strategic issues during decommissioning of six fuel cycle facilities:

- Clean and remove equipment as extensive as possible during the pre-decommissioning phase under the existing license; do not expect restrictions will be considerably lifted when production ends and activity inventory is reduced.

- Apply proven technique and tools; avoid the "not invented here"-argument of your employees.

- Focus all considerations about decommissioning techniques, packaging, logistics, documentation etc. on long-term, maintenance-free interim storage and final disposal requirements; final disposal will not come as early as you may wish and it will be more expensive as you may imagine.

- Assay accurately the fissile material hold-up, not only to avoid criticality hazards but also to optimize the decommissioning process with respect to occupational dose rate, waste separation, homogeneity of fissile material within the waste matrix, etc.

- Rely on your experienced employees at least for the initial phase; however, they will expect from you a comprehensible explanation/vision, why they should remain on a sinking ship (time aspects, motivation, transfer concepts, social plan, etc.).

- Inform on a regular basis involved authorities and their experts about progress and further plans of your projects in order to give them guidelines to plan manpower and competence; long-term availability of personnel is sometimes underestimated for decommissioning projects.

- Accept or even encourage the dialogue with competent opponents having high public reputation; do not ignore ideological foes, but do not invest in convincing them.

- Fight at the beginning for your project for a sufficiently allocated lifetime budget/reserves.

The authors will outline some of the above-mentioned issues in more detail during the presentation.

Decommissioning technique and tools

Whereas the two facilities of Siemens AG in Hanau are currently in the stage of dismantling of installations, the complete contamination and dismantling of the former Nukem Hanau fuel production facilities took already place in the last years. Currently comprehensive soil and groundwater remediation activities are under way. Therefore, the experiences made up to date can be used for a discussion of suitable decontamination and demolition techniques.

After the removal of all installations, a comprehensive contamination mapping of all surfaces was done by using *in situ* Gamma Spectroscopy and a manual contamination monitor for areas, which are difficult to access. Particular attention was given to the geometrical reference model of the measurement to ensure that highly contaminated spots can be marked exactly for special treatment. Analysis of samples provided the necessary data for the depth of contamination.

After the assessment of the contamination condition together with the regulator, the various decontamination techniques were defined. The most influencing parameters were the commercial aspects of the technology, the necessary approval processes by the regulatory body, the applicability and last but not least the related ratio of radioactive waste compared to low level and conventional waste volumes of the various techniques.

With respect to the inhomogeneous contamination condition of the structures that usually occurs in fuel production facilities different techniques were used for the decontamination and dismantling:

- fixation of volatile contaminations with decontamination coatings;
- washing of contamination from smooth surfaces;
- caulking of local concentrations of contamination;
- milling of contaminated large surfaces;
- steel sandblasting for metal and painted parts.

After the demolition of the released buildings with dust-avoiding techniques, the decontamination of the ground and the ground water was necessary. For both objectives, industrial processes were developed in order to handle the huge volumes of material in acceptable time periods.

Finally, the waste management had to be defined together with the authorities. In order to optimize the cost of waste management, several disposal streams have been defined including long-term storage, landfill repository and recycling of free released material.

The authors will discuss some of the applied technologies and corresponding experiences in detail during the presentation.

HEMATITE NUCLEAR FUEL CYCLE FACILITY DECOMMISSIONING

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Overview

Westinghouse Electric Company LLC ("Westinghouse") acquired a nuclear fuel processing plant at Hematite, Missouri ("Hematite", the "Facility", or the "Plant") in April 2000. The plant has subsequently been closed, and its operations have been relocated to a newer, larger facility. Westinghouse has announced plans to complete its clean-up, decommissioning, and license retirement in a safe, socially responsible, and environmentally sound manner as required by internal policies, as well as those of its parent company, British Nuclear Fuels plc. ("BNFL"). Preliminary investigations have revealed the presence of environmental contamination in various areas of the facility and grounds, including both radioactive contamination and various other substances related to the nuclear fuel processing operations. The disparity in regulatory requirements for radiological and non-radiological contaminants, the variety of historic and recent operations, and the number of previous owners working under various contractual arrangements for both governmental and private concerns has resulted in a complex project. This paper discusses Westinghouse's efforts to develop and implement a comprehensive decontamination and decommissioning (D&D) strategy for the facility and grounds.

Ownership history

The Mallinckrodt Chemical Works ("Mallinckrodt") became the first large-scale producer of uranium oxide for the United States' atomic energy programme in 1942. In 1956, Mallinckrodt constructed and began operating a fuel processing facility at Hematite, which is approximately 35 miles south of St. Louis, Missouri. In April 1961, Mallinckrodt, Nuclear Development Corporation of America, and Olin Mathieson Chemical Corporation formed a joint venture, United Nuclear Corporation ("UNC"), to become the first integrated nuclear service organization in the country. UNC primarily served the federal government's nuclear fuel production needs, and some commercial customers, from the Hematite facility. In 1970, UNC and Gulf Nuclear Corporation entered into a joint venture, Gulf United Nuclear Fuels Corporation ("Gulf"), which owned and operated the Hematite Plant in a similar capacity until the spring of 1974. Late in 1973, Gulf announced that it was discontinuing certain aspects of its nuclear fuel business, and consequently offered Hematite for sale. Combustion Engineering Corp. ("CE") purchased the Hematite Facility in May 1974, and began operating it as a commercial nuclear fuel cycle facility. Ownership again changed hands in 1989, when Asea Brown Boveri ("ABB") purchased the stock of CE and expanded the facility's commercial operations. Finally, in April 2000, Westinghouse Electric Company LLC purchased the global nuclear operations of ABB, subsequently closing the Hematite facility.

Production history

Throughout its history, Hematite's primary function has been to manufacture uranium metal and uranium compounds from natural and enriched uranium for use as nuclear fuel. Specifically, Hematite was initially used to convert government-owned and leased uranium hexafluoride ("UF_6") gas with high to low ^{235}U enrichment into uranium oxide, uranium carbide, uranium dioxide ("UO_2") pellets, and uranium metal. These products were manufactured for use by the federal government and government contractors and by commercial and research reactors approved by the US Atomic Energy Commission ("AEC"). Research and development was also conducted at the Plant, as were uranium scrap recovery processes. Government projects dominated the operations at Hematite until Gulf terminated its operations there in 1974.

CE purchased the facility in 1974 and began converting UF_6 gas having less than 5% ^{235}U into UO_2 powder for use in commercial nuclear power reactors. Uranium scrap recovery processes were continued to support manufacturing operations. Powder was shipped to CE's facility in Windsor, Connecticut for pelletization and fuel assembly fabrication, although Hematite was able to manufacture pellets in a reserve capacity.

The Plant employed approximately 50 people working in 8 separate process and support buildings within a 5 acre security fence until the mid-1980s. CE then added a warehouse, support building, and two pellet manufacturing lines in the late 1980s, and transferred its load from the Windsor plant to Hematite. ABB brought the facility to its final manufacturing configuration when it added a fuel assembly fabrication building in 1992 and closed its Windsor plant. These construction campaigns and additional load significantly changed the facility's configuration to 6 contiguous radiological process buildings, a separate fuel fabrication building, and 3 separate support buildings employing approximately 225 people within a 7,5 acre security fence.

On-site disposal

Beginning no later than 1965, and perhaps as early as 1958 or 1959, and continuing at least until November of 1970, on-site burial was used as a means of disposal of contaminated materials and waste at Hematite. From 1965 until 1971, up to 40 large unlined pits were dug east of the Plant buildings. These pits were used to dispose of materials and waste generated by the Plant processes, potentially including tetrachloroethylene ("PCE") and trichloroethylene ("TCE"). This on-site burial was a formally authorized activity, conducted pursuant to a policy and memoranda describing the size and spacing of the pits, the thickness of the cover, and the quantity of radioactive material that could be buried in each pit. On-site burial of radioactive material was terminated in November 1970.

The Hematite Plant has two former filtrate evaporation ponds that were also used for on-site disposal of low-level contaminants, potentially including PCE and TCE, and both high enrichment and low enrichment uranium materials containing insoluble uranium bearing precipitates and other solids. The precipitates and solids were allowed to settle and the water evaporated naturally. As additional liquids were added to the primary pond, the overflow flowed through a pipe into the secondary pond. Immediately after CE purchased the Plant in 1974, use of the Ponds was curtailed so as to allow only disposal of spent potassium hydroxide scrubber solution from the uranium dry recycle process and liquids from startup testing of the wet recovery process. Use of the ponds was discontinued altogether in September 1978.

Although use of the burial pits and evaporation ponds has been terminated, and the ponds have been subject to several remedial efforts, both remain as areas of concern requiring investigation and final remediation.

Environmental monitoring and investigations

The Hematite facility initially operated under the authority of the AEC, then under a license from the AEC's successor, the US Nuclear Regulatory Commission ("NRC"). Those authorizations and the license required a variety of environmental monitoring related to radiological safety. Monitoring included process and ventilation stack emissions, downwind air samplers, soils, vegetation, surface water, and groundwater. The introduction of environmental regulations in the 1970s resulted in a state-issued permit for wastewater discharges and associated monitoring requirements.

The owners and regulatory agencies also conducted a number of investigative actions at the Hematite facility over the past twenty years, with increasing emphasis on non-radiological environmental aspects and impacts. An NRC contractor conducted a radiological evaluation of the burial pits in the spring and summer of 1982 that was subsequently published as NUREG/CR-3387. A private contractor for ABB Combustion Engineering completed an investigation to determine the source of Technetium-99 detected in on-site monitoring wells in September 1996. Missouri's Department of Natural Resources ("DNR") and Department of Health and Senior Services ("DHSS") completed an investigation to determine groundwater conditions at and around the facility, including radiological and volatile organic contaminants in November 1996. ABB Combustion Engineering's contractor completed in April 1997 an exploratory probe-hole investigation to evaluate the stratigraphy of the on-site evaporation ponds. Finally, another ABB Combustion Engineering contractor conducted a hydrogeologic investigation from April 1998 to March 1999 to determine whether past operations and waste management practices at the site had impacted groundwater and surface water quality around the burial pit area.

The prevailing conclusion from ongoing monitoring and the various investigations was that the site itself had contaminated soils and groundwater, but that there was no indication of off-site contaminant migration.

D&D considerations

The radiological contaminants in and around the Plant are subject to NRC regulations, and operations were conducted under a NRC special nuclear materials license. The NRC requires that a licensed facility undergo timely D&D after closure. That process typically involves a historic site assessment, surveys and sampling to determine the nature and extent of contamination as well as natural background levels, followed by development of a D&D plan. That plan is submitted to the NRC for review and approval, which may take two or more years to complete. The licensee then performs against the approved plan, and is subject to a final status survey to verify or refute achievement of the release criteria specified in the plan. That plan is currently under development, and will be submitted in April 2004.

Non-radiological contaminants in and around the Plant are regulated by the DNR, whose programs have been authorized by the US Environmental Protection Agency ("EPA"). The DNR programs are required to be at least as stringent as, and may exceed, EPA requirements. Their process is similar to that of the NRC in that it seeks to investigate the nature and extent of contamination, identify feasible alternatives for remediation, implement appropriate remedial actions, and perform a long-term remedial assessment. Westinghouse considered the previous investigations as it began developing a remedial investigation and feasibility study (RI/FS) work plan shortly after it announced closure of the facility in May 2000. The RI/FS work plan is a major component of the process described by the Comprehensive Environmental Response, Compensation, and Liability Act ("CERCLA" or "Superfund"), which is administered through the EPA and authorized state programs. Westinghouse is following the CERCLA process as the best means for protecting its rights under law, as well as those of the previous owners and operators. However, that process has different review and approval cycles from those used by the NRC. Final release criteria may also be substantially different from those of NRC. Nevertheless, information gained through the RI/FS will be used to supplement other investigations performed for the decommissioning plan. The RI/FS work plan was formally submitted to the DNR in May 2003.

D&D strategies

Two basic strategies were identified and evaluated for the facility's D&D – "Big Bang" and "Operational Units". The Big Bang is a typical approach of investigation of the site as a whole, followed by a long stand-down as the decommissioning plan is reviewed, modified as necessary, approved, and implemented. This approach has the advantage of facilitating a variety of technical D&D aspects. It has the disadvantage of resulting in a complex D&D plan, long periods in relative inactivity, and a significantly extended project schedule. Westinghouse is very sensitive to public perception of the project, and concluded that such inactivity would not be well-received. Two alternative Big Bang scenarios, early building removal and early burial pit removal, were evaluated for their ability to address those disadvantages. These would be performed under modifications to the existing facility license, or through special authorization. Early removal of the burial pits is particularly desirable because they are thought to be a potential source of off-site volatile organic solvent contamination in drinking water wells that was discovered in December 2001. However, both were found to have too many disadvantages. Early removal of the pits was problematic within CERCLA rules, and early removal of the buildings could complicate cost recovery efforts through the CERCLA process. Early pit removal also failed to optimize resource utilization, and required high early cash flow. Neither was found to significantly improve the overall schedule. The Big Bang strategy was therefore discarded.

The Operational Units strategy involves dividing the facility into areas of similar concern, such as buildings, soils, groundwater, and surface water. The need to investigate and develop appropriate plans is unchanged, although the requirements for review and approval of those plans are significantly altered with this approach. Demolition, packaging, and removal of the buildings and their contents was found to be feasible through modification of the existing NRC license, a process that is not as rigorous as that for a D&D plan. Early pit removal remained desirable and was considered, but it was determined that disturbing or removal of any below grade soils would inevitably require a D&D plan using the typical approach previously described. However, early removal of the buildings as an operational unit was found to provide an interference removal that improved access for investigation of the potentially contaminated soils below. This approach also allows for better compartmentalization of costs for future recovery through the CERCLA process, and significantly improves the overall project schedule. The ability to demonstrate continuous activity also serves to publicly demonstrate the company's commitment to license retirement and site remediation in a safe, socially responsible, and environmentally sound manner. The Operational Unit strategy was therefore selected for use at the Hematite site.

Current status

A contract was let in early 2003 for interference removal that is currently underway in the former fuel assembly building, which is the most recent construction and was the least contaminated structure. Site management functions have been moved into the radiologically clear areas of that building while the few radiologically contaminated rooms are decontaminated. That work is nearly finished, and will be completed in late-2003. This building will become the base of operations for interference removal in the remaining radioactive process buildings. Requests for proposals for work in those buildings have been solicited, and selection of the successful bidder is imminent. That work should be completed in mid-2004.

SESSION V: SOCIAL ASPECTS

EXPERIENCE FROM THE TRAWSFYNYDD PUBLIC INQUIRY

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Background

Decommissioning strategy

BNFL Magnox Electric's reactor decommissioning strategy has been described in detail in another paper to this seminar. In outline:

- All buildings on power station sites will be dismantled as soon as practicable after the end of generation.

- Dismantling of the reactor buildings will be deferred for around 100 years, with the buildings being suitably treated for this time period to make them weatherproof and to deter intruders.

- Operational intermediate level waste (ILW) will be packaged and stored on its site of origin, usually in a new, purpose built facility.

UK land use legislation and public inquiries

UK land use legislation (contained in the Town and Country Planning Act 1990) in general terms requires an application to be made to the local planning authority for permission to execute any works that involve construction of new buildings or a change to the appearance of existing buildings. No consent is required for total demolition. This legislation applies to all forms of building, whether for housing, supermarkets, quarries or nuclear decommissioning. Additional legislation applies in specific cases. For example nuclear safety is covered by the Nuclear Installations Act and regulated by the Nuclear Installations Inspectorate. So local authorities are not required to determine the nuclear safety, for example, of a decommissioning proposal. They have only to determine whether the impact on the environment is acceptable.

Locally elected representatives usually determine the outcome of a planning application. However, if the application raises issues of more than local importance the application can be "called in" by the national or regional government. This results in the setting up of a public inquiry. A public inquiry is also set up if the organisation applying for permission (the applicant) appeals against rejection.

An Inspector is appointed to manage the Inquiry and to produce a report making recommendations to the decision-maker. The inspector does not make the decision and the decision maker (usually a government minister or, as in this case, a government committee) does not have to accept his recommendation. A detailed timetable is laid out in the legislation which allows all parties time to produce evidence. It is normal for all major participants (applicant and local authority) to be represented by lawyers and counsel who are expert in planning matters.

The main aim of an inquiry is to allow the public to have their views heard and the process is more informal than might be expected in a law court. Inquiries are held local to the application site in whatever accommodation is available. Inspectors will normally allow members of the public to air their views on matters that may be of only limited relevance to the inquiry or the relevant legislation. The public is free to cross-examine all witnesses and is usually helped by the Inspector without any need for legal representation.

The situation at Trawsfynydd nuclear power station

Trawsfynydd power station in Wales is unique in being sited in a National Park. Magnox Electric plc (the applicant in this case) therefore decided to implement a Safestore design that would minimise the visual impact of the reactor buildings over the envisaged care and maintenance period. This involves (for this power station only) reducing the building height by about 20 m, down to 35 m, with a curved roof designed to blend into the surrounding landscape. The ILW store, which will be 91 m in length x 34 m wide x 19 m high, was also designed to minimise visual intrusion.

A planning application for these works was submitted to the Snowdonia National Park Authority (the local planning authority in this instance), but subsequently called in by the National Assembly for Wales on the grounds that the application raised matters of more than local importance.

The public inquiry started some 16 months after the application was made and lasted for three weeks. It is interesting to note that the original inquiry into construction of the power station lasted just three days. At the time of writing (May 2003), the Inspector has submitted his report, in confidence, to the National Assembly for Wales but they have not yet informed Magnox Electric of their decision. It is hoped that a decision will have been announced before the Vandellós Seminar in September 2003.

Lessons learned from the inquiry

Land use legislation in the UK derives from a European directive and is therefore, in principle, similar to that in other European countries. However, mindful that this Seminar on decommissioning strategy selection has an international audience and that the application of land use legislation will be different from country to country, this paper notes some broadly applicable lessons learnt on the social aspects of a public inquiry.

Stakeholder relationships

- Understanding the views of the various national regulators is of paramount importance to ensure the Applicant’s evidence is in alignment with their requirements. The Inquiry Inspector will seek to assure himself that safety matters are appropriately covered by existing legislation and that the inspection regime is adequate to ensure compliance.

- At a national level it is important to understand the concerns of non-governmental organisations, mainly anti-nuclear groups, who seek to oppose the planning application. Their objections may be based on matters that lie outside the scope of land use legislation or may be purely philosophical.

- At a local level it is essential to build relationships with the planning authority to ensure that the concerns of the elected members representing the local communities, and of the professionals who advise them, are fully taken into account. This is particularly the case for environmental matters such as visual impact and noise.

- Relationships with local residents are in many ways the most important, for it is they who will be most affected by the proposals. Evidence from local residents, whether they support or oppose the proposals, is likely to outweigh evidence from objectors, who may live far from the site, unless they can demonstrate local support.

Media relations

- Many of the applicant's opponents, especially anti-nuclear groups, will try to use the media extensively to promote their case. Often local papers will publish anti-nuclear viewpoints without bothering to check accuracy.

- Finding these articles and seeking to correct the inevitable mistakes and sometimes deliberate distortions can be time consuming. However, applicants should not to become involved in media arguments during the course of the inquiry and such interventions should only be to correct factual errors. The correct place to argue the case is inside the Inquiry, not on the pages of the local newspaper.

- Access to the site to allow factual media briefing on the proposals contained in the application and, in particular, to allow television crews to film the site is helpful in setting the scene for the public who may never have visited the plant.

- Media interest is high at the start of the inquiry, but rapidly falls as proceedings become routine.

Public understanding

- Anti-nuclear groups may oppose decommissioning planning applications without understanding the legal basis of the land use legislation. They may seek to broaden the remit of the inquiry to cover a wide range of matters that are outside its scope. To allow public confidence in the process the Inspector may sometimes allow such matters to be discussed.

- The applicant's case should be prepared from the outset on the assumption that all the information provided will be subject to cross-examination: all documents should be written in a manner which the public can understand and which does not compromise commercial or security sensitivities. They should not contain phrases that could be misleading if taken out of context in a newspaper.

- Nuclear matters are complex and the nuclear community tends to suggest decommissioning is technically straightforward. Hence we may assume others have understood the technical evidence, even if they dispute it. This is often not the case.

- Every strategic decision should have a robust rationale and should have resulted from a detailed options analysis. Anti-nuclear groups want this analysis to be visible and transparent. In some cases commercial considerations make this difficult: public domain reports should be prepared that present as much information as practicable. In some cases this will never satisfy all objectors.

- Every aspect of the detailed design requires a detailed, transparent audit trail, again subject to public scrutiny. For environmental matters like noise and visual impact this should be readily achievable.

- There is a requirement to assess the alternative options in detail to answer questions about what would happen in the event that planning consent was not granted. In the case of, say, a proposal to build a supermarket this is straightforward: if no consent is granted no store is built. But when no disposal route exists for the waste from decommissioning, as in the UK, the options for dismantling a nuclear power station are limited.

Some views expressed at the Trawsfynydd public inquiry

By national anti-nuclear groups

Few of the objectors spoke against the proposal to build a large new ILW store in a National Park, even though the inquiry's purpose was the consider the environmental consequences of land use proposals. The primary concerns expressed at the inquiry were related to deferral of reactor dismantling for 100 years. Some objectors:

- Did not believe the Company's dose reduction analysis (based on Co-60 decay in a carbon steel system) even after detailed questioning of Company witnesses by the Inspector.

- Appeared not to understand the difference between the radiological implications of total activity (primarily pure β) decay in comparison with γ dose reductions, although the matter was explained several times.

- Questioned why Trawsfynydd dismantling is to be deferred in comparison with plans for early dismantling of Tokai Mura, without accepting the seismic sitting requirements in Japan.

- Thought the reactors should be dismantled immediately with the resultant waste placed in a store very much larger than the existing reactor buildings.

- Did not understand or accept the engineering associated with nuclear decommissioning.

There were also concerns that the Company had not made available all of its extensive decision-making documentation for commercial confidentiality reasons.

In short the anti-nuclear groups simply did not trust Magnox Electric and appeared unwilling, almost as a matter of principle to believe what they were told.

By regulators

- The Nuclear Installations Inspectorate said they were content that the proposals are compatible with their expectations for the safe management of radioactive waste.

- The Environment Agency told the inquiry that it saw no reason to withhold planning permission for the proposals.

The Regulators accepted that the proposed reduced height reactor buildings and the ILW store would be built and operated safely and, on several occasions, explained that they would not allow work to proceed until they were content with the safety aspects.

By local authorities

- The local planning authority (Snowdonia National Park Authority) offered no objection in principle to the proposal, subject (primarily) to a review of the need for the ILW store in around 25 years.

- The local authority with responsibility for enforcing environmental and transport matters (Gwynydd County Council) offered "cautious" support considering that no ultimate radioactive waste disposal site is available in the UK.

The local authorities accepted that there is no real alternative to the proposals but, unlike the anti-nuclear groups, were more concerned about the new ILW store to be built in the National Park than reducing the height of the existing reactor buildings. They sought to retain a measure of control over the new store by asking for a review of its need in the future.

By local people

Some local residents expressed views against the proposals with concerns that:

- radioactive waste would be imported to Trawsfynydd from other sites;
- related to a range of matters outside the remit of the inquiry.

Other residents spoke in favour of the proposals citing:

- economic benefits that had been derived from the power station;
- acceptance of the Company's willingness to reduce the height of the reactor buildings to improve visual amenity

Most of the local population, either now or in the past, has worked at the site or enjoyed the secondary benefits brought by the power station to an area with widespread unemployment. They are in general supportive of the Company's efforts to retain employment and reduce the visual impact of the shutdown station.

Conclusions

- Magnox Electric's proposals for decommissioning Trawsfynydd power station were not opposed by either the nuclear Regulators or the elected representatives of the local communities, including the local planning authority, even though the station is situated in a National Park.

- The primary concerns came from national anti-nuclear groups and focussed on matters outside the remit of the relevant land use legislation.

- A number of significant lessons have been learnt from this Inquiry which should assist both the Company and the wider public's understanding in the event of a future public inquiry into decommissioning proposals at other UK nuclear power stations.

LOCAL INFORMATION COMMITTEE AND SOCIAL REPERCUSSIONS OF THE CLOSURE AND DISMANTLING OF VANDELLÓS-I

Josep Castellnou
Mayor of L'Hospitalet i Vandellós, Spain

Description of the D&D project: Vandellós-I D&D

Vandellós-I is a 497 MW gas graphite type nuclear power plant located in the Province of Tarragona. Its construction began in 1967 and it started operating in 1972. Its design was very similar to the French plant at St. Laurent des Eaux.

In 1989 a fire in the turbine house led to the final shutdown of the reactor in 1990 by Ministerial Order. Responsibility for the site was transferred from the utility to ENRESA in February 1998. Since then, main decommissioning activities of Vandellós-I have been undertaken, following post operational clean out, conditioning of spent fuel and treatment of operational wastes including the graphite components from fuel elements. Stage 2 decommissioning activities have been extended up to 2003.

Socio-economic factors

As it is known, when a new nuclear installation is commissioned, exists a change in the socio-economic activity in the local area. This new activity usually begins with an increase of employment and population until the finalisation of the commissioning contracts when the NPP starts up. At the same time during the operational stage, municipal incomes are increased.

During the decommissioning of a nuclear installation, some socio-economic impacts in the surrounded area are produced, strongly dependent on the activity of the decommissioned facility. For a complete evaluation of the impact of the dismantling phase, the overall process of decommissioning of a nuclear installation should be considered, including the following three phases:

- permanent shutdown;
- decommissioning period;
- post-closure.

Permanent shutdown

Socio-economic impact of decommissioning of an installation is marked by loss of employment (direct and indirect) and therefore loss of income.

Direct loss of employment is generated because the activity ceases at the installation and the activity decays during the decommissioning. The overall effect may be summarised in a demographic slump in the area. The reduction in employment leads to the relocation of people who are no longer going to work at the installation and who have no special ties to the area, this especially affecting the younger people, better trained generations, which have to look for work in other places. As a result, there is a migratory effect in the opposite direction from that occurring on the implementation of the facility.

Indirect loss of employment is produced both activities directly relating to the installation are reduced (auxiliary companies, refuelling work, etc.) and activities linked to the community (commerce and services) are affected.

This direct/indirect loss of employment causes:

- Reduction in economic activity in the municipal areas affected, caused by the disappearance or decrease of activities formerly carried out during the operation of the facility: services (maintenance, cleaning, subcontracting), refuelling outages and indirect activities (commercial and services).

- Reduction in revenues for the municipal administrations (taxes, rates and economic compensations), causing in turn a reduction in the activity of these administrations: lower investments and reduced activity.

- Blocking of the site for other uses, with the impossibility of promoting alternative activities.

- The negative impact of decommissioning makes it necessary for the time lag between permanent shutdown and decommissioning to be as short as possible, as this is a period of uncertainty and economic slowing down in the area.

In the case of Vandellós-I nuclear power plant, where the transition period between the permanent shutdown and the start of decommissioning works has taken ten years, the direct loss of employment has meant the disappearance of almost 300 jobs in a community of some 4 000 inhabitants. Local administrations during this transition period were involved directly in the decommissioning project, satisfying all the information requirements.

Decommissioning period

With the start of the decommissioning works, a new stage begins, meaning new activity for the area of influence of the nuclear installation. This does not have the characteristics of a nuclear power plant construction and operation project (less time and lower costs) but for a number of years (5 years in the case of dismantling of the Vandellós-I nuclear power plant) it provides new impulse for the area.

The social impact of the decommissioning period is marked by the desire in society to access information and the need to participate in decision-making process affecting the area of influence. During the licensing process, the decommissioning project is subject to public hearings, negotiation with the local administrations and informative meetings with the media and the population of the area. This promotes participation by society and the local administrations throughout the entire process of project approval.

In Vandellós-I, during the decommissioning period, a Commission was created, made up of representatives of the company in charge of dismantling, the administrations of the area of influence and other representative bodies. The purpose of this Commission was to track the evolution of the dismantling process and receive information on it.

The aspects that were dealt with by the Commission are the following:

- compliance with the conditions agreed on in the license (permit);
- work progress, evolution of contracted personnel, etc.;
- waste management, materials accounting;
- safety (training and accident rates) and environmental surveillance;
- events.

The Commission has proved to be a valid instrument for participation by the stakeholders in the area of influence in the dismantling project.

Also highly important, in addition to this policy of communication, is the training policy, which serves not only to prepare the workers who are going to participate in dismantling but also helps to improve the knowledge and skills of people who might in the future undertake similar work in the same area.

The economic impact during the dismantling phase is clearly positive. It cannot be compared to the activity that occurs as a result of construction of a nuclear power plant, but it does significantly reactivate the local economy. The most important economic impact is the generation of local employment, both direct and indirect. This generation of employment arises from both the direct contracting of workers and from the contracting of companies in the area.

In the case of Vandellós-I decommissioning, a total of 1 800 people were involved during the period 1998-2001, with a peak figure of 400 workers simultaneously on site. The composition of this employment was 65% local and 35% from other areas. The following table shows the latest data on employment and on the companies that have participated in the dismantling process.

Table 1. Data on employment and companies participating in the dismantling process

	Local	**Provincial**	**Remainder**	**Total**
Employees (current)	194	–	112	306
Companies (November 1999)	40	48	38	126

Indirect employment, which is more difficult to quantify, arises from increasing activity in the area, especially in the services sector.

The other pillar supporting economic activity is the contribution made by dismantling to the local administrations, through: Revenues from licenses and permits, compensation in the form of a fee for waste storage, and agreements with the administrations of the area to promote economic, cultural and sporting activities and investments in equipment.

Post-closure

The completion of the decommissioning works means the end of the activity. All the incentives arising from having hosted a nuclear installation disappear and new alternatives are needed for the area to survive. Planning for the future must be based on the training of people and on the preparation of the companies and entrepreneurs in the area.

There are three areas of training management:

- The local administrations, through agreements with other administrations (for training fund management) and with the companies responsible for dismantling (for the management of local employment), may generate job profiles that serve not only to provide work during the dismantling phase but also to offer alternatives in other sectors during and subsequent to dismantling: construction and services.

- The University, taking advantage of its collaboration in dismantling, may create a specialisation for both its teachers and students in areas implying a high level of technology and providing expectations for the future and growth: the management of conventional and non-conventional wastes or environmental aspects.

- Companies, through their own needs for training of the personnel working in dismantling, may promote the creation of groups of experts in a field as innovative as dismantling, thus allowing for the creation of stable jobs. Furthermore, offering internships and scholarships to students allows for the professional orientation of the best-trained people in the area.

As regards the preparation of companies and entrepreneurs in the area, advantage should be taken of the economic resources contributed by dismantling to the local administrations in order to promote economic activities, either through the strengthening of existing sectors (services, light industry, tourism, farming, etc.) or the creation of new activities relating to the environment or to dismantling itself.

Finally, the release of the site allows the resulting space to be recovered for new activities. The released site may house a wide variety of companies requiring space and services, since advantage may be taken of all the infrastructures (electricity lines, water supplies, cooling systems, etc.) already existing at the site.

A 25 years latency period is beginning at Vandellós-I, in this sense and besides the developments carried out during the level 2 decommissioning stage by the local administrations in infrastructures, socio-cultural interests and industry, a technological centre is going to be created at the site. The objectives of this centre are to survey the latency period, to serve as a way of public information and training, and to develop research projects related to decommissioning activities.

Consequently, the post-closure phase may be tackled with guarantees as long as the necessary efforts are first made by both those responsible for dismantling and by the administrations, in order to plan the diversification of activities in the area of influence of the installation.

GROUNDWATER CONTAMINATION AND COMMUNITY RELATIONS

Kevin Hayes
Westinghouse Electric Company LLC, United Kingdom

Overview

Westinghouse Electric Company LLC ("Westinghouse") acquired a nuclear fuel processing plant at Hematite, Missouri ("Hematite", the "Facility", or the "Plant") in April 2000. The plant has subsequently been closed, and its operations have been relocated to a newer, larger facility. Westinghouse has announced plans to complete its clean-up, decommissioning, and License retirement in a safe, socially responsible, and environmentally sound manner as required by internal policies, as well as those of its parent company, British Nuclear Fuels plc. (BNFL). Preliminary investigations have revealed the presence of environmental contamination in various areas of the facility and grounds, including both radioactive contamination and various other substances related to the nuclear fuel processing operations. Most noteworthy among the areas of contamination are seven private drinking water wells up to 3 000 feet to the southeast, and one private drinking water well approximately 1 000 feet to the northeast, that have been found to contain tetrachloroethylene ("PCE"), trichloroethylene ("TCE"), and other contaminants associated with their environmental degradation. Potential sources of this contamination include approximately 40 large unlined on-site burial pits and 2 evaporation ponds in which previous operators of the facility disposed of uranium-contaminated wastes and a variety of other hazardous substances. This paper discusses Westinghouse's response to the discovery of drinking water contamination, and the significance of its community relations program within that response.

Ownership history

The Mallinckrodt Chemical Works ("Mallinckrodt") became the first large-scale producer of uranium oxide for the United States' atomic energy program in 1942. In 1956, Mallinckrodt constructed and began operating a fuel processing facility at Hematite, which is approximately 35 miles south of St. Louis. In April of 1961, Mallinckrodt, Nuclear Development Corporation of America, and Olin Mathieson Chemical Corporation formed a joint venture, United Nuclear Corporation ("UNC"), to become the first integrated nuclear service organization in the country. UNC serviced primarily the federal government's nuclear fuel production needs, and some commercial customers, from the Hematite facility. In 1970, UNC and Gulf Nuclear Corporation entered into a joint venture, Gulf United Nuclear Fuels Corporation ("Gulf"), which owned and operated the Hematite Plant in a similar capacity until the spring of 1974. Late in 1973, Gulf announced that it was discontinuing certain aspects of its nuclear fuel business, and consequently offered Hematite for sale. Combustion Engineering Corp. ("CE") purchased the Hematite Facility in May 1974, and began operating it as a commercial nuclear fuel cycle facility. Ownership again changed hands in 1989, when Asea Brown Boveri ("ABB") purchased the stock of CE and expanded the facility's commercial operations. Finally, in April 2000, Westinghouse Electric Company LLC, purchased the global nuclear operations of ABB, subsequently closing the Hematite facility.

On-site disposal

Beginning no later than 1965, and perhaps as early as 1958 or 1959, and continuing at least until November of 1970, on-site burial was used as a means of disposal of contaminated materials and waste at Hematite. From 1965 until 1971, up to 40 large unlined pits were dug east of the Plant buildings. These pits were used to dispose of materials and waste generated by the Plant processes, potentially including tetrachloroethylene ("PCE") and trichloroethylene ("TCE"). This on-site burial was a formally authorized activity, conducted pursuant to a policy and memoranda describing the size and spacing of the pits, the thickness of the cover, and the quantity of radioactive material that could be buried in each pit. On-site burial of radioactive material was terminated in November 1970.

The Hematite Plant has two former filtrate evaporation ponds that were also used for on-site disposal of low-level contaminants, potentially including PCE and TCE, and both high enrichment and low enrichment uranium materials containing insoluble uranium bearing precipitates and other solids. The precipitates and solids were allowed to settle and the water evaporated naturally. As additional liquids were added to the primary pond, the overflow flowed through a pipe into the secondary pond. Immediately after CE purchased the Plant in 1974, use of the Ponds was curtailed so as to allow only disposal of spent potassium hydroxide scrubber solution from the uranium dry recycle process and liquids from startup testing of the wet recovery process. Use of the ponds was discontinued altogether in September 1978.

Although use of the burial pits and evaporation ponds has been terminated, and the ponds have been subject to several remedial efforts, both remain as areas of concern requiring investigation and final remediation.

Environmental monitoring and investigations

The Hematite facility initially operated under the authority of the AEC, then under a license from the AEC's successor, the US Nuclear Regulatory Commission ("NRC"). Those authorizations and the license required a variety of environmental monitoring related to radiological safety. Monitoring included process and ventilation stack emissions, downwind air samplers, soils, vegetation, surface water, and groundwater. The introduction of environmental regulations in the 1970s resulted in a state-issued permit for wastewater discharges and associated monitoring requirements.

The owners and regulatory agencies also conducted a number of investigative actions at the Hematite facility over the past twenty years, with increasing emphasis on non-radiological environmental aspects and impacts. An NRC contractor conducted a radiological evaluation of the burial pits in the spring and summer of 1982 that was subsequently published as NUREG/CR-3387. A private contractor for ABB Combustion Engineering completed an investigation to determine the source of Technetium-99 detected in on-site monitoring wells in September 1996. Missouri's Department of Natural Resources ("DNR") and Department of Health and Senior Services ("DHSS") completed an investigation to determine groundwater conditions at and around the facility, including radiological and volatile organic contaminants in November 1996. ABB Combustion Engineering's contractor completed in April 1997 an exploratory probe-hole investigation to evaluate the stratigraphy of the on-site evaporation ponds. Finally, another ABB Combustion Engineering contractor conducted a hydrogeologic investigation from April 1998 to March 1999 to determine whether past operations and waste management practices at the site had impacted groundwater and surface water quality around the burial pit area.

The prevailing conclusion from ongoing monitoring and the various investigations was that the site itself had contaminated soils and groundwater, but that there was no indication of off-site contaminant migration.

Response to drinking water contamination

DHSS conducted annual radiological monitoring (gross alpha and gross beta) of four private wells near the Hematite facility during December 2001. Samples were also collected for VOCs at the request of the DNR. Results of that sampling revealed that one of the private drinking water wells sampled by DHSS exhibited VOC concentrations, including PCE and TCE, above drinking water standards. This well is located northeast of the facility, at a leased residence situated on Westinghouse property. It had last been sampled for VOCs by DHSS in 1996, at which time none were detected. Westinghouse and the DNR conducted follow-up testing upon being informed of the VOC finding in early-January 2003. With the objective of being socially responsible and proactive in providing public protection, Westinghouse also ensured that the resident had bottled water for consumptive purposes while the situation was being evaluated. Follow-up testing then confirmed the presence of VOCs. Again in a proactive manner, Westinghouse installed an activated carbon filtration system in the residence after gaining the DNR's concurrence for such action.

In March 2002, Westinghouse and DNR tested 20 additional wells located southeast of the Hematite facility. Five of those wells were found to contain VOCs, bringing the total number of affected wells to six. Westinghouse again took the immediate action of providing bottled water and installing carbon filtration systems in each of the affected residences. Bottled water was also provided to 17 additional residences located within the potentially affected area, which was defined as the planned groundwater investigation area of the draft RI/FS work plan.

In April 2002, DNR, DHSS, and Westinghouse sampled additional private wells located within a 1-mile radius of the facility, and within a wedge up to 2 miles to the northeast/southeast. Westinghouse also conducted repeat sampling of previously sampled residences. Analytical results from that sampling event showed that no additional private wells were affected. Nevertheless, it was apparent that additional investigation was warranted. Westinghouse, again with the DNR's concurrence, initiated an interim hydrogeologic investigation of groundwater conditions, thereby accelerating that component of the RI/FS work plan, to quickly determine appropriate final corrective action(s) regarding residential drinking water.

Westinghouse proactively signed a Time Critical Removal Action Memorandum with the DNR during June 2002. That document formalized the actions already taken regarding the provision of bottled water, installation of filtration systems, and the interim hydrogeologic investigation. It also established a quarterly monitoring program for residential wells and those being installed through the interim investigation.

The first round of quarterly sampling was conducted in July 2002, and detectable levels of VOCs were found in two more private wells, bringing the total number of affected wells to eight. Except for the well to the northeast, all of the affected wells are at residences located southeast of the site.

Westinghouse completed its interim hydrogeologic investigation and used it to develop an Engineering Evaluation and Cost Analysis (EE/CA) of alternatives for final corrective action regarding residential drinking water well contamination. The alternatives it considered were taking no action; continued provision of bottled water, filtration, and periodic monitoring; installation of deeper private drinking water wells, and; extension of public water to 24 currently and potentially affected residences. Of the four, Westinghouse recommended the provision of public water as the most effective, implementable, and cost-effective alternative. The EE/CA was presented for public comment in January 2003. Following evaluation of and response to the comments received, Westinghouse and the DNR signed in May 2003 a Non-time Critical Removal Action Memorandum that authorized implementation of the public water alternative. Construction began that same month, and will to be completed in October 2003.

Community relations

The need to proactively communicate and work with the community and regulators was easily and quickly identified when considering the potential scope of concerns that could be encountered while the Hematite site was safely decontaminated, decommissioned, and returned to future use. Based on its corporate philosophy of being socially responsible and proactive in community outreach, Westinghouse developed a community relations plan using CERCLA guidance and model documents provided by the DNR. Community interviews were conducted during November 2001 to ensure the plan recognized and addressed local concerns. Such ability was thought to be an essential first step in building an effective mechanism for providing timely project updates to the community, and being able to receive and understand community feedback. There was also a strong desire to contain the "rumour mill". Both the local community and the news media will inevitably hear and pass a story along. The success of the community relations plan can be gauged if such exchanges, and the resulting perspectives, are made from an informed position instead of one of ignorance and suspicion.

Key features in the resulting draft plan included a prime public contact, planned public meetings and smaller workshops with the local community, regular communication with local elected officials and regulatory agencies, and news media releases regarding significant events and public meetings. It also featured the generation of fact sheets regarding subjects or developments of particular interest, periodic newsletters to the community, development of a mailing list that is shared with regulators, establishment of a local repository to ensure access to official documents, and the opportunity for site tours.

Discovery of drinking water contamination in December 2001 provided an immediate test of the plan, and invaluable opportunities to refine it. Dialogue with the first affected resident revealed something that had been underestimated – provisions for a resident's privacy, particularly for those who refrain from being in the public spotlight. Implementation of the plan also had to ensure that information was disseminated so that an affected resident was the first person to be informed, followed by elected official and regulatory agencies, and then the public and news media if appropriate.

Experience with public meetings provided more opportunities for plan refinement. The public, especially interveners and concerned citizens, is quickly able to recognize and pursue any lack of common understanding between meeting presenters. That is particularly true when such misunderstanding is between a licensee or permittee and its regulators. It can have embarrassing consequences, and may undermine public confidence in either party's ability to achieve appropriate results. They must be able to project an informed, understanding, and appropriately responsive demeanour. Tremendous value was therefore found in pre-meeting conferences to better ensure common understanding, albeit without collaboration. It is equally important to quickly, within 24 hours, hold a post-meeting debrief to share lessons learned and ensure that any outstanding public questions are addressed in a timely manner. That is also the ideal time to plan the timing of the next public meeting and the topics it should address.

Conclusion

A variety of lessons can be learned through the Westinghouse experience at Hematite. First and foremost is the need for proactive planning, particularly the development of a community relations plan. Nearly as important is the need for community involvement and stewardship before starting potentially high-profile operations, or the development of a potentially serious problem. Even the most carefully developed plan will be undermined if it's brought by a messenger that is unknown to the community, and is therefore received with suspicion.

The ability to take prompt actions and meet commitments can not be underestimated as a mechanism for overcoming public suspicion and building trust under adverse conditions. It is important to be aware that direct cost is not the only cost when determining a course of action. Safety, environmental impact, and social responsibility must be considered in order to make appropriate decisions. Information gained in the course of developing a community relations plan will help frame the relative significance of those considerations.

While it is probable that someone will be unhappy or disagree with some decision or outcome while dealing with a situation such as the groundwater contamination encountered at Hematite, they are most likely to accept it if there is a candid and rational explanation. Public concern is typically amplified as the complexity of the problem increases and their understanding of it decreases. A public information and education process that is coordinated with elected officials and regulatory agencies is therefore a vital function of community relations.

The court of public opinion is always in session. Its trust must be earned through appropriate and proactive planning supported by effective and ongoing communication.

SOME EXPECTATIONS FROM EUROPEAN MUNICIPALITIES HOSTING NUCLEAR FACILITIES

Philip Moding
Secretary of the municipalities of Sweden hosting NPPs (KSO), Sweden

Firstly I want to repeat what I said at the NEA WPDD meeting at Karlsruhe June 2002. Even if the NEA papers so far have focused on the strategies and especially on the important more technical aspects GMF and us from KSO Sweden are eager to underline the social aspects of closing, dismantling and decommissioning. The decisions either to shut down a NPP or to site a new nuclear installation are of highest interest to the affected local democracy, i.e. the municipality. Together with the self evident nuclear safety matter nothing else is as important as the social consequences of any large-scale investment to us as local stakeholders. Too many large scale investments in the nuclear sector have been taken from the top and down, often using the well-known method of “father knows best” or the DAD principle (decide, announce, defend). Therefore GMF and the European municipalities welcome the NEA initiative and efforts to at least listen to what will be said from us as representatives nearest to the affected citizens. You must excuse us as laymen not being able to melt all your expert dominated strategies. I think that most citizens and affected municipalities just thrust our very competent national and international regulators. We expect a high competence from them and you including an independent to different lobby groups and interests.

But do remember that any decision concerning the expansion or phasing out of energy production has its clear, concrete social effects at defined geographic place or places. This must be explained and understood long before a decommissioning procedure can take place. This very first face must be much better developed methodologically and systematically at the local level. There is a long way to go still. From a local point of view we are happy to see some initiatives or better new directives from EU as given June 2001 on the environmental impacts of some plans (EU Directive 2001/42/EG). Unfortunately the term Strategic Environmental Assessment, SEA, seems to be replaced by a weaker definition. How these new directives will be applied the best are now discussed in the member countries. Also by us in Sweden, where there is still a lack of communication between our central government, including it’s different central agencies, and our affected municipalities. Some sort of DAD procedure is maybe taking place. As far as I know the affected municipalities have not been heard so far at all.

As investors and regulators you have a need for cooperate much better with us as local stakeholders. With other words the network of GMF is needed as you have heard earlier from its Secretary, to day chairing this part of the Seminar.

A problem to those wanting a more developed and democratic dialogue between national government and the local municipalities, the grassroots, is that it is inconvenient and uncomfortable to a national government for instance our Swedish or the German one to develop a dialogue on the phasing out of nuclear also with the affected communes. But on the sitting of new waste repositories our governments have learnt it is a must to come on speaking terms with the affected citizens and their local politicians. It is easier for the government or the investor to send a letter to the local addressee than to mail a letter about a planned (!) funeral! This is a dilemma to any national government dealing with the phasing out of a nuclear concept. Our Swedish National Council for radioactive waste, "KASAM", has in its report to the government (SOU 2002:63) asked for a research programme focusing on societal humanistic aspects of these issues. A very important prerequisite is of course that such a research must be completely independent of the main stakeholders, read the industry and its organisations. An interesting seminar on this theme for those understanding Swedish will take place in Stockholm, 22 October 2003. Ask KASAM, Ministry of Environment, Stockholm, about this seminar on "the role of social sciences in the decision making on large scale investments and democracy" (mats.lindman@environment.ministry.se).

As local stakeholders we know probably better than the rest of the nation which benefits the establishments of nuclear power has brought to the sites and their surroundings. As seen from a broad and general point of view: Most NPPs in Europe are sited at "minus regions" i.e. at places losing people and employment. In most cases a phasing out of nuclear should not only be measured in the number of jobs lost on the national level – a rather uninteresting consequence compared with the grave, local affects on each affected place. Geography counts... with other words! The phasing out impacts must also be regarded qualitatively as a significant loss of many qualified jobs. The heavy investments in the nuclear energy have brought advanced technological activities as well as many "normal" jobs to areas needing it. A clear social indication of phasing out is that it will affect most of all elderly people and those with the least education. These groups will have a great difficulty in finding other jobs. Houses, certain shops, schools, nurseries, local service firms will lose their base. Worst of all could be that the inhabitants cease to believe in the future. Any strategy for decommissioning must start from the background of a total approach of the decision making on why shut down? As I said in Karlsruhe from the municipal and grassroots level there is a lower interest to participate in the decommissioning phase if there is a lack of answer to the following primary questions:

1. What environmental gains and losses will accompany the planned shutdown?
2. How and where will the diminished electrical supply be compensated for?
3. How and when will the affected local districts be compensated and by who?

As an example of the decided shut down of the nuclear production in Sweden we know from our KSO investigations (KSO Report given May 1999 that around 8 000 jobs will disappear, most of them not being replaced in the existing NPP areas. Our affected municipalities have therefore created list of concrete investments as compensations for the closing down of NPPs. The majority concern infrastructure in roads, railways, higher education, etc. Currently it is still unlikely that a power company would invest in new large fossil fuel power plants in Sweden. Also new windmills are discussed more and more from an environmental and economic point of view by us. In stead our Swedish Vattenfall, owned by us as citizens of Sweden, is allowed to buy and invest in coal fired plants in Germany and in Poland. Many mean that it is a typical example of double moral. Isn't it or is it just allowed business thinking in the EU? The issue was also discussed in the Swedish Parliament! Back to the aims of this Seminar. You want us as local stakeholders to comment your hard, technical strategies for the decommissioning of nuclear facilities and I am answering the same way as in Karlsruhe. You may think that I am playing offside again but... My advice to you to day: Listen also to us as stakeholders of the social and geographic aspects just at the affected areas. The national level for this is not enough as you could see from my Swedish examples. No decommissioning or no phasing out is taking place without mostly enormous effects on the local level. Develop better dialogues with us on just this more grassroots level. And don't forget to develop your best talents as fair and unbiased teachers and stakeholders. Try to understand us who demand intelligibility. Local democracies must also be offered a fair possibility to change plans not wanted by them. This is also included in the Maastricht agreement and in the principle of subsidiary!

COMMUNITY EXPECTATIONS

Larry Kraemer
Chairperson of the Canadian Association of Nuclear Host Communities
Mayor of the Municipality of Kincardine

Canadian Association of Nuclear Host Communities

Presentation

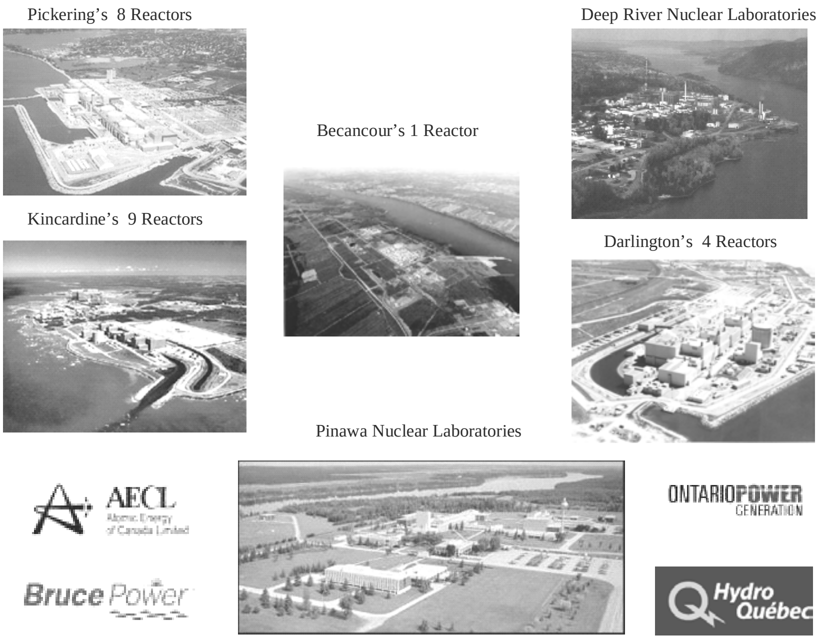
Community Expectations

CANHC

Introduction

Good afternoon, ladies and gentlemen, my name is Larry Kraemer and I wish to speak to you to-day in the capacity of the Chairperson of the Canadian Association of Nuclear Host Communities and also as the Mayor of the Municipality of Kincardine, which is the home to North America's largest Nuclear Generating Station the Bruce Nuclear Power Development.

Historically, the relationship between the nuclear generator and the local community has been one of stability and co-operation. However in more recent times (2000-2003) the nuclear landscape has had several major issues that directly effect the local nuclear host communities.



CANHC Canadian Association of Nuclear Host Communities

Goals

- The associations mandate is to be supportive of the nuclear industry through ongoing dialogue, mutual cooperation and education.
- To strengthen community representation with the nuclear industry and politically through networking with other nuclear host communities.

As a result of these issues, the Mayors of a number of communities started having informal meetings to discuss the issues at hand and how they effect their constituents. These meetings led to the official formation of the CANHC with representation from:

- Pickering, Ontario;
- Clarington, Ontario;
- Kincardine, Ontario;

- Deep River, Ontario;
- Becancour, Quebec;
- Pinawa, Manitoba.

In Canada it is almost impossible to discuss decommissioning and dismantling of Nuclear Facilities without also discussing Nuclear Waste disposal for reasons that I will soon make clear.

Also I would like to briefly touch on how and why expectation of communities may differ by geography and circumstance.

Pickering

A disposal solution for either calandria, decommissioning wastes or used fuel local to the Pickering site would seem to be unlikely given the density of urban population, the low percentage of workers employed in the nuclear industry compared to the rest of the population and Pickering's close proximity to Toronto and its suburbs.

- Pickering Nuclear Generating Station;
- 8 550 mw reactors at end of life;
- 8 calandria + LLW and ILW from decommissioning;
- at end of life site will house approximately 1 200 cylinders of used fuel;
- site is not large acreage;
- urban boundary has pretty much surrounded plant;
- close proximity to Toronto.

Clarington

By end of life it is likely that the urban boundary will have reached this site as well making a local solution unlikely there as well.

- Darlington Nuclear Generating Station;
- 4 950 mw reactors;
- 4 calandria + all LLW and ILW from decommissioning;
- smaller site in terms of acreage;
- approximately 1 000 cylinders of used fuel at end of life;
- next most densely populated;
- approximately 30 mile east of Pickering.

Kincardine

Looking at the size and the volumes of the various substances at the Bruce site it does not take long to figure out why we insisted that Ontario Power Generation enter into a memorandum of understanding to decide the future directions of the waste operations and how decommissioning wastes will be fit into that agreement.

- Bruce Nuclear Generating Station;
- 9 reactors (4 x 750 mw, 4 x 850 mw, 1 x 200 mw in safe storage);
- 9 calandria + LLW and ILW from decommissioning;
- all Ontario's LLW and ILW from operations in interim storage;
- approximately 2 000 cylinders of used fuel at end of life;
- large site approximately 2 400 acres;
- lowest population density of major Canadian generating sites.

Deep River

Majority of population employed in Nuclear Industry very knowledgeable of issues as it stands today. Have shown willingness to look at local solutions to waste and decommissioning issues in the past this trend will probably continue.

- Chalk River Laboratories;
- several research reactors;
- hot cells;
- Maple 1 and Maple 2 reactors for medical isotopes;
- site well removed from major urban centres.

Becancour

Gentilly 2 is Quebec's only Nuclear Generating Station therefore unless Quebec enters into an agreement with some other facility it does not at present look probable for disposal of decommissioning wastes offsite.

- Gentilly 2 Nuclear Generating Station;
- 1 625 mw reactor;
- all wastes ever generated remain on site;
- 150-200 used fuel cylinders at end of life;
- 1 hour from Montreal lightly populated agricultural area.

Pinawa, Manitoba case study

Our association has a diverse geographic base with many unique nuclear experiences. One of these experiences that I would like to share with you is the Pinawa, Manitoba case study.

In 1995 a decision was made to close the more modern facilities in Pinawa and upgrade those in Chalk River as a cost cutting measure. Atomic Energy of Canada has recently received approval to proceed with Phase 1 of their plan for decommissioning of the Pinawa facilities. These include several contaminated buildings, hot cells, an experimental reactor in a safe shutdown state and waste management. Real decommissioning, that is the demolition of buildings and the placement of all waste in permanent disposal facilities, is to be deferred indefinitely because of the lack of disposal facilities in Canada.

It is the will of Pinawa and its surrounding community that decommissioning proceed in a continuous manner until the site can be delicensed, with a permanent decommissioning staff in place until the job is complete. This would prevent severe economic disruption to the communities from the loss of 150 – 200 jobs associated with decommissioning at the completion of Phase 1. This would also ensure that Phase 2 and 3 would be carried out by staff knowledgeable of the site and its hazards. It is the fear of the communities that once the nuclear expertise has been removed 1 500 km away, that the completion of decommissioning will be continuously deferred for centuries.

Long-term management of nuclear fuel waste (Bill C-27)

Concurrent with the formation of the CANHC, the Federal Government of Canada introduced Bill C-27, an Act respecting the long-term management of nuclear fuel waste. Bill C-27 was tasked with the formidable job of creating recommendations for the long-term management of spent nuclear fuel in Canada. The relevant context of this process, was that it was the first time that Canadian Mayors of Nuclear Host Communities have taken collective action in order to further the responsible discussions surrounding nuclear waste management. Also relevant to today's discussion is that this bill did not address the management of LLW of ILW either from operations or decommissioning or dismantling of existing Nuclear Stations or Research Facilities. Serious dismantling efforts in Canada are unlikely to begin until a site has been identified for used fuel wastes. Some of you may be surprised at the expected volumes of HLW by end of life for Canadian plants however our canister size roughly half that of the European canister. And because the Candu system uses natural uranium, fuel life is shorter resulting in a larger volume of a much safer waste. However in much of the publics mind it is still nuclear waste.

Kincardine/OPG Memorandum of Understanding Work Plan (15 April 2002)

At this point I wish to remove myself from the CANHC Chairperson's role and put on my hat as the Mayor of the Municipality of Kincardine.

In early 2002, the Municipality of Kincardine entered into a "Memorandum of Understanding" with Ontario Power Generation to formalize the long-term management of low and intermediate level nuclear waste generated in the Province of Ontario, Canada. The Work Plan included the following tasks:

- initiate independent assessment study;
- conduct geotechnical feasibility study;
- conduct preliminary safety assessment;
- conduct social assessment;
- conduct economic analysis;
- conduct environmental protection feasibility;
- carry out consultation in communities;
- review European and American model for long term management of LLW and ILW.

Project visits goals

- To review best practices in low and intermediate waste management practices;
- to discuss governmental approval processes and talk with local officials;
- to ascertain public consultation methodologies.

LLW facilities visited by Kincardine delegation

- Zwilag, Switzerland;
- NAGRA Project, Wellenberg;
- Centre de l'Aube, France;
- SKB Facility, Sweden;
- Barnwell, South Carolina, USA;
- Carlsbad, New Mexico, USA.

General trends discovered

- Siting some with referendum some not;
- technology generally includes incineration, compaction, concrete liners & water collection systems;
- some facilities built to accept decommissioning wastes some not;
- LLW and ILW can be contained in the same facility;
- in all areas safety was paramount resulting in excellent safety records in all facilities;
- all facilities are good examples for their respective circumstances, however the proposed Bruce facility may have different combinations of all sites visited;
- in general the European facilities are preferred over American facilities;
- sites generate enhanced taxation, real property taxes and business license taxes,
- overall the economic and social well being of the host municipalities is supported by the presence of the LLW waste management facilities;
- increase in visitor traffic (Surprise);
- once sited, community support was evident everywhere;
- farther away you go, more opposition you will experience.

Feasible options identified

1) Deep geological;

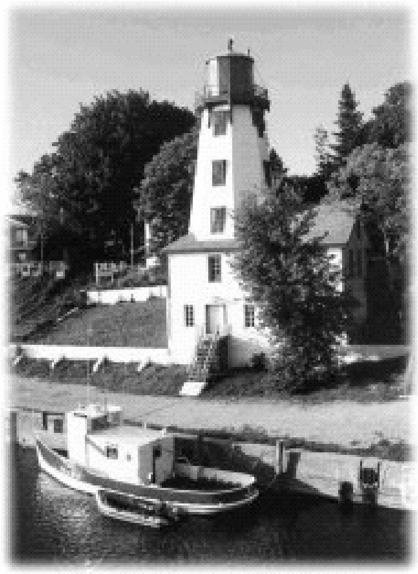
2) above ground concrete vault;

3) enhanced processing.

Communities path forward (LLW discussions)

The following is the Communities path forward:

- begin fall 2003 if results of studies positive;
- develop community offsets and benefits plan;
- community discussions and decision;
- must benefit municipality and region;
- must benefit nuclear industry.



Ivey Business School

Independent study for the Municipality of Kincardine.

In order to show the public that the Municipality of Kincardine took an independent view of the MOU process, the municipality has undertaken a partnership with the Ivey School of Business. This evaluation is structured to utilize the experience of Ivey field project (under the guidance of the programs professors) to analyze the long term financial impact of the proposed LLW facility in Kincardine, with respect to both the community & industry.

The results of this study will enable the municipality to enter discussions with financial information and knowledge equivalent to that of industries.

Kincardine's community vision

Our process has yielded a large amount of information. However one of the challenges we face as a council in bringing this to a successful conclusion is negotiating a deal. And to that end much to our councils credit we have realized that greater time and expertise was needed to identify, One, what is the value of what we were offering to our society both in regard to operational and decommissioning responsibilities? Secondly what it was that would benefit our community over the long haul and ensure that our residents needs and concerns were addressed in that time frame? To that end Council has teamed up with Ivy Business School one of the worlds top 20 Business schools to study these issues in depth and help us design a deal that will fulfill the parameters we have set for success:

- economic diversity;
- secure advanced Healthcare;
- direct financial advantage for community and region;
- support for the nuclear industry centre for energy excellence;
- post-secondary education opportunities for our youth.

Upcoming issues

Even though we are spending the pre-requisite time talking with industry and the public, I feel that we are at a stage where we have defined some of the questions; however, I feel that both time and future issues will lead us to the proper solutions for nuclear waste management. Please note that I wish to leave you with some of the upcoming issues that will define the Canadian nuclear waste and decommissioning issues in the future:

- referendum.
- Canada's nuclear fleet will be reaching its life cycle and serious thought must be given to either refurbishment or long-term decommissioning of the facilities.
- these pending waste volumes be dealt with by long-term waste management facilities.
- ongoing education of the public with respect to our responsibilities in nuclear waste management and the education of industry with respect to the public's views of industry at the local community level must continue.

Decommissioning and dismantling

In a general sense the community is becoming aware of the requirement to deal with the large volumes of LLW that will be generated upon the final decommissioning/dismantling of the generation plants. It is estimated that the existing Ontario Nuclear facilities will contribute 100 000 m^3 of LLW material to an unknown waste repository. These specific facts lead credence to the views of my municipal colleagues, that we must now seriously work with industry to strike firm plans to accommodate these significant environmental responsibilities. We feel strongly that our M.O.U. with Ontario Power Generation is a step in the right direction and that when time does pass and we do indeed reach full term on our facilities life span, that the long term management facilities are in place and ready to accommodate the LLW material. The nuclear generation sites in Canada have different social & geographic realities, some being in the centre of large economic hubs, while others being situated in more rural settings. These differences will play a role in both the Canadian determination of the final facilities that will manage both the LLW, ILW and HLW.

Expectations

- We expect that decommissioning and dismantling can not take place in Canada until facilities are in place to accept the wastes.

- Nuclear Host Communities away from the urban boundary seem to be seen as the best hope for sitting such a facility.

- Present policies have the funds for decommissioning and dismantling invested elsewhere we expect to see some significant amount of these invested where the waste a located.

- Prompt or continuous decommissioning starting with the easiest system first and moving to the more difficult is much preferable to continuously delayed decommissioning.

- Legacy management is very necessary meaning, the lowest negative impact possible on future generations should be sought in making decommissioning decisions.

- We expect that nuclear decommissioning and dismantling expertise will continue to be invested in, so that the completion of decommissioning will not be continuously deferred for centuries.

FINAL PLENARY DISCUSSION

Moderator: Margaret Federline
USNRC, USA
Chair of NEA Radioactive Waste Management Committee

Introduction

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 specifically noted 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 also noted 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.

Also, 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 well-established background, **Allan Duncan**, as *rapporteur*, chose to highlight other themes and issues from the seminar that appeared to be:

- important for successful D&D;
- worth further work in an international context;
- controversial and worthy of further debate.

The five main themes selected were as follows:

- stakeholder involvement and communication;

- strategy selection;
- waste management and clearance;
- funding and costs;
- satisfying social demands.

Various issues were identified under each one of these five themes and, in order to make best use of the time available for discussion, participants were invited to vote on the issues of most importance to them. Subsequent discussion was then focussed on the issues so identified.

Stakeholder involvement and communication

As shown below, six specific issues were identified by the *rapporteur* as appearing to be of most importance or interest under this general theme. The voting by participants showed that issues 2 and 5 were of most interest followed closely by issues 3 and 6:

1. early indication of intention, seeking views (not decide – announce – defend);
2. early discussion of plans with stakeholders;
3. identification of key stakeholders [operators, politicians (local and national), policy-makers, regulators, concerned public, neighbouring states, NGOs, employees];
4. engaging the press and broadcast media;
5. continued dialogue with local communities;
6. communication by demonstration. (Show us you can do it!)

Discussion around items 2 and 5 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. It was recognised that this participation, involving two-way communication, is necessary in the development of D&D plans and in their successful implementation. This reflected the messages that emerged from the session on social aspects and that were flagged for discussion under the theme of "satisfying social demands". It also re-confirmed 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, and that the NEA would be a suitable focal point for it.[1]

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1. 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).

In the context of items 3 and 6, it was noted that it is particularly important to engage those politicians representing the local community, as discussed below in the context of social aspects. A "no surprises policy" was judged to be very important in this regard. Lessons learned 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 also 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.

Factors in strategy selection

This was the overall theme of the seminar, of course, and the following list identifies all the issues that seemed particularly relevant to strategy selection, other than the obvious issues of safety and practical techniques, as mentioned above:

1. basic options; (Early or deferred dismantling; entombment?)
2. flexibility (one size *does not* fit all);
3. project planning/analysis of materials flow;
4. regulatory/policy requirements (timing; release criteria);
5. socio-economic issues;
6. waste management provision;
7. costs and funding arrangements;
8. staff availability and personnel issues;
9. knowledge retention;
10. site reuse;

11. strategy selection process (e.g. multi-attribute analysis);

12. who are the “regulators” and the actual decision makers?

Other relevant factors include life cycle stage (end of life, or shut prior to end of life), community support and who selects strategy.

The voting showed that “waste management provision” and “costs and funding arrangements”, items 6 and 7, were of the highest importance to participants, subject of course to the proviso about safety issues. These, together with “socio-economic issues”, were judged important enough to be themes on their own and were discussed in more detail under the relevant theme heading. After items 6 and 7, items 1, 2, 3, 4 and 11 appeared to be of broadly similar importance.

As regards items 1 and 2, 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 GCRs 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, item 3, 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, item 4, 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 0.25 mSv/year, coupled with a requirement for ALARA, as compared with the figure of 0.01 mSv/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. Representatives of nuclear operators appeared to be unaware of this important development and it was suggested that WPDD might usefully provide feedback to WENRA from an operator's perspective, either directly or by way of the 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 eight issues identified below for this theme, items 3 and 5 were voted the most important issues by a large margin, followed by item 1:

1. general waste management plan;
2. inventory of decommissioning liabilities;
3. availability of waste disposal routes;
4. conditioning of waste and avoidance of rework for disposal;
5. standards for clearance, and effects of differences on costs and international business;
6. handling of large quantities of VLLW;
7. effects of variation of national WM arrangements on D&D strategy and cost comparisons;
8. benefits of having single body (e.g. ENRESA) for both D&D and waste management? (Any parallels?)

It was generally acknowledged that the availability of a national general waste management Plan, item 1, 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. This had been discussed to some extent in the context of strategy selection and the further remarks served only to confirm its importance in that context. 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, item 5. 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 under this theme that seemed to be important during the seminar were as follows:

1. Differences between commercial facilities and early R&D/Development facilities.

2. Relationship between funding and safety.

3. Hazards to the long-term security of funds.

4. Cost effects of using in-house staff, contractors or separate body for D&D (e.g. training and management costs).

5. Need for better breakdown of waste management costs?

6. Can harmonised funding arrangements ensure fair competition in the electricity supply market?

7. Interests of the local community (e.g. in use of local labour and services).

The voting showed that the greatest concern was about hazards to long-term security of funds created for D&D operations, item 3, followed closely by the relationship between funding and safety, item 2, and then item 4, which dealt with the effects of staffing policy on costs.

The first concern was about ensuring 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, of course, 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.

Satisfying social demands

The issues associated with social aspects were:

1. Implementing "Pillars of Trust" (safety, participation, economic development).

2. Providing channels for communication.

3. Creating representative local committees.

4. Does the EIA process satisfy the requirements of local communities?

5. Implementation of international conventions.

The voting clearly showed item 1, implementing "Pillars of Trust", as being most important to participants in this context. In practice, it covers most of the social aspects.

The presentations had shown 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 answer questions and hear comments. 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 are essential for effective progress of D&D.

BIOGRAPHICAL SKETCHES

OPENING SESSION

Curriculum Vitae

Margaret V. FEDERLINE

As Deputy Director of the Office of Nuclear Material Safety and Safeguards at the US Nuclear Regulatory Commission (NRC), Mrs. Federline is responsible for ensuring public health and safety by managing the development of regulatory policy for the licensing and inspection of civilian uses of nuclear materials in industrial, medical, and fuel cycle applications, spent fuel transportation, as well as radioactive waste management and decommissioning.

Prior to assuming her current responsibilities, she served in increasingly responsible Senior Executive Service positions in NRC's Office of Research, Division of Waste Management, and Performance Assessment and Hydrology Branch. Mrs. Federline served as Senior Policy Advisor to NRC Chairperson Kenneth M. Carr and as Assistant to NRC's Executive Director for Operations. Prior to joining the Federal government, she participated in life sciences research and management of a commercial analytical chemistry and industrial hygiene laboratory.

Mrs. Federline's broad experience has been recognised internationally including service as Chairperson of the OECD/Nuclear Energy Agency Radioactive Waste Management Committee and Chairperson of the Halden Management Board.

Luis E. ECHÁVARRI

Mr. Echávarri, who is of Spanish nationality, was born in 1949 in Bilbao, Spain. Mr. Echávarri obtained Masters Degrees from the Superior Technical School of Industrial Engineering of Bilbao University and from the Faculty of Information Sciences of the Complutensis University of Madrid. He obtained a post-graduate degree in Management from the Industrial Organization School of Madrid, and is a Fellow of the College of Industrial Engineers of Madrid.

Mr. Echávarri began his career as an engineer in Bilbao and in 1975 joined Westinghouse Electric in Madrid. He went on to become Project Manager of the Lemoniz, Sayago and Almaraz nuclear power plants, for Westinghouse, in Spain. In 1985 Mr. Echávarri became Technical Director of the Spanish Nuclear Safety Council (CSN). He was named Commissioner of the CSN in 1987, a position which requires the approval of the Spanish Parliament.

In July 1995, Mr. Echávarri became Director-General of the Spanish Nuclear Industry Forum, a post held until July 1997, when he was appointed Director-General of the Nuclear Energy Agency of the Organisation for Economic Co-operation and Development (OECD).

María-Teresa ESTEVAN BOLEA

Industrial Engineer at the Polytechnics University of Barcelona. Degree of High Specialisation in Weld and Environmental Engineering. She belongs to the Body of Industrial Engineers of the State. She has worked in companies of Engineering and Construction and Assembly of Cement Factories, Chemical Plants, Refineries, Thermal Power Stations, Oil and Gas Pipelines. She has also worked in Power Planning, in Power Technologies, Thermal Power Stations and Nuclear Energy.

She has been Advisor of the National Commission of Energy. President of the National Council of Industry and Energy (Ministry of Industry and Energy). Deputy of the European Parliament.

Member and Spokesperson at the Commissions of Energy, Technological Research and Development and Environment. Deputy of the Spanish Congress of Deputies, Spokesperson for Energy and Environment matters. General Director for Environment and Secretary General of the Inter-ministerial Commission of Environment from the Ministry of Public Works (1979-1982) and General sub-Director at the Ministry of Public Works (1977-1978). She has worked in the General Directorate of Energy: Hydrocarbon and Gas Departments, Subdivision of Power Planning of the Ministry of Industry and Energy, and at the Subdivision of Industrial Contamination of the Ministry of Industry and Energy. In July, 2001 she was appointed President of the Spanish Nuclear Safety Council (CSN).

Antonio COLINO

Antonio Colino was born in Madrid (Spain) in 1946 where he later gained his Ph.D. in Civil Engineering. He has devoted his professional career to the electricity and nuclear field. He has worked at Bechtel Power Corporation in California (USA), Westinghouse (USA) and ENDESA, a Spanish Electrical Company, before being appointed Chairperson and Chief Executive Officer of ENRESA, the Spanish National Company for the Radioactive Waste Management, in 1996.

As ENRESA's Chairperson, he was the first Chairperson of the International Association for the Environmental Disposal of Radioactive Waste, EDRAM, and is a member of several high level advisory groups of the IAEA and the European Commission on Nuclear Energy.

He is also a member of the Board of the Spanish National Research Centre for Energy, Environment and Technology (CIEMAT).

THE SPANISH DECOMMISSIONING SCENE

José REVILLA

José. L. Revilla graduated as a chemical engineer in the Basque Country University (Spain). He began his work as a civil servant in 1987 for the technical staff of the CSN (Spanish Nuclear Safety Council). From the beginning of his professional career in CSN till 1996 he belonged to the Radioactive Waste Branch of the CSN as an inspector in charge of controlling and regulating the generation and management of solid radioactive waste in the different Spanish Nuclear Power Plants and others nuclear facilities. He has participated in the licensing process of the "El Cabril", the low-level radioactive waste repository in Spain. Since 1996 till 1999 he was in charge of inspecting the spent fuel pools of the Spanish Nuclear Power Plants and the pre-licensing process for centralised interim storage facilities for spent fuel and also for the final geological disposal concept.

Since the beginning of 1999 he is in charge, as a Project Manager, of the Decommissioning Program of Vandellós-I NPP, the first Spanish Nuclear Power Plant being decommissioned.

Paloma SENDIN

Mrs. Paloma Sendin graduated as an Economist at the Autonomous University of Madrid in 1974. Mrs. Sendin entered in 1983 the National Body of Economists and Trade Technicians as a Civil Servant.

During her career, Mrs. Sendin was appointed Director General for Exports Promotion for the Spanish Institute for the Promotion of Foreign Trade (ICEX) from 1990 to 1994, Senior Advisor at the Prime Minister's Office for the Organisation Committee of the Spanish Presidency of the EU Council from 1994 to 1996, and Director General for Mining at the Ministry of Industry and Energy from 1996 to 2000. Since the beginning of the year 2000, Paloma Sendin is Commissioner for the Nuclear Regulatory Commission of Spain ("Consejo de Seguridad Nuclear").

Mrs. Sendin is author of many articles and publications in specialised media and lectures at Conferences in the fields related to her professional background and experience. She has also been a member of several Executive Boards.

Javier Arana LANDA

Javier Arana Landa is an Industrial Engineer who completed his studies at the Superior Technical School of Industrial Engineering of Bilbao University in 1975.

From 1975 to 1986, he worked for SENER and INITEC architect engineering companies, dealing with the start-up of several nuclear projects as well as energy projects, particularly in relation to design and construction.

In 1985 he joined in the Spanish Administration, holding several positions in the Direction General for Energy. Since 1997, he became Deputy Director General for Nuclear Energy for the department of the Ministry of Economy, responsible for all nuclear energy subjects, including the follow up of decommissioning activities from technical and economic standpoints.

During his career, Mr. Landa has participated in many international committees and working groups hosted by international organisations in different areas related to nuclear energy.

José M. GRÁVALOS LASUEN

A graduate in Physics by the University of Zaragoza, Mr. Grávalos began his professional career in the Department of Nuclear Calculations of SENER. He subsequently worked at INTECSA, where he reached the post of Head of the Energy Division. Since 1985 he has been working at ENRESA, where he initially held the post of Head of the Engineering Department. In 1995 he was appointed as Director of Operations and Projects, the post that he occupies today. He is a member of the Board of Directors of Cassioppe, the Consortium of European Waste Management Agencies and several national and overseas professional associations. Mr. Grávalos is also the author of numerous articles and publications.

César DOPAZO

César Dopazo graduated in Aeronautical Engineering (AE) at Madrid Technical University (UPM). He holds a Ph.D. in Mechanical Engineering from the State University of New York and a PhD in AE from UPM. Dr. Dopazo has devoted most of his professional career, as a scientist at Brookhaven National Laboratory (BNL) and as Professor of Zaragoza University, to teaching, research and technological development in the fields of combustion, pollutant dispersion and industrial aerodynamics and hydrodynamics, with a significant number of international publications.

Dr. Dopazo has acted as a consultant to UNESA, BNL and United Technologies Corp. He has been a representative of some Spanish Ministries in EC Programmes and international organizations. He is member of the Royal Academy of Engineering of Spain and of several scientific and engineering societies. Since January 2002 he is General Director of CIEMAT (Research and Technological Development Center on Energy and the Environment) of the Spanish Ministry of Science and Technology.

Mariano Vila d'ABADAL

Mariano Vila d'Abadal is a lawyer with training from the University of Barcelona. He graduated in institutional relations and public management f the European Union in the European Centre Public Affairs Brussels (Templeton College, Oxford). He has a masters in Local Administration for the Independent University of Barcelona.

Mariano Vila d'Abadal is General Secretary of the Association of Nuclear Municipalities of Spain (A.M.A.C) since 1988. He is General Secretary of the Group of European Municipalities with Nuclear Facilities (GMF) since 1999.

He is also a lawyer in the office "M.B. Advocats Associats", with specialisation in Administrative, Environmental and City-Planning issues with emphasis on administrative questions related to the nuclear power plants.

INTERNATIONAL STOCKTAKING

Ernst WARNECKE

University education in chemistry at the Universities of Hanover and Heidelberg.

R&D work on waste minimisation in the reprocessing of spent fuel by the application of electrolytic methods at the Nuclear Research Centre Karlsruhe.

Ph.D. with a thesis in Nuclear Chemistry at the University of Heidelberg.

Development of repositories for radioactive waste at the Federal Office for Physics and Technology, Braunschweig/Federal Office for Radiation Protection, Salzgitter.

Development and application of international safety standards for radioactive waste management at the International Atomic Energy Agency, Vienna.

Decommissioning of nuclear facilities at the Federal Office for Radiation Protection, Salzgitter.

Ingemar LUND

Ingemar Lund was born in Sweden. In 1985 he gained his Ph.D. in High Energy Nuclear Physics in Lund, Sweden. During 1985-1992 he worked with research, high energy physics, at Conseil Européen pour la recherche nucléaire (CERN), France/Switzerland.

In 1992, Ingemar Lund joined the Swedish Radiation Protection Authority, SSI, working with issues connected to Occupational Exposure. Further to this he also co-ordinates SSI's work with decommissioning issues.

Gordon LINSLEY

Gordon Linsley has a B.Sc. in physics and a Ph.D. in solid state physics both awarded by the University of Sheffield in the United Kingdom. He was a staff member of the United Kingdom's National Radiological Protection Board (NRPB), from its inception in 1970 until 1984. During a period as a radiation protection advisor, he acquired a broad experience in relation to safety in the uses of ionising radiations in industry, research and medicine. From 1976, the focus of his work changed to environmental impact assessment and subsequently, he led a group at NRPB, which carried out several important impact assessments including the first comprehensive assessment of the 1957 Windscale Fire.

In 1984, he joined the International Atomic Energy Agency (IAEA), Vienna, Austria, to lead a group concerned with the environmental aspects of radioactive waste management, safety assessment and radiological criteria for application to waste management. Since 1996, he has been Head of the Waste Safety Section at the IAEA. This section is responsible for establishing international safety standards for radioactive waste management and providing for their application. He has been involved in the international activities concerned with establishing guidance on exemption and clearance since the mid-1980s.

José Antonio HOYOS PÉREZ

José Antonio Hoyos Pérez, currently works as a principal Administrator in the European Commission Directorate-General for Energy and Transport for Nuclear Energy, Decommissioning of Nuclear Installations.

He gained a M.Sc. Nuclear Power Engineering (Polytechnic University, Madrid), and a Masters in Enterprise Organisation (ICADE).

He has also worked in the Spanish Navy as an Engineer Officer, in a Nuclear Power Plant, Reactor, BOP, ISI engineering and also in Private industry, in Management of nuclear technology and services supply (waste management, inspection technologies. Further to this he has worked in EC DGTREN, Nuclear Safeguards Directorate (Fuel reprocessing installations) and EC DG Enterprise (Innovation Programme, Energy Technologies).

Manuel D. IBÁÑEZ

After, graduating as an Industrial Engineer from the Polytechnic University of Barcelona, Manuel Ibáñez joined FECSA (Electrical Utility now part of the ENDESA Group) and then went on to train with Westinghouse, USA where he obtained a SRO certificate.

During his career, Mr. Ibáñez has worked as Technical Superintendent and later, Operations Superintendent of Ascó I and II NPP, he then in 1986 joined UNESA (Spanish Electricity Industry Association) and between 1990-1992 he became Liaison Engineer of the Spanish Electricity Sector at INPO. During the period 1993-1995 he was Team Leader of the European Commission TACIS Programme “On-site Assistance to South Ukraine NPP”.

In 2001, Manuel Ibáñez was promoted to Nuclear Affairs Department Manager of UNESA where he is currently working.

Manuel Ibáñez is also a representative of UNESA at the International Participants Advisory Committee (IPAC) of INPO and WANO Interface Officer (WIO) with WANO Paris Centre. Further to this is also a member of the Spanish Nuclear Society and of the Latin American section of the American Nuclear Society as well as Member of the Nuclear Working Group of EURELECTRIC He also collaborates with the IAEA and Spanish Nuclear Industry Forum and is professor of the Nuclear Energy Master Course of the CIEMAT (Spanish National Research Center).

SESSION I: GAS/GRAPHITE REACTORS

Vincent MASSAUT

Vincent Massaut holds a Master of Science in Engineering, with a specialisation in Nuclear Science from the University of Liège. He has been involved for several years in accelerated irradiation of fusion reactor materials and in robotics for the nuclear environment.

Involved since 1989 in the project of Decommissioning the BR3 PWR reactor (pilot project of the European Commission) as an assistant to the project leader, he became project leader at the end of 1992. He is now leading the department of international relations within the waste and clean-up division at SCK•CEN.

He lectures on decommissioning nuclear installations at the University of Liège. He was designated several times as expert for the IAEA concerning problems related to dismantling, decontamination and restoration of sites and is a member of different international committees on decommissioning and decontamination.

Alejandro RODRÍGUEZ

Alejandro Rodríguez is a Nuclear Engineer, and Risk Analysis Master. During several years, he was involved in design and construction of NPP and from 1991 he started working for ENRESA as a Project Manager of Vandellós-I NPP Decommissioning, and from 1998, he has been Technical Manager of the project on site.

He has been a lecturer on different courses related to nuclear energy and radioactive waste, he is a member of different international groups related to decommissioning and waste management and he has published diverse articles on these topics.

Paul B. WOOLLAM

Paul Woollam is a nuclear physicist who graduated from the University of London. He started researching reactor decommissioning issues in 1975 and presented a paper to the first international decommissioning conference held in Vienna in 1978, organised by IAEA.

Over the next 25 years Dr. Woollam became heavily involved with reactor decommissioning and particularly with policy, strategy, safety and radioactive inventory matters.

Paul was a member of the Oversight Committee supervising the world's largest reactor decommissioning project at Fort St. Vrain in Colorado. The only non-American associated with this project, his role was to advise the plant's owners on the safety implications of the work. He has also presented evidence to USNRC hearings on decommissioning rule-making and is on the Decommissioning Executive Committees of both EPRI and ANS. Over the past two years he chaired the OECD/NEA Expert Group on decommissioning policies, strategies and costs. He recently gave evidence to the UK's first Public Inquiry related to a reactor decommissioning project.

Dr. Woollam is currently Decommissioning Manager with British Nuclear Fuel's Magnox Generation Business.

He is married with two daughters and lives in the Cotswold Hills in England.

Tadamichi SATOH

Tadamichi Satoh graduated from the University of Hokkaido (Nuclear Engineering) and entered The Japan Atomic Power Company in 1974.

Between 1974-1994 Tadamichi Satoh has worked in Radioactive Waste Management and Health Physics, Public Acceptance on Radiation Safety and Environment Radiation Safety (9 years).

From 1994-2003, he worked in Decommissioning Planning and Preparing Works for Tokai-1 Project.

Tadamichi Satoh is currently the General Manager, for the Decommissioning Project Department, in the Japan Atomic Power.

SESSION II: LIGHT WATER REACTORS

Luigi NOVIELLO

After gaining his electrotechnical Engineering with honours, in 1964 at the University of Rome, Luigi Noviello was engaged by ENEL (Ente Nazionale Energia Elettrica) in the Engineering Division. He was involved in the start-up, automation tests and installations of several Thermal power plants as well as the start up of process computers in NPP.

As manager of the Nuclear Engineering Division at ENEL, he coordinated the bid evaluation for the fifth NPP of ENEL and was involved in the development of Nuclear Standard Plant (PUN). He was further assigned to the Nuclear Systems Branch of the Engineering Division and became active in the setting of the PWR standard plant (PUN) national policies.

In 1991 responsibilities were assigned to him in the European initiative (EUR) and he was appointed Chairman of the EPP Steering Committee, the joint project of Westinghouse and 7 European Utilities to adapt the AP600 design to EUR. He was appointed Director for the Engineering unit, responsible for decommissioning strategy for Italian NPPs.

Currently Luigi Noviello is the Director of Quality Assurance Department of SOGIN and also a member of the S.C. of the Consortium for the decommissioning of the Italian fuel cycle facilities. He has been with SOGIN (former ENEL NPP management) for 37 years.

Klaus SCHIFFER

Dr. Klaus Schiffer is head of the decommissioning department in EON Kernkraft GmbH, one of the major utilities in Germany. Since 1995, he has been involved in licensing and planning of upgrades of nuclear power plants, operation of boiling water reactors, conceptual planning and licensing of decommissioning for the nuclear power plant in Würgassen. He has also been involved in the same activities since 2001 in Stade.

After gaining his PHD at the University of Cologne in nuclear physics and nuclear chemistry, he went on to work at the Nils Bohr Institut Copenhagen for 2,5 years and then at the Australian National University in Canberra for 2 years.

Ján TIMULÁK

Ján Timulák completed his Master of Science in Chemical Engineering and Doctor of Philosophy in Nuclear Chemistry at the Slovak Technical University of Bratislava in 1974 and 1983 respectively.

Currently Ján Timulák is the director for the Decom Slovakia, spol. s r.o. and is actively involved in the management of engineering work in the field of NPP decommissioning, radioactive waste and spent fuel management. He is responsible for deep disposal development in the Slovak Republic.

Prior to 1993, he has gained experience in Engineering work in the field of chemical engineering as well as the measurement of radioactivity in surface waters. He has also worked in the field of research of radioactive waste management – solidification of liquid waste.

Ján Timulák is a member of the Slovak Nuclear Society. He speaks several languages fluently and is married.

Håkan STERNER

Håkan Sterner is Project Leader Conceptual Planning and International Projects et the Energiewerke Nord GmbH (EWN). He started in the nuclear business 30 years ago in the Research Center Studsvik in Sweden, continued in the Eurochemic reprocessing plant in Mol in the waste management area and worked subsequently by the Engineering company Noell in Germany with the design of a plant for conditioning of fuel elements in view of direct disposal. Since 1992 he has been with Energiewerke Nord in the decommissioning project of the Russian WWER reactors. Present responsibilities include all international activities, conceptual planning and IT-systems. Presently he is also Project Manager for the decommissioning project AVR, i.e. the High Temperature Pilot Reactor at the Research Center site.

SESSION III: NATIONAL STRATEGIES

Stan GORDELIER

Stan Gordelier is a Fellow of the Institute of Mechanical Engineers and the Institute of Nuclear Engineers. He graduated in mechanical engineering and joined the nuclear power generation industry, working in research and development for the Central Electricity Generating Board in the UK.

He spent the first 10 years of his career in nuclear R&D, the second 10 years in technical support for operating nuclear plant and, when the first commercial reactor in the UK moved into decommissioning, took up a full time role in radioactive waste management and decommissioning and has stayed in that field ever since. During his career he had worked for the CEGB, Nuclear Electric, Magnox Electric, BNFL and is now the Director of Southern Division of the UKAEA, responsible for the decommissioning programmes on three major sites.

Marnix BRAECKEVELDT

In 1985, Marnix Braeckeveldt graduated as an Industrial Engineer in Nuclear Energy. He then completed his Master of Safety Techniques in 1990 and in 1996 gained a Master of Science in Nuclear Engineering.

He began his nuclear career in 1986 at Belgonucleaire as Deputy Chief Safety section at the MOX-fuel fabrication facility in Dessel. This nuclear career continued in 1990 when he became responsible for elaborating radioactive waste acceptance criteria and specifications at the National Agency for Radioactive Waste Management (NIRAS/ONDRAF).

In 1994, Marnix Braeckeveldt entered the field of decommissioning and became contract-manager in charge of the follow up of the decommissioning activities at the nuclear research centre SCK•CEN in Mol, these activities are financed by a fund managed by NIRAS/ONDRAF. The most important ongoing activities cover, amongst others, the decommissioning of the BR3-nuclear reactor. Within these responsibilities, he became the project-manager for the dry storage project of the BR3 spent fuel.

As well as a member of several international organisations, Marnix Braeckeveldt is a member of the Board of Mols Overleg Nucleair Afval "(MONA)".

Ivo TRIPPUTI

Ivo Tripputi is a nuclear engineer, who since 1973 has been involved in the design and operations of Nuclear Power Plants mainly inside the Italian utility ENEL.

After the closure of all Italian NPP's after Chernobyl, in the 90s he participated in the development of the utility requirements for a new generation of reactors, both in the US at EPRI and in Europe in the EUR organisation. In the last organisation he was responsible for the safety requirements and the Containment system requirements.

More recently, after SOGIN was created for the decommissioning of all nuclear installations in Italy, he took the responsibility for the Interim storage of all spent fuel.

Since February 2003, he is the Director of the SOGIN Department for the Decommissioning of the Nuclear Fuel Cycle Installations.

Dominick A. ORLANDO

Mr. Orlando's experience in the field of radiation safety and radioactive and chemical waste management spans 17 years and includes work in research, private consulting and service with the Federal government. Currently, he is a Technical Assistant in NRC's Decommissioning Branch, in the Office of Nuclear Material Safety and Safeguards. In this position he is responsible for the review, evaluation and co-ordination of all technical, policy and administrative issues within the Decommissioning Branch and is the principal advisor to the Branch Chief in these areas. Prior to his assuming his current position, he was a Project Manager in the Decommissioning Branch where his principal responsibilities included development and co-ordination of NRC's regulatory policies and positions on mixed waste and Superfund issues, source material issues, and the development guidance for decommissioning and radioactive waste management. In addition, he has been the project manager for the decommissioning of several materials, fuel cycle, and non-power reactor facilities.

He earned a Bachelors of Science degree from St. Mary's College of Maryland in 1979. He currently lives in Catonsville, Maryland with his wife and two daughters.

Jean-Jacques GRENOUILLET

Jean-Jacques Grenouillet is a graduate engineer in Mechanics and Microtechniques and he has got a Master of Science degree in Mechanics.

He has been working with Électricité de France since 1982 always in the field of nuclear energy. He started his career within the Nuclear Operation Division of EDF where he was first involved in the commissioning of Saint-Alban NPP (2 x 1 300 MW units) from 1982 to 1986. He then held different positions on several NPPS or at corporate levels where he was responsible for the implementation of modifications and improvements on EDF power plants. In 1988 he joined EDF Engineering Division where he was responsible for the development of EDF nuclear engineering activities in Eastern and central Europe. At that same time he started to be involved in the development of several decommissioning projects in Central Europe and he is currently responsible for the development of EDF activities in the field of decommissioning and radwaste management outside France.

SESSION IV: OTHER FUEL CYCLE FACILITIES

Guy DECOBERT

Guy Decobert is currently working for AREVA/COGEMA Reprocessing Business Unit. Prior to this he was involved in decommissioning expertise inside COGEMA, he was in charge of the construction of 2 laboratories on La Hague site (an on-site laboratory for EURATOM and a laboratory for the new plutonium fabrication facility). Further to this he is managing projects dealing with decommissioning such as; the development of a cost evaluation methodology for reprocessing plants decommissioning; the Research and Development programme with CEA (the French AtomicEnergy Agency) concerning new processes for decontamination knowledge management on decommissioning inside his business unit.

He has been a member of TAG since 2001.

Tim MILNER

Tim Milner has over 19 years experience of research and development with 14 years being in the area of nuclear decontamination, decommissioning and waste management. He is the Technical Manager in BNFL Inc for the D&D Operations Group at the West Valley Demonstration Project in Western New York. In addition he supports the Big Rock Point Reactor D&D project in Michigan, and the Three Building D&D Project at the East Tennessee Technology Park.

Prior to moving to BNFL Inc Tim was employed by BNFL at its Sellafield site in the UK where he worked in Research and Technology, specializing in the development and application of chemistry and chemical processes in support of decontamination and decommissioning, waste treatment and disposal of nuclear waste in the UK, Europe and USA. He is cited as inventor of numerous patents in D&D technologies and has produced articles and technical papers on a wide range of D&D related topics. Tim is a Chartered Chemist and Member of the Royal Society of Chemistry

Helmut RUPAR

Dr. Helmut Rupar was born in Graz (Austria) in 1942 and has remained an Austrian citizen although he has lived over 30 years in Germany. He studied in Vienna Technical Physics. Thereafter he was employed by Belgonucléaire (Belgium) and by Siemens AG (Germany). He started his career with development and design of fuel for breeders and thermal reactors. He continued to sell fuel reloads for Non-Siemens nuclear power plants all over the world and to provide the relevant services.

Presently he is responsible for decommissioning of four Siemens owned fuel cycle facilities in Hanau and Karlstein (Germany).

Thorsten SCHWARZ

Thorsten Schwatz complete his degree in Aerospace Engineering at the University of Stuttgart in 1995, and has worked for years in several functions in the Aerospace Industry including Marketing and Business Development. In 2000 he changed to RWE Solutions AG, the engineering service arm of the German Utility RWE (and parent of the current Employer RWE NUKEM GmbH), were he was promoted to Vice President for Marketing and Sales Coordination. Since February 2003 he is General Manager for Western Europe with RWE NUKEM GmbH. RWE NUKEM which is one of the leading European contractors for nuclear engineering, specialised in Waste Management and Decommissioning Solutions.

Kevin HAYES

Kevin Hayes possesses an Associate of Science in Manufacturing Engineering and a Bachelor of Science in Industrial Technology. Mr. Hayes has fifteen years of experience in the nuclear fuel industry, during which time he has been responsible in areas of environment, health and safety.

Currently, he is Environment, Health & Safety Manager, his responsibilities include providing leadership for meeting Westinghouse Hematite Site D&D Project goals and continually improving Project performance regarding environmental protection and occupational health and safety. Mr. Hayes manages radiological and non-radiological regulatory compliance, security, emergency preparedeness, and community relations at commercial nuclear fuel cycle facilities.

Previously Mr. Hayes has worked as a program manager for non-radiological regulatory compliance, as a Site Safety Coordinator and a security officer. His experience has also included security and emergency services, as well as coordination of site environmental programs.

SESSION V: SOCIAL ASPECTS

José CASTELLNOU

José Castellnou is a chemical analyst technician. From 1987 to 1997 has been member of the town council of the municipality of Vandellós, a town with two nuclear power plants. He was elected as Mayor of this municipality in 1997.

Philip MODING

Philip Moding, is currently the secretary of the Swedish network for municipalities hosting nuclear facilities, where he has been since 1977. He also works as a private consultant (KAAB Prognos AB, Sweden.).

He has a long background in Swedish radioactive waste management issues such as Secretary general to the Swedish parliamentary committee on the management of radioactive waste from 1973-76 and creating the strategies for waste management, many of these are still valid. Mr. Moding has a Licentiate in Geography and Physical planning.

Larry KRAEMER

Larry Kraemer was educated in Toronto and was elected as Mayor of Municipality of Kincardine in November 2000. His current responsibilities as well as mayor is, is as counsellor for the county of Bruce.

He was also the first Chairman of Canadian Association Nuclear Host Communities (CANHC) as well as first Chairman Kincardine Centre for the Arts) and currently is Chairman of the Board of Bruce Municipal Telephone Company and Bruce County Library Board with 18 branches. He is an avid reader, his primary interests are History, politics, Sciences and Psychology.

Allan DUNCAN

Allan Duncan graduated from Oxford University in 1966 and worked in cryogenic engineering in the US for three years. He then spent ten years with the UK Atomic Energy Authority in nuclear chemical engineering and nuclear waste management. Since 1979 he has been involved in environmental regulation, including nuclear waste disposal. He was Chief Inspector of Her Majesty's Inspectorate of Pollution and, subsequently, Head of Radioactive Substances Regulation in the Environment Agency, formed in 1996.

Throughout his career he has participated in the work of the OECD Nuclear Energy Agency, the International Atomic Energy Agency and the European Commission. Since retiring in 2000, he has continued as a member of the EURATOM Scientific and Technical Committee and as a member of the Nirex Waste Management Advisory Committee. He now acts as an independent environmental advisor and has supported the NEA in the areas of nuclear facility decommissioning and regulation of radioactive waste management.

LIST OF PARTICIPANTS

BELGIUM

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METCALFE, Doug	Natural Resources Canada (NRCAN)

CHINESE TAIPEI

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YANAGIHARA, Satoshi	Japan Atomic Energy Research Institute (JAERI)

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HORVATH, Ján	SE-VYZ

TIMULÁK, Ján	DECOM Slovakia, spol. s r.o

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CASTELLNOU, Josep	Ayuntamiento de Vandellós-I
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GRÁVALOS, José Maria	ENRESA
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