WM'01 Conference, February 25-March 1, 2001, Tucson, AZ

DECOMMISSIONING OF A UK NUCLEAR POWER STATION IN A NATIONAL PARK - AN OWNERS PERSPECTIVE

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ABSTRACT

Trawsfynydd was one of the UK's first commercial nuclear power stations to produce electricity for the National Grid. At that time in 1965 it stood at the leading edge of nuclear technology. After over twenty-five years of successful operation and the supply of 70 billion units of electricity, the station ceased generation in 1993. Just as it was at start up, Trawsfynydd is continuing to lead the way as one of the UK's first commercial nuclear power stations to be decommissioned.

This process, to eventually make the site available for re-use, is now well under way. The principal activities comprise:

- defuelling the reactors and removal of all fuel from site;
- recovery, conditioning, packaging and interim storage of operational wastes;
- modifications to the reactor buildings and dismantling of peripheral plant to simplify and put the site into a passive state;
- care and maintenance thereafter for about 100 years from cessation of generation; and,
- final dismantling of the residual structures and site clearance.

Defuelling of the reactors was completed in 1995. Attention was then given to planning for the recovery, conditioning, packaging and storage of the operational wastes and these preparations are now well advanced. In the interim the reactor buildings have been partially deplanted, the cooling ponds have been drained, desludged, and deplanted and some conventional plant has been removed.

Planned work in this phase includes the reduction of the primary gas circuits to be followed by the lowering of the reactor buildings and their subsequent enclosure as 'safestores'; the decontamination of the cooling ponds, the clean up of all waste processing and treatment plant; the deplanting and demolition of the turbine hall and all other conventional plant followed by landscaping of cleared areas.

Decommissioning of nuclear plant on this scale has not been undertaken before in the UK other than at Berkeley and Hunterston and the work practices at these sites and at Trawsfynydd have had to evolve largely from own experience. Hazard identification, assessment of risk and reviews of the adequacy of control measures have been ongoing processes. A total risk approach has been taken of which radiological risk has been only one component. Optimisation of risk has required careful consideration of all risks. As the work has progressed, a better appreciation of the hazards and the risks has developed.

There have been other issues to address at Trawsfynydd, not least the social and economic aspects of managing the closure of a power station in a low employment area. In addition there have been the environmental aspects to consider. Having to manage the decommissioning process within a National Park, by definition an area of outstanding natural beauty, has required special considerations.

INTRODUCTION AND BACKGROUND

Trawsfynydd Power Station was one of eleven Magnox nuclear power stations built in the UK. Seven of these remain operational - the original BNFL sites of Calder Hall and Chapelcross and the five Magnox Electric sites of Bradwell, Dungeness A, Oldbury, Sizewell A and Wylfa. Four of the eleven sites have been shutdown - the Magnox Electric[2] sites of Berkeley (in 1989), Hunterston A (in 1990), Trawsfynydd (in 1993) and recently Hinkley Point A (in 2000).

These four stations were first generation Magnox design each comprising two gas-cooled reactors with steel pressure vessels using natural uranium magnox clad fuel. At that time in the early/mid 1960s, as the UK's first commercial nuclear power stations to produce electricity they stood at the leading edge of nuclear technology. Just as they were at start up, they are continuing to lead the way as the first to be decommissioned.

Construction of the Trawsfynydd nuclear power station started in 1959 and the plant was commissioned in 1965 with a nominal electrical output of 400 megawatts. After a successful operating period of over 25 years the reactors were shut down in 1991 because of concerns over the materials property data used to support the reactor pressure vessel safety case. Following an extended period, during which endeavours were made to prepare an economic case for continued operation, closure was formally announced in July of 1993.

Defuelling started almost immediately in November 1993 and was successfully completed ahead of programme and below budget in August 1995. Decommissioning and waste management activities have been progressing at the site since; the objective being to put the site into a minimum cost care and maintenance regime at the earliest opportunity. The projected date for this is March 2006.

The work practices have had to evolve largely from own experience. Simple techniques have proved to be most successful. Hazard identification, assessment of risk and reviews of the adequacy of control measures have been ongoing processes. A total risk approach has been taken of which radiological risk has been only one component. Optimisation of risk has required careful consideration of all risks. As the work has progressed, a better appreciation of the hazards and the risks has developed.

There have been other issues to address, not least the social and economic aspects of managing the closure of a power station in a low employment area. In addition there have been the environmental aspects to consider. Having to manage the decommissioning process within a National Park, by definition an area of outstanding natural beauty, has required special considerations.

To set the scene the paper first provides a summary of the development of the decommissioning strategy. The social and economic aspects and the environmental considerations are discussed. Waste management and decommissioning progress to date is reported and future intentions given. The paper identifies the principal hazards, describes the risk assessment process and reports on EHS performance. Finally and most importantly the paper shares some of the lessons learnt.

STRATEGY, OBJECTIVES AND PROGRAMME

Strategy

Decommissioning strategy development work associated with the Magnox Electric reactor sites started in the late 1970s and has continued to this date. The preferred decommissioning strategies for the reactor sites have evolved and changed over the years to reflect increasing knowledge and as a

result of the application of rigorous strategy options identification, analysis and review processes. All aspects of decommissioning have been considered and detailed technical proposals, plans and costings are available for each of the Magnox Electric reactor sites (1).

The potential benefits of deferring some dismantling work (e.g. of the reactors) for a period were first identified about 20 years ago. Deferral of some dismantling has been a key component of the decommissioning strategies ever since, although the extent of this and the deferral period assumed have varied. By allowing the residual radioactivity to substantially decay prior to the dismantling of the reactors, this approach minimises the exposures of workers, the technical complexity of the task, the volumes of secondary wastes and the cost. From this background and for these reasons, the safestore strategy[3] evolved and was formally adopted by Nuclear Electric[4] in 1991.

Work has been continued by Magnox Electric (since its formation in 1996 and integration with BNFL in 1998) to further develop and review decommissioning proposals and strategies. In the last two years a major strategy review, assessing a wide range of relevant factors, has been undertaken. In parallel with which, extensive discussions have been held with the regulator. The work has culminated in the adoption of a revised safestore strategy which involves the early dismantling of large parts of the Magnox reactor sites but defers the dismantling of the reactor buildings and their main contents (e.g. reactors and boilers) for a notional period of around 100 years.

It is considered that this revised strategy is a reasonable and balanced response following consideration of all of the relevant factors and their associated benefits and dis-benefits. As a result this strategy has been adopted as the basis for the financial provisions for the decommissioning of the Magnox Electric reactor sites now and in the future. The revised strategy has also been used as the basis for the quinquennial review submission that was sent to the Nuclear Installations Inspectorate (NII) for assessment at the end of April 2000 (3).

In summary, this revised safestore strategy comprises the following phases:

- Defuelling (~ 2 year duration)
  - Removal of all fuel from the reactors and ponds
- Care & Maintenance Preparations (~ 7 year duration overlapping with defuelling)
  - Recovery, processing, packaging and storage of the operational wastes (for which a new storage facility may be required)
  - Dismantling of all plant and structures other than the reactor buildings
  - Refurbishment as required of the reactor buildings (and limited dismantling within)
- Care & Maintenance (several tens of years)
  - A prolonged but mainly quiescent period but including refurbishment of reactor buildings as required to maintain safety and security standards
- Site Clearance: (~ 8 years duration, sequenced programme notionally beginning around 100 years after the first station shutdown)
  - Removal of remaining site structures and site delicensing

These strategy changes, and local or site specific circumstances, have been reflected in the decommissioning work performed on the sites to date and that planned for the future. However, the most recent strategy change is resulting in a more consistent approach across all sites. The three sites, Berkeley, Hunterston and Trawsfynydd, are in the care and maintenance preparations phase and are aiming to fully dismantle all structures other than the reactor buildings prior to entering the care and maintenance phase. Waste management work is also proceeding on these sites to retrieve and package accumulated operational wastes. This will result in a packaged waste store also remaining on each of the sites into the care and maintenance phase.

Objectives

The development of decommissioning strategies as described above has been performed in accordance with a number of key objectives or principles that have been specifically defined for the purpose. These have been modified or redefined a number of times over the period but have consistently stated the primary importance of maintaining the continuing safety of the public and workers on the sites. Next in importance comes the maintenance of appropriate environmental standards and minimising environmental impact. Cost minimisation has also been recognised as a key issue but it has always been placed below safety and environmental standards in order of importance.

Programme

The Trawsfynydd decommissioning programme is given below:

Activity/Phase	*Current position*
Defuelling	Completed in 1995
Preparations for care and maintenance	Some work completed, other work in progress or planned
Consolidation of 'safe stored' site	Safety case(s) completed / in progress
Care and maintenance period	Entry planned - April 2006
Reactor dismantling and site clearance	Deferred until ~ 100 years from shutdown

SOCIAL, ECONOMIC AND ENVIRONMENTAL CONSIDERATIONS

Soon after the closure announcement, the company was approached by local representatives who suggested that local people should have a say in how the power station would be decommissioned. It was recognised that some special factors applied at Trawsfynydd, including the unplanned closure, the significant input that the power station had to the local economy, and its location within the Snowdonia National Park. After some debate within the company it was agreed that the public local to the power station should be consulted. (4).

The public consultation exercise was carried out in April and May 1994. Particular efforts were made to ensure that the views expressed would be those of an informed, local population. A special display was prepared which identified the decommissioning options that were available. Those who attended the display were given the opportunity to complete a questionnaire, which had been prepared by an independent opinion pollster. In order to prevent the consultation being hijacked by pressure groups, the questionnaire was only made available to those who attended the display. In addition to the display, presentations were made to the local councils and to trade union officers as representatives of the staff.

The options presented during the consultation ranged from early site clearance through various forms of deferred site clearance or safestore options to in situ decommissioning or mounding. For each option, data were given on a number of parameters such as the risk to those doing the work, the cost, and the direct effect on the local community, for example by lorry movements to and from the site.

The result of the public consultation was that a majority of local people preferred deferred site clearance to early clearance or mounding. This suggested that the benefits of allowing highly radioactive components to decay, thereby reducing risk to workers, were recognised as significant. In addition, two key issues were identified. The work on site should be maximised in the short term (so as to minimise the effects of closure on the local economy) and in the longer term the visual impact of the site should be reduced. Not all of the local councils agreed with these views but nevertheless the company decided that it was reasonable to adapt the decommissioning strategy for Trawsfynydd to

take account of the general views of the local community. Therefore an early reduced height safestore strategy has been adopted for the site within the framework of the Company's generic strategy.

Having determined the decommissioning and radioactive waste strategies to be applied, the question was raised of whether or not planning consent under the Town and Country Planning Act was required. As Trawsfynydd is located within the Snowdonia National Park, the local planning authority is the park authority rather than the local council. Thus the view taken by the planning authority on the applicability of the Town and Country Planning Act is different to that taken at sites not in a National Park. After some debate, and both sides having sought legal advice, the company decided that a planning application would be submitted for the long-term appearance of the Trawsfynydd site and the continued use of the site for the storage of radioactive material. BNFL does not accept that planning consent is needed for any of the activities being carried out at Trawsfynydd nor for the care and maintenance period up to final site clearance; however, the pragmatic decision has been taken to submit a planning application rather than enter into a legal dispute to determine whether or not one is actually required.

The planning application was submitted in August 1998 and subsequently called in by the Secretary of State for Wales in December that year. The planning application was supported by a comprehensive environmental statement, which the planning authority and various other bodies had started to assess. However as time moved on, it become apparent that the environmental statement would need to be revised to take account of recent developments. Specifically a better understanding of ground water flow, timing of final site clearance from discussions with the regulator and the need or not for a new packaged waste store.

Because of these recent developments the company has written to the Snowdonia National Park Authority suggesting that work on the assessment of the existing ES should be suspended until the position is clearer. In the interim a new planning application and updated environmental statement are being prepared for submission early this year (2001).

PROGRESS TO DATE AND FUTURE INTENTIONS

Defuelling was started in November 1993 and was carried out with the reactors in air at atmospheric pressure with all control rods inserted and immobilised. Defuelling operations were undertaken on one reactor at a time, alternating between reactors, to progressively and equally reduce the fuel loading of each reactor and hence reduce the reactivity. The overall rate of defuelling was determined by the availability of the irradiated fuel transport flasks for shipping the fuel to Sellafield. The fuel was removed using the existing refuelling equipment and the fuel route, which had served to exchange fuel during operation of the station. This work was completed by August 1995, having dispatched some 67,000 fuel elements to Sellafield for reprocessing.

Attention has since been given to the recovery, processing, packaging and storage of the operational wastes and modifications to the reactor buildings and dismantling of peripheral plant to simplify and put the site into a passive state as part of the preparations for entry to care and maintenance.

Progress and future intentions in these two areas are given in the following sub-sections.

Management of Intermediate and Low Level Wastes (ILW and LLW)

Of the three categories of radioactive waste (high-level, intermediate level, and low level) it is the Intermediate Level Wastes (ILW) that were accumulated during the operation of the site that require

particular consideration post-defuelling. These wastes are therefore discussed first. Low Level Wastes (LLW) are also discussed. There are no high level wastes.

Intermediate Level Wastes

At Trawsfynydd there are four principal ILW streams and work to recover and process these wastes is described in some detail below. The processing and packaging of these wastes is expected to take until March 2004. As there is no national repository for intermediate-level wastes, the packages will have to be stored on site until a repository is available. The intention was to store waste within existing buildings. To this effect, interim storage facilities have been prepared but use of these in the long term is under review as it may not be possible to satisfactorily demonstrate safe passive storage in this way. A new store to hold all the packaged waste is being considered.

- **Fuel Element Debris (FED)**

FED consists primarily of splitters that were removed from irradiated fuel elements before dispatch to Sellafield in order to increase the number that could be sent in a fuel transport flask. This waste stream also contains nimonic springs that became detached from the fuel elements during desplittering. Their high cobalt content means that these springs become highly activated giving rise to significant doserates from the mixed waste. This waste remains stored in the original two vaults.

New plant is currently being installed to recover the FED from these vaults, to place it in Nirex[5] approved containers and to immobilise the waste in cement grout. Recovery of the first FED material is planned for later this year (2001).

- **Ion Exchange Material**

Due to its inland location and the use of a lake as the discharge route for treated liquid effluent, Trawsfynydd has accumulated a larger quantity of ion exchange media than any other Magnox reactor site. By the mid-1980s the originally installed storage facilities and additional vaults constructed during the 1970s were full. Instead of installing further additional vaults, an encapsulation plant (the Resin Solidification Plant) was built and operated to encapsulate the material in a polymer matrix. The waste was packaged in a form suitable for sea disposal but by the time the plant was operational this route was no longer available. In the absence of any other disposal route, the drum packages have had to remain on site.

The Resin Solidification Plant has since been refurbished and recommissioned and has completed its first campaign during decommissioning – Resin Vault 3. Pipework modifications have recently been made to allow the second campaign to begin and the next vault to be emptied - Resin Vault 1.

- **Miscellaneous Activated Components (MAC)**

During operation of the reactors, flux flattening bars and other in vessel components were disposed of in MAC vaults within the reactor buildings. At Trawsfynydd it has been decided that this waste will be recovered and conditioned during the care and maintenance preparation phase. The main reason for this decision was the difficulty in making a long-term safety case, meeting the requirements for passive safety, due to the location of the vaults below the reactor foundation slab and below the level of the water table. New plant has been installed to recover the MAC from these vaults, to place it in Nirex approved containers and to immobilise the waste in cement grout. Recovery of the first MAC material has begun.

Some activated and contaminated components are also stored in so called mortuary tubes built into the reactor biological shields. The mortuary tube contents will be left in place and recovered during site clearance, subject to a satisfactory safety case being made.

- **Sludges**

Trawsfynydd has accumulated sludges from corrosion products in the fuel cooling ponds and from effluent treatment plants. A transportable plant has been developed by the Company to deal with this type of waste. The plant, which encapsulates the waste in a cement matrix, has just been installed at Trawsfynydd. Recovery of the first sludge material is planned for later this year (2001).

Low Level Wastes

Minimisation of secondary waste arisings continues to be one of the principal objectives in the management of radioactive wastes. Where they do arise, maximum use is made of available disposal routes and best practicable means to reduce discharges to the environment.

Solid waste disposals have been higher than during operation, as would be expected from the nature of the work being undertaken. Typically about 300-400 m^3 a year. These wastes when suitably packaged are consigned for disposal to the national repository at Drigg in West Cumbria, either directly or via Winfrith in Dorset.

Liquid effluent discharges significantly reduced when the ponds were drained having continued at close to the same levels since cessation of generation. The active effluent treatment plant has remained in service throughout for the treatment of liquid waste arisings. Discharges are made to the lake.

Gaseous discharges have reduced from cessation of generation and remained very low. The number of fixed gaseous waste outlets will reduce as the decommissioning work progresses although this will be off-set in part as the use of mobile ventilation plant requiring temporary outlets increases.

Decommissioning

The plant decommissioning work, which is expected to take until March 2006 and will result in only the reactor buildings left (albeit at reduced height) and possibly a waste store, can be broadly divided into three areas.

Reactor Buildings and Plant

All the gas circulators and associated support plant and systems have been removed. The gas circulator hall basements have been converted into interim stores for packaged ILW.

All four fuelling machines have been dismantled. Most of the component parts have been decontaminated and made available for recycling. Other parts have had to be disposed of as low level waste.

The primary gas circuits are to be reduced to allow the reactor building roofs to be lowered. This will involve the dismantling of the upper gas ducts and the removal of the top sections of the heat exchangers. These components will then be stored within the safestore enclosures. The design work for this has begun with engineering work expected to start on site early in 2001.

The work to reduce the height of the reactor buildings will involve the removal of the existing roofs, the removal of all structures above a certain height, the fitting of new roofs and the re-cladding of the existing lower wall panels.

The reactor buildings are being deplanted in part in preparation for the reduction in height of the roofs and in part to remove redundant systems. The chargefaces are to be declassified and one will be included in the Visitor's Route.

Air purging of the reactor vessels has now ceased and following shutdown of the shield air cooling fans, the vessels will breathe to atmosphere via engineered vents. Continuous monitoring of the main parameters (temperature, moisture, etc) remains in place.

Cooling Ponds Building and Waste Storage/Treatment Plants

The fuel chutes from the reactor buildings to the cooling ponds building have been dismantled. These chutes were of a composite concrete/steel construction to provide the necessary shielding during fuel transfers. All this shielding has been cleared for free release.

The cooling pond tanks have been drained and desludged. The building has been largely deplanted. The planned decontamination of the tanks and other structures awaits the refurbishment/replacement of the ventilation system. The aim is to achieve the clearance criterion of de-minimus activity at which point the building can be demolished and the area levelled, subject to regulatory agreement.

Decommissioning of the waste storage facilities cannot be undertaken until the operational wastes have been recovered. Thereafter it is expected that these facilities will be decontaminated, deplanted, demolished and the areas levelled in conjunction with the demolition of the adjacent cooling ponds building.

The active effluent treatment plant will be required until all the decontamination work has been completed and will be the last of the active plants to be decommissioned.

Conventional Plant

Steam and feed pipework between the heat exchangers and the Turbine Hall has been removed.

The turbine/alternator sets and steam separators are being removed from the Turbine Hall. Materials have been reused or recycled where possible. Demolition of the building is planned for early 2002 with landscaping of the area to follow.

A programme of work to remove other buildings and landscape cleared areas is now underway. This will be ongoing, ending finally with the demolition of the administration and workshop buildings.

HAZARDS AND RISK ASSESSMENT

Hazards

A progressive and systematic approach has been taken to reduce the hazards.

Some 99.9% of the radioactivity inventory is removed during defuelling. The remaining radioactivity is largely associated with the reactor vessels and their internals and the operational wastes (magnox debris, redundant chutes and control rods, spent resins, etc). Thereafter radioactivity exists as residual

contamination in some plant areas (e.g. the cooling ponds), as internally contaminated primary circuit components and as accumulated low level waste awaiting disposal primarily from the decommissioning activities and to a lesser extent from the maintenance of remaining active plant.

Radioactivity is however not the only hazard. There are other hazards that have the potential to cause harm, which need to be considered and given equal attention. Conventional hazards – electricity, chemicals, asbestos, noise etc. not forgetting slips, trips and falls or being hit by moving or falling objects. On a decommissioning site where dismantling work is being carried out, the hazards associated with working at height and/or moving large and heavy items can be significant. An awareness of confined spaces, which can be inadvertently created as decommissioning progresses, is also important.

Risk assessment

Risk assessment is essentially a three-part process within the Company. It is aligned with regulatory requirements and is largely consistent with practices in other parts of the nuclear industry.

The first part of the process considers the nuclear safety issues only and is concerned with safety principles. Decommissioning activities are modifications to plant and each modification is assessed for its potential effect on nuclear safety. The initial assessment identifies those changes, which could, if inadequately conceived or executed, lead to an increase in the risk of radiological hazard and thereby defines the level of approval necessary before the change can be implemented. For those changes, which might lead to a very significant increase in the risk of radiological hazard, regulatory approval is required. For changes of lesser significance, internal approval can be given.

The second part follows from approval and considers both the radiological and conventional safety issues and is concerned with safety from the system. A detailed work specification is developed and assessed by site safety specialists.

Thereafter the work is subject to periodic reassessment. As the work progresses, a better appreciation of the hazards and the risks develops. The risks are re-assessed and where necessary additional control measures are introduced. It should be noted that in some cases re-assessment shows the risk to be reduced and control measures are relaxed accordingly.

ENVIRONMENT HEALTH AND SAFETY PERFORMANCE

Environment

Trawsfynydd's position in the National Park and by an inland lake demands the highest level of attention to environmental matters. A Land Management Plan has been established to comprehensively and sensitively manage the estate around the site. Good progress has been made with the implementation of this plan, in particular the development and maintenance of new woodlands. In due course these woodlands will provide some screening of the residual safestore enclosures.

An Environmental Management Plan sets objectives and targets for activities on site. The principles of reduce, reuse and recycle, which are at the core of the objectives, are applicable to all the decommissioning work activities being undertaken. Many thousands of tons of materials have been made available for recycling.

The site has achieved and is maintaining the ISO14001 environmental management standard.

Health

Attention is given to health promotion as an enabler to maintaining a healthy workforce. Health assessments are carried out on a task-related basis and fitness testing is made available. In recognition of the management of the health of its employees, the site has recently been awarded a Silver Award by the North Wales Health Authority.

Safety

- Industrial safety

The site has an improving industrial safety record. The current lost workday case rate (LWCR) is zero having gone over 21 months (~700,000 man.hrs) without a lost time injury to staff or contractors. The total recordable injury rate (TRIR) is less than 0.5 (one injury in the last 12 months).

As a safeguard against complacency a Safety Enhancement Plan sets objectives and targets, the development of which involves staff and contractors to ensure ownership. In recognition of the management of the safety of its employees, the site was awarded a RoSPA Gold Award for 1999/2000.

- Radiological safety

In comparison with dose accrued during the operational years, the decommissioning to date has been achieved at very low dose. The total collective dose to 1999 attributable to decommissioning to date is 1.8 man.Sv. The projected total collective dose for the completion of all the safestore preparatory work, including that already received) is 3 man.Sv.

Of the activities undertaken to date, the work within the Cooling Ponds has been and will remain the most challenging. Higher than expected internal exposures in 1999 to front line and support workers required investigation and were assessed respectively as being attributable largely to weaknesses in the engineering controls, specifically the ventilation arrangements. As a result of the investigation and subsequent re-assessment of risk, a number of improvements to the control measures have been or are being made. As the work progresses these measures will be reviewed.

ORGANISATIONAL DEVELOPMENTS

At its peak during the operation years, Trawsfynydd employed just over 600 staff. By the time of the closure announcement this had been reduced to just under 500. Thereafter the structure and resource level have followed the programme and workload. About a half (270) were retained for defuelling.

Following defuelling, numbers reduced to about 140, a level which had been broadly maintained up until March 2000 when numbers settled at about 120. Project management support currently equating to about 30 persons per year is provided from within the Company. In addition, between 80 and 120 specialist contractors support the decommissioning work, numbers varying with planned activities. In recognition of the low employment in the area, contractor firms are encouraged to use local resources and skills whenever possible.

As the resource requirement has reduced, every effort has been made to accommodate the wishes of those staff without positions. Some have taken the opportunity to retire early, others to be relocated within the Company. Surprisingly the impact on the local community in a remote area of low employment has been less that that expected at the time of closure. A report on the impact of the

decommissioning carried out in 1998 found that "local unemployment shows little sign of a significant Trawsfynydd effect" (5).

For those that remain, the Company has been clear about the future. There is work to be done and a project to deliver. When it is completed, there will be those that will take the opportunity to retire early. For those that wish to remain with the Company and are prepared either to relocate or travel "there may be life after Traws" with another decommissioning project.

In the interim, attention is being given to establishing the right organisational culture. Moving from a *process* approach to a *project* approach has been a fundamental requirement. Team building has been important and efforts have and continue to be made to better integrate staff and contractors. Safety and quality are being strengthened with the introduction of new and more widely experienced staff. Supervisors are being further developed.

The current structure comprises the following groups:

- decommissioning projects providing project and contract management and responsible for the delivery of projects to time and cost.
- standards, compliance and culture setting the highest safety standards, providing appropriate guidance, checking for compliance and most importantly taking the lead in promoting the right safety and quality culture.
- site services operating and maintaining the plant, providing security and general services.
- business support providing HR, administration, finance and procurement services.

LESSONS LEARNED

There are many lessons that have been learnt from the experience of the decommissioning of to date. Some of these have been summarised below.

The need for Vision and a clear strategy and objective

To be successful, one needs to have vision. The Trawsfynydd vision is *"to achieve world class performance in safety and decommissioning"*. To ensure that this is fully understood by all involved, the two aspects have been qualified as meaning:

For *safety (and the environment):*

- zero lost work day case rate,
- continuous improvement in total recordable injury rate,
- no significant events, and
- a clean and tidy site.

For *decommissioning:*

- doing the right things at the right times,
- making use of available disposal routes,
- knowing the end point(s), and
- achieving milestone dates, and lifetime costs within provisions.

The strategy and objective(s) must be clear and acceptable to stakeholders. Knowing where one's going and how to get there is clearly important. No less so is the management of stakeholders and

there are many to consider in the reactor decommissioning business. Not least the local community for it is these people that will continue to live around the UK reactor sites when they have been put into safestore. Providing reassurance will be an ongoing requirement.

Integrated project approach

If the objective of the care and maintenance preparatory phase is to simplify the site as soon as possible, then an integrated project approach must be adopted. Consider the project as a jigsaw. Whilst each piece is important, the 'value' comes from the sum of the pieces all of which must be in place to complete 'the big picture'.

As a means of facilitating the process, reactor sites can be simply divided into three principal areas. Reactor plant; cooling ponds and waste treatment/storage plants; and conventional plant. There is no reason why decommissioning and waste management activities cannot progress across all three areas. This approach optimises the use of the retained workforce.

Equal attention should be given to decommissioning and waste management activities. Whilst the management of the operational wastes requires early consideration and a start might be made even before cessation of generation in this area, early progress with decommissioning and more specifically with plant dismantling is essential. All stakeholders expect to *see* a difference.

For example, at cessation of generation, the turbine plant becomes redundant. Dismantling and removal of the plant followed by demolition of the building, removes a large part of site and makes a big visible difference. Furthermore there are clear safety benefits for no one can have an accident in a building that's no longer there.

Staff/contractor workforce

An integrated and committed staff/contractor workforce, putting safety first at all times, is required.

Whilst the staff have the knowledge and experience of operating and maintaining the site, they are unlikely to have the specialist decommissioning skills that are required for many of the planned activities. Working together, however, an integrated team should have all the competencies to deliver a successful project. In all cases, selection is critical.

Whilst knowledge and skills are very important, other attributes are of equal if not greater importance. The right attitude and behaviour are essential. Persons with bad attitudes or persons who are unreceptive to instructions or reminders can jeopardise their own safety and that of others. A questioning attitude on matters of safety is considered to be an essential attribute which workers should be encouraged to adopt.

Investment in infrastructure

Typically at cessation of generation (or operation of whatever process has been taking place) a stop or defer spending regime prevails. The need to invest for decommissioning is not always recognised. Maintaining the site in good order is essential and in this respect housekeeping must be a high profile management activity.

Facilities established for operational use are likely to prove inadequate for decommissioning work for the numbers of persons entering plant areas and the frequency of entries may be considerably higher. In addition to the throughput of persons, consideration should also be given to the variety of tools and

equipment that may be needed and in particular to the PPE support requirements. Change facilities, where high levels of control are required, should be made fit for purpose and in this respect the best option may be to establish new arrangements.

A major improvement programme is underway at Trawsfynydd to replace or refurbish essential facilities and raise the standard of housekeeping.

Total risk approach

A total risk approach should be adopted. The need to consider the relative significance of all risks and how they relate to one another is very important. Careful consideration should be given to the introduction of control measures to reduce radiological risk for these controls may elevate other risks.

It is noteworthy that when a total risk approach is taken in assessing risks associated with work activities of this nature, it is not always the case that the radiological risks are the highest (6). However it is often the case that the perception of radiological risk is such that, when considering control measures, this risk is elevated above all others. By comparison the need to put the radiological risk into context and consider the relative significance of other risks is probably less well appreciated.

The decommissioning experience to date supports the UK regulatory view that risk assessment should not be a once-and-for-all activity. The management system should provide for and ensure that periodic reviews are carried out (7).

SUMMARY

As one of the UK's first commercial nuclear power stations to be decommissioned, Trawsfynydd together with Hunterston, has been following Berkeley's lead into decommissioning. All parties have learnt from the experience. The Company, contractors and visitors. Indeed in the author's view, even the regulators.

To have achieved what Berkeley, Hunterston and Trawsfynydd have achieved a questioning and challenging approach has been necessary. The progress of the work has not been without its difficulties and there will no doubt be challenges ahead but the opportunity exists to deliver successful projects. Above all safety will remain the highest priority.

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FOOTNOTES

1 The views expressed in this paper are those of the author and do not necessarily represent those of BNFL.

2 Magnox Electric plc is now a subsidiary of BNFL.

3 Safestore has since become widely recognised within the UK. One of the conclusions reached in the Government's review of waste management policy carried out in 1995 (2) was 'that there were a number of potentially feasible decommissioning strategies for nuclear power stations, including safestore'

4 Nuclear Electric was Magnox Electric's predecessor company

5 Nirex is the UK company, owned and operated by the nuclear industry, responsible for the disposal of intermediate and some low level radioactive waste.