THE DECOMMISSIONING OF THE LATINA NUCLEAR POWER PLANT

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ABSTRACT

Following a referendum in Italy in the late 1980s, the four nuclear power stations owned and operated by the state utility ENEL were closed down. During the late 1990s, twin decisions were made to privatise ENEL and to transform the nuclear division of ENEL into a separate subsidiary of the ENEL group. This group was renamed Sogin and during the past year, the shares in the company have been transferred from ENEL to the Italian Treasury. After agreeing to close the Italian NPPs, ENEL selected a "safestore" decommissioning strategy; anticipating a safestore period of some 40-50 years. This approach was consistent with the funds collected by ENEL during plant operation, and was reinforced by the lack of both a LLW repository and an unambiguous set of clearance limits for the free release of contaminated materials in Italy.

On formation, Sogin was asked by the Italian government to review the national decommissioning strategy. The objective of the review was to move from a safestore strategy to a prompt decommissioning strategy, with the target of releasing all of the nuclear sites by 2020. It was recognised that this target was conditional upon the availability of a national LLW repository together with interim stores for both spent fuel and HLW by 2009. The government also agreed that additional costs caused by the acceleration of the decommissioning programme would be considered as stranded costs. These costs will be recovered by a levy on the kwh price of electricity, a process established and controlled by the Regulator of the Italian energy sector.

As Sogin considered the development of new strategies for their NPPs, they looked to BNFL for assistance. BNFL is currently decommissioning three Magnox stations in the UK and is at an advanced stage of planning for the decommissioning of two further NPPs, one of these being Bradwell, the sister station to the Latina plant. BNFL Group also has considerable experience of prompt decommissioning programmes through, amongst others, their work at the WAGR reactor in the UK and at Big Rock Point in the US. The combination of Sogin's site and plant operations experience with BNFL's power reactor decommissioning including remote operations, planning and regulatory experience was a perfect fit.

Over the past year, a revised decommissioning programme, drawing upon the combined experience of the two companies, has been developed. This has incorporated a study for dismantling the reactor vessel and contents, the bio-shield and embedded equipment and the handling and packaging of wastes for disposal. This has been achieved despite a very demanding time-scale. Theoretical and practical experiences from both Sogin's site operations and BNFL's operations in North America and Europe have been used to quantify liabilities and progress the planning process to the point where Sogin have been able to define their funding requirements for Latina with their stakeholders.

HISTORICAL PERSPECTIVE

The history of commercial nuclear power in Italy dates back nearly 40 years to the opening of the Latina reactor in 1963. In the same year, the nationalised electricity utility ENEL was formed by the combination of the existing private utilities, including Simea (the operator of Latina), Selni, (the operator of Trino) and Senn (the operator of Garigliano). By 1978, the BWR reactor at Caorso was on line and the earlier BWR at Garigliano had been retired. Plans for a further reactor at Alto Lazio were also well advanced. However, the Chernobyl accident in 1986 triggered a strong anti-nuclear sentiment in Italy, and in 1987, a referendum resulted in a decision to close the remaining nuclear power stations. In 1992, after a five-year moratorium, the Italian Government took the final decision to permanently shut down all Italian NPPs (Figure 1).

	Type	Designer	MWe	Commercial Operation	Plant Shutdown
Latina	Gas Graphite	TNPG	200	1963	1986
Garigliano	BWR Dual Cycle	General Electric	150	1964	1978
Trino	PWR	Westinghouse	260	1964	1987
Caorso	BWR	AMN - GETSCO	860	1978	1986

Fig. 1. The Italian NPPs

The closed NPPs continued to be owned and managed by the state owned utility ENEL, which remains the largest utility in Italy (and one of the largest in the world). However, during the late 1990s, the decision was made to privatise ENEL and at the same time, to transform the nuclear division of ENEL into a separate subsidiary of the ENEL group. This subsidiary was renamed Sogin. Finally, in late 2000, the shares in Sogin were transferred from ENEL to the Italian Treasury.

The newly formed organisation was tasked with three main objectives:

- To manage the post operation activities of the four Italian NPPs,
- To manage the decommissioning, spent fuel management and site restoration issues associated with each site,
- To pursue business opportunities in external markets drawing on ENELs nuclear experience.

BNFL's operations combine the capabilities and interests of the former BNFL, Westinghouse, ABB and Magnox Electric organisations. The company has considerable nuclear site management experience and is familiar with owning and managing nuclear liabilities over long periods of time. The company has also developed considerable regulatory and risk management experience as it has started to decommission its earlier plant, some of which date back to the 1940's. This breadth and depth of D&D experience, both in terms of alpha and beta/gamma projects, has helped BNFL to gain significant experience of the developing reactor decommissioning market.

DECOMMISSIONING STRATEGIES

Prior to the closure of the Italian NPPs, ENEL had developed a safestore decommissioning strategy. The strategy anticipated a safestore period of some 40-50 years. Both the strategy and the safestore period were designed to be consistent with the funds that had been collected by ENEL during plant operation, i.e., over the period 1964-1987. Furthermore, the overall approach being adopted was reinforced by the lack of both an Italian LLW repository and an unambiguous set of Italian clearance limits for the free release of contaminated materials. After the NPP closure decision, it was agreed that decommissioning work should start, commencing with the Garigliano station which had closed some 10 years earlier, and this station is now close to being in a safestore condition.

However, when Sogin was formed, the Italian government instructed the new management to review the Italian NPP decommissioning strategy. The objective of the review was to assess the feasibility and impact (both technical and commercial) of changing from the existing safestore strategy to a more aggressive decommissioning strategy, with the target of releasing all of the nuclear sites by 2020. It was recognised that this target was conditional upon the availability, by 2009, of a national LLW repository together with interim stores for both spent fuel and HLW.

From the outset, the government recognised that any additional costs due to the acceleration of the decommissioning programme would have to be considered as "stranded costs". It was envisaged that these extra costs would have to be recovered by a levy on the (kwh) price of electricity, and that the whole process of financing the new decommissioning programme would be established and controlled by the Regulator of the Italian energy sector. Obviously, a revised strategy, programme and overview of associated decommissioning costs was required quickly so that the appropriate funding measures could be put in place.

As Sogin considered the development of prompt decommissioning strategies for their NPPs, BNFL was an obvious source of support and assistance. BNFL has enjoyed a long relationship with the Italian nuclear industry, both as a supplier of fuel and reprocessing services, but also (since the acquisition of Magnox Electric in 1998) as a fellow utility. Furthermore, BNFL is currently decommissioning three Magnox stations in the UK and is at an advanced stage of planning for the decommissioning of two further NPPs, one of these being Bradwell - the sister station to the Italian Latina plant. Finally, BNFL Group (through Westinghouse and ABB) has considerable experience of most of the major reactor types and significant experience of prompt decommissioning programmes through, amongst others, their work for the UKAEA at the WAGR reactor in the UK and at Big Rock Point in the US. The combination of Sogin's site and plant operations experience with BNFL's remote operations, planning and regulatory experience was attractive to both parties.

THE DEVELOPMENT OF A PROMPT DECOMMISSIONING STRATEGY

Over the past year, a revised decommissioning strategy with associated programme and cost, has been developed for the Latina NPP drawing upon the combined experience of Sogin and BNFL. This has been achieved despite a very demanding time-scale. Theoretical and practical experiences from both Sogin and BNFL's operations in North America and Europe have been used to quantify liabilities and progress the planning process to the point where Sogin have been able to define their funding requirements for Latina with their stakeholders.

The target set was that the reactor was to be decommissioned to green field within 20 years, recognising that the higher radiation levels would require the deployment of totally remote dismantling techniques for the reactor core components. A major factor in the planning assumptions was the availability of a repository in 2009. Without such a repository, prompt decommissioning is not practicable. For this reason, a second planning constraint has been that during the period 2000-2005, decommissioning must progress in a manner which does not preclude returning to a safestore strategy should the repository not materialise.

Further critical issues identified are:

(a) The lack of free-release clearance levels. At this time there are no "free release" clearance levels set by law for the whole of Italy. During the second half of 2000, preliminary free release levels were set for Caorso by ANPA(1). Future permits for the other NPPs and other nuclear installations are expected on a case-by-case basis.

(b) Waste acceptance criteria. Technical Guide #26(2) is the Italian regulation that specifies acceptable final waste forms and the properties of the conditioned wastes. Three categories of waste are considered as a function of activity concentrations. It is assumed in the decommissioning plans that TG 26 will form the basis of the acceptance criteria for the LLW national repository. Still to be defined however, are issues such as: the maximum dimensions and weights that can be handled in the repository, the possibility of delivering whole components to the repository and issues connected to waste characterisation requirements and the cost of disposal.

(c) The speed at which licensing applications can be processed by ANPA. The Italian licencing process is very complex and it is recognised by all parties that it needs to be speeded up. Sogin and ANPA are now trying to develop a joint approach to resolving this problem.

THE SCOPE OF THE LATINA STUDY

The first task of the study team was to clarify the boundary conditions for the project. The scope of the study was defined as being, "the retrieval of all plant and structures within the confines of the secondary bio-shield and annexes". As such the study considered: the reactor vessel and contents, the bio-shield and embedded equipment, all stored waste and all plant remaining on the pile cap or within the annexes. The physical scope of the study is shown diagrammatically in Figure 2.

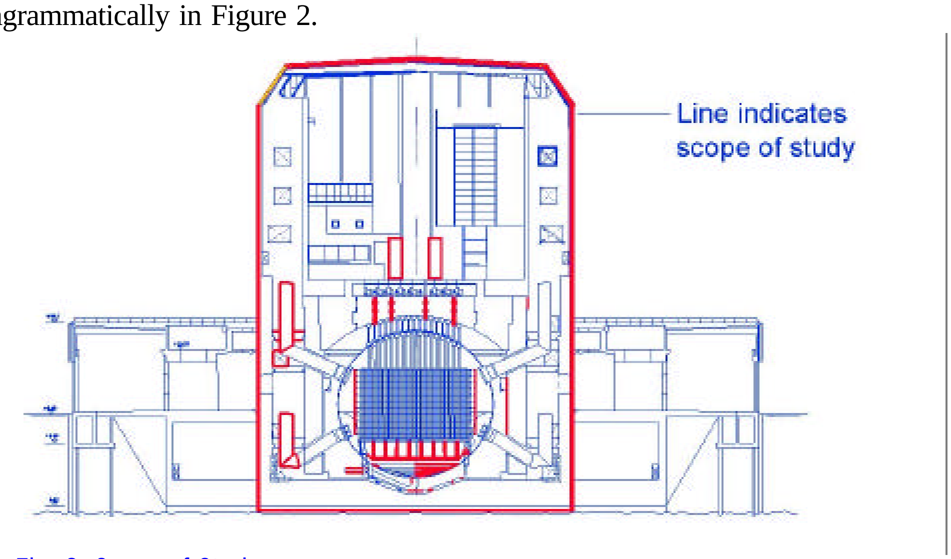


Fig. 2. Scope of Study

The study was based upon BNFLs existing Pre-Decommissioning Safety Report (PDSR) for the Bradwell NPP in the UK. The PDSR describes in detail a fully remote method of dismantling the NPP to a green-field site. However, significant modifications were made to the Bradw ell document, drawing upon the site-specific experience of the Sogin staff at Latina and BNFLs hands-on decommissioning experience at the WAGR reactor at Sellafield in the UK.

An early conclusion by the study team was that the dismantling procedure would be a fully remote, top-down approach, accessing the reactor from a single hole in the pile cap. All core components would be removed using tools deployed on two main manipulator types:

(a) Fixed base "snake" manipulators. These are 15 degree-of-freedom manipulators with a reach of up to 6.5m (Figure 3)

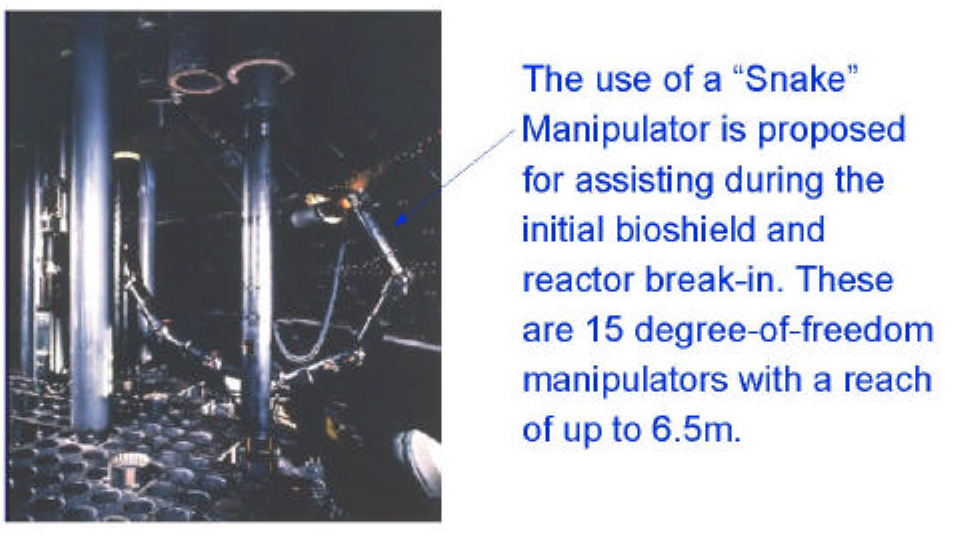


Fig. 3. Fixed Base "Snake" Manipulator

and

(b) Remote handling machines (RHMs). These are standard machines that can be fitted with BNFL developed accessories in order to perform a range of tasks within the reactor vessel (Figure 4).

Standard Remote Handling Machines (RHMs) are recommended for operations within the reactor vessel. These machines can be fitted with "off-the-shelf accessories (wide tracks, automatic tool change, automatic power connections, cameras etc).

Fig. 4. Remote Handling Machines

The study concluded that waste would be removed from the reactor, in purpose designed baskets. The waste would first be carried upwards through the same pile cap penetration before passing downwards through a shielded waste route to a dedicated waste management facility (WMF) at ground level where it would be characterised and sorted for waste optimisation purposes.

The decision to use the RHMs (as opposed to a "mast" manipulator approach) was made on the grounds of cost, weight and flexiblity. In addition, the study team also favoured the use of proven, currently available tools and equipment wherever possible in order to reduce operational risks. BNFL has considerable experience and site-feedback of both the snake manipulators and RHM. The company also has computer simulation packages already set up that allow manipulator operations to be planned and optimised and operators trained prior to deployment and use on site.

THE REACTOR DISMANTLING PROCEDURE

Before breaking through the pile cap and beginning the decommissioning proper, the study team recognised that a number of new facilities and systems needed to be installed. These included: maintenance facilities, ventilation plant, control equipment, a shielded transfer cell, a shielded waste route and a waste management facility for waste characterisation and sorting.

The benefits of bringing together the combined capabilities of the Sogin site team with BNFLs decommissioning team were highlighted during the detailed design and positioning of the waste management facility and waste route. This provided a perfect example of how BNFLs prior experience and Sogin's plant knowledge could be brought together to optimise the final waste strategy for the plant.

Following installation of the new facilities, decommissioning proper would begin with the removal of "long" items from the core and mortuary tubes (Figure 5).

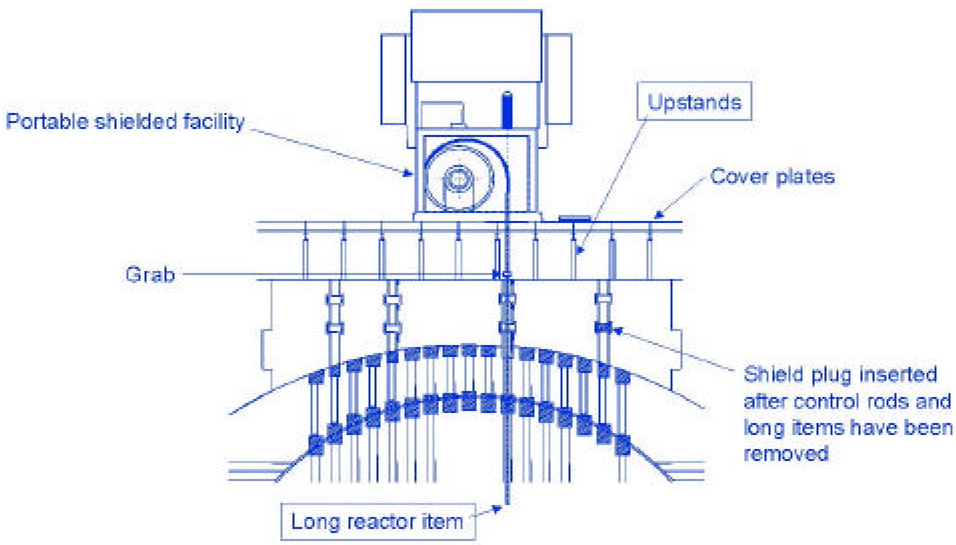


Fig. 5. Long Item Retrieval

This procedure would utilise the new portable shielded facility located on the existing fuelling machine gantry. Items such as control rods would be raised into the facility and cut into pieces prior to transfer to the waste management facility and shield plugs inserted after the items have been removed.

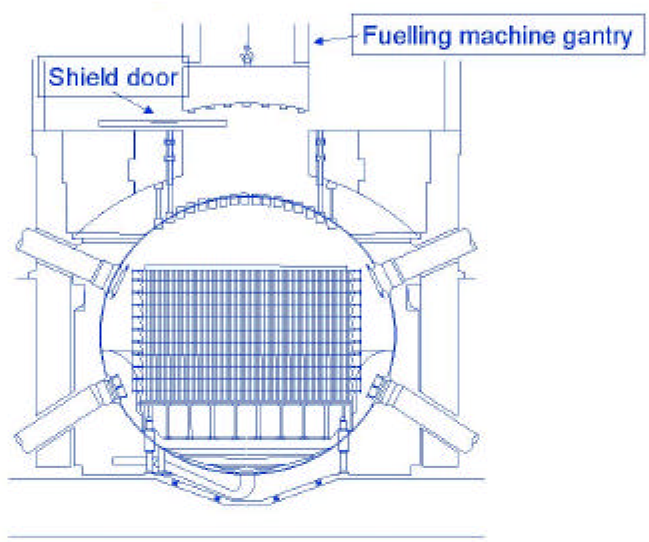


Fig. 6. Pile Cap Block Removal

Once these items have been removed, work can commence on creating the pile-cap penetration. To achieve this, the study team recommended the use of a diamond-wire saw, the wire being threaded using a fixed-base snake manipulator. The pile-cap block will be supported and removed by a lifting assembly mounted on the fuelling machine gantry. After removal, a shield cover will be moved over the penetration, the gantry dismantled and a transfer cell constructed (see figure 7).

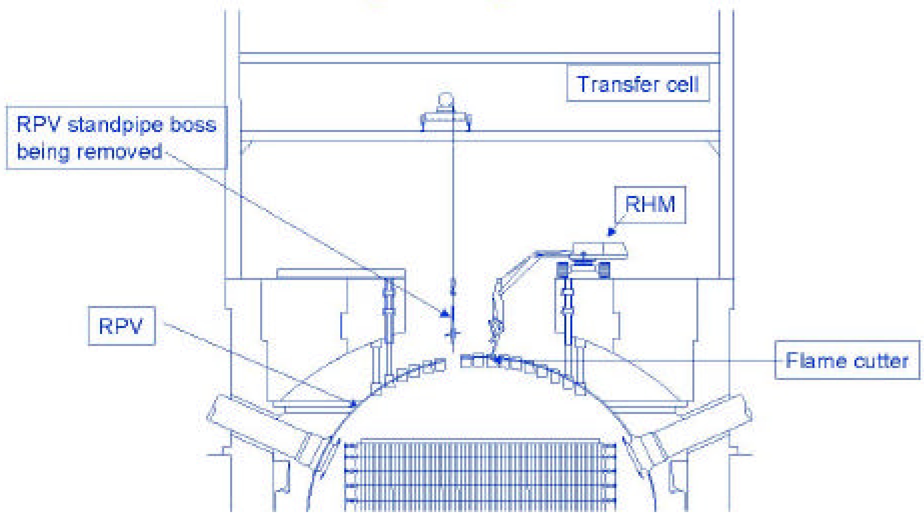
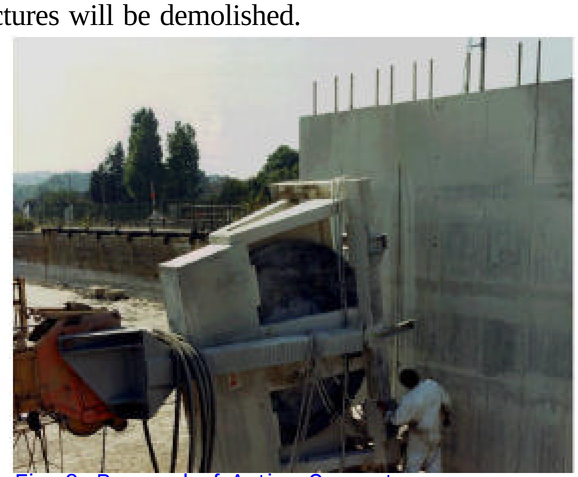


Fig. 7. Cutting Through the RPV

The next task planned is the removal, in pieces, of the top of the reactor pressure vessel (RPV). The RPV would be flame-cut using a manipulator mounted on an RHM (Figure 7). Once the RPV penetration is complete, an RHM will be lowered onto the charge pan. The remainder of the core steelwork will then be removed using the combined capabilities of the RHM and a snake manipulator. These two devices would then be used to remove the graphite core and associated steelwork, before the RHM would be used on its own to cut the diagrid, vessel bottom dome and the remaining steelwork.

The removal of the remaining pile-cap and any active concrete from the pile floor would then be achieved in three stages. Firstly, any activated concrete in the floor will be removed using an hydraulic breaker and flame cutter mounted on an RHM. Secondly, the remaining pile-cap will be cut and broken out before, thirdly, removing any active concrete, including any fallen from above, from the floor.

The activated layer of concrete in the wall of the bio-shield will then be removed using a circular saw mounted on rails. Vertical and horizontal cuts will be made and the blocks of concrete will be broken out using wedges (Figure 8). At this point, the mortuary tubes will also be cut out and removed. Following this, the remaining equipment will be dismantled and the buildings and facilities decontaminated and surveyed. Finally, the building structures will be demolished.



Large circular saws will cut the bioshield walls into 1m square blocks ready for breaking away from the wall and disposal.

The prototype saw is shown here during tests.

Fig. 8. Removal of Active Concrete

WASTE OPTIMISATION, PROGRAMME AND COST

A key factor in the design of the overall decommissioning process is the issue of waste optimisation. This was another important area where the different experiences of the Sogin/BNFL team was brought to bear with great effect; Sogin with their knowledge of the Italian regulatory experience and BNFL with their experience of the UK and US systems.

The study team concluded that in order to optimise the total volume of packaged waste requiring disposal, the plan needed to include for the following:

(a) the construction of a waste management facility (WMF) to characterise, sort and optimise the packaging of waste. The construction of this facility will require the existing pile-cap, control annex and east circulator hall to be modified as part of the preparatory activities prior to the start of actual dismantling.

(b) The use of two types of unshielded disposal boxes. First, the "4m box" for all low level waste and graphite. This container has been specifically designed to carry low specific activity material or surface contaminated objects under IAEA transport regulations(3).
A second type of disposal box, "$3m^3$ box", would be used for activated steel and concrete items, stabilised in a cementatious grout matrix. Reusable concrete over-packs would be used as shielding for the $3m^3$ boxes during on-site storage in unshielded facilities. Re-usable steel shielded flasks would be used to transport $3m^3$ boxes to the repository.

Based on these assumptions, the study concluded that the total packaged volume of activated material and low level waste graphite would be under $5000m^3$ and that the total packaged volume of the balance of low level waste (including some $1000m^3$ of non-reactor waste) would be under $12,000m^3$. This would be disposed in approximately 700- $3m^3$ boxes and 700- 4m boxes.

The total project cost has been estimated at approximately \$410M +, with \$160M for the dismantling work and new facilities and a further \$250M (based on UK rates) for the transport and disposal of active waste. In addition, the project duration has been estimated at slightly less than 12 years.

After the final study report was presented to Sogin senior management, the findings were incorporated into the revised national decommissioning plan. Both parties considered the co-operation to have been successful, demonstrating the benefits of international collaboration.

CONCLUSIONS

Over the past year, a revised decommissioning programme, drawing upon the combined experience of the two companies, has been developed for the Latina NPP. This has been achieved despite a very demanding time-scale. Theoretical and practical experiences from both Sogin and BNFL's operations in North America and Europe have been used to quantify liabilities and progress the planning process to the point where Sogin have been able to define their funding requirements for Latina with their stakeholders. The project has demonstrated, based on real experience and data, that the Latina NPP can be decommissioned economically for a known cost within the timescale set by the Italian Government.

Work now continues to generate equivalent costed programmes for the other Sogin NPPs. At the same time, as the co-operation and understanding between the two companies develops, waste retrieval and decommissioning techniques developed by Sogin are being assessed for use on BNFLs sites.

Both BNFL and Sogin consider international collaborations to be the best way of ensuring the communication of best practice across the nuclear industry; thereby helping to close the nuclear life cycle with potential benefits to the credibility of the industry and improving the prospects for possible future nuclear development.

REFERENCES

(1) Decree #230, "The recycling, reuse and release of radioactive materials within the licencing process of Caorso NPP decommissioning"(translated), August 2000. Issued by the Italian Ministry of Industry.

(2) 'Gestione Dei Rifiuti Radioattivi In Italia' (Appendice - Guida Tecnica #26)'
ENEA/DISP - Technical Guide #26 - 1990
(Translation No. 88/34)

(3) IAEA Safety Series #80
Shedule of requirements for the transport of specified types of radioactive material consignments (as ammended 1990)
IAEA Publications, Austria 1990.
ISBN 92-0-124190-9

ACKNOWLEDGEMENTS

The authors would like to recognise the efforts of the combined BNFL/Sogin study team in producing the report that this paper draws heavily on, in particular: Luigi Brusa, Roberto De Santis, Aldo Cacace and Antonio Imparto from Sogin and Nick Meek, Bob Swenson and Gordon Bellard from BNFL.