

DON'T REINVENT THE D&D WHEEL-THE POTENTIAL FOR LESSONS LEARNED FROM EXPERIENCES ELSEWHERE

Andrew V. Roberts
D&D Services
BNFL Inc.
9781, South Meridian Blvd., #100
Englewood, CO 80112
Tel: (303) 874-3965

ABSTRACT

The cost of safely removing redundant nuclear facilities throughout the US is expected to reach in excess of \$400Bn and take most of the next century. The complexity of the problem is significant with many unknowns contributing to the estimated cost. In many cases, however, a particular decommissioning problem will have already been met and solved elsewhere. Some countries are further along the 'decommissioning road' as a result of different D&D drivers that exist elsewhere. There is a great deal of opportunity for D&D projects in the US to learn from other countries which have tackled similar D&D problems. In many cases, the US stands to learn from others' mistakes which can often be as valuable as learning from successes. Some systems are being set up for transfer of technologies and the existence of D&D-experienced companies within DOE site contracting organizations can only help spread the word. Further methods should be sought for transfer of experiences and technology so that economies in the cost of D&D can be realized.

INTRODUCTION

Owners and operators of nuclear fuel cycle facilities throughout the world will, one day, be faced with the reality of removing redundant nuclear facilities and restoring land to less restricted use. The drivers for accomplishing this cleanup vary but usually center around stakeholder pressure and facility deterioration. D&D drivers vary from location to location and, as a result of the relative strengths or weaknesses of such drivers, some countries have progressed more with D&D than others. Those that have made inroads into the expensive world of nuclear facility D&D have usually learned the hard way on what works and what doesn't. For those countries and organizations embarking on large scale D&D, there is a significant amount of information available to assist in the planning, organization and execution of D&D projects. This paper outlines some of the similarities between United Kingdom (UK) and United States (US) nuclear fuel cycle facilities in an attempt to show that it is not necessary to continually reinvent the 'D&D wheel' and that much time and money can be saved learning from the experiences of others.

BACKGROUND

Both the UK and US possess nuclear fuel cycle facilities, which grew from military applications during or immediately following World War II. In the US, the initial requirements for fissile materials were met by the Hanford Site, Washington, operations. In the UK, these same requirements were met by facilities located at Sellafield in Cumbria. Both sites initially carried out similar roles within each country's respective weapons programs and both include fissile material production reactors, irradiated fuel handling pools, dissolution/separation plant, product purification facilities and facilities for handling the solid, liquid and gaseous waste arising from these processes. In addition, both sites include power reactors and research and development facilities supporting the fuel cycle.

The two sites were specifically chosen for their relative remoteness from large populations, from potential aggressor action, and because of the potential risk of the operations to be performed there. In addition, suitable land and supplies of natural resources was a location-deciding factor in both cases.

The availability of land to the respective program managers did result in differences between the two sites. For instance, the Sellafield site has a land area of approximately 700 acres while the Hanford reservation encompasses over 500 square miles. The layout of the Sellafield site and its inability to grow beyond its current boundaries has been one of the principal drivers in the development of the UK D&D program.

WHY IS D&D REQUIRED?

As nuclear facilities age, the cost of maintaining these facilities increases. If the facility is unused, then the costs of maintenance are not offset by production gains. In instances such as these, unused and aging facilities become a significant net cash drain for an owner/operator.

It is now over 50 years since the first radioactive material handling facilities were commissioned. Organizations who own or operate facilities of this age group are, for the first time in the history of nuclear facility management, being required to consider how to close out their redundant material processing facilities.

At this point, it is also worthwhile stating that most facilities dating from the first or second generation production processes were not built with any consideration for eventual decommissioning. The drivers for weapons production processes were so strong that how they were going to be dealt with in the future was not an important issue during their operational life. The processes being developed and used (often simultaneously) were not fully understood, neither were the effects they would have on the environment or those people who came in to contact with those process materials. It is hardly surprising, considering these factors that little thought was placed on eventual D&D

during design and construction and even less surprising that financial planning for D&D did not take place either.

THE COST OF D&D

The cost of cleanup of the US weapons program has been estimated as being in excess of \$400Bn. D&D costs are notoriously difficult to estimate as a result of the many unknowns facing D&D estimators. Factors such as the unknown extent of radioactive contamination, the need for robotics, the cost (and methods) of waste disposal, the cost of safety equipment, the productivity expected from D&D workers, etc. all contribute to the cost of the decommissioning of a facility. Many of these factors remain unknown until the project is well underway. The tendency in D&D planning is often to 'assume the worst case' which inflates the estimated cost of D&D. There is also a widely held belief that technology can solve many if not all of today's D&D problems. Technical developments have certainly caused many improvements in materials handling, for instance NDA equipment, but in many areas all the technology required to carry out D&D is currently available and is in use somewhere in the industry. There is a tendency to seek the most technologically advanced solution to a D&D problem whereas, in reality, most success is obtained by using the least technologically-advanced solution possible with more emphasis placed on safety, planning, estimating, work methods and D&D project management. Money spent seeking a high tech solution to a D&D problem can only escalate costs while more money spent on ensuring simpler systems work well and efficiently can only help control D&D costs. This does not mean that low-tech solutions are the answer to all D&D problems, some high radiation environments must be tackled remotely. However, the use of such complex (and expensive) systems should be used only where absolutely necessary.

DRIVERS FOR DECOMMISSIONING

UK

The UK decommissioning program formally began in the 1980s and has now developed into a 100+ year schedule that includes current operational facilities on site. The requirement for such a program stems from a continuing requirement to provide fuel cycle capabilities with the space constraints noted above while also taking into consideration the deterioration of older facilities. The continuing use of existing infrastructure also drives reuse of buildings. For example, one Sellafield plutonium processing building, in particular, has had several production facilities successively installed within it, taking advantage of the existing ventilation, security, criticality detection systems and air monitoring systems. In addition to the replacement requirements for redundant processes, some buildings deteriorate with time also necessitating refurbishment. Buildings housing plutonium facilities are an example here. They are not usually built as substantially as beta/gamma facilities and so have a limited lifespan.

Stakeholders in the UK play an important role in determining the pace of D&D at Sellafield. Regulators (the Nuclear Installations Inspectorate and the Environment Agency) and local organizations (local liaison committees, environmental pressure groups) all contribute towards the formulation of D&D programs on the site.

US

Whereas the principal driver for D&D in the UK was space requirements, this has not been the case in the US due to the relative sizes of the US nuclear facilities. In the deserts of Hanford and Idaho, for instance, there was no requirement to D&D a redundant facility before a new one could be built. The operators could simply reduce the building into a surveillance and maintenance mode and move elsewhere. The availability of space in a relatively sparsely populated area meant that there were no major reasons for D&D at that time.

The driver for D&D in the US which has had most impact on the industry has been stakeholder pressure. Increasing interest from state governments, the EPA and public have forced the DOE to consider site cleanup. Stakeholder interest in legacy waste, environmental damage, currently operating buildings and the potential cost of decommissioning (and who will pay for it) have increased the interest in decommissioning to new levels. The response from the industry has been a series of complex-wide and site-specific plans. Many of these plans stretch out into the mid-21st century, as in the case of sites such as Hanford or Idaho, because many facilities are still heavily contaminated but stable with no demands upon the local land.

UK/US DRIVER COMPARISON

In summary, the UK has been forced down a path requiring early decommissioning. The stripping out of facilities has been ongoing for over 30 years and, as a consequence, the UK program is well established with liability issues being discussed and resolved for all facilities to be decommissioned. Stakeholder issues are the major driver in the US and a significant contributor in the UK.

UK EXPERIENCE

In the UK, the constraints upon site expansion have resulted in a 30+ year history of decommissioning of nuclear facilities taking place at Sellafield. This history stems from the early projects where a facility was removed at minimal cost and packaged for future retrieval to modern projects where the facility is reduced to a waste form suitable for direct disposal as TRU, ILW or LLW.

Examples of completed or in-progress D&D projects at UK facilities are given below. Although the subject of this paper is a comparison of Sellafield/Hanford facilities, other facility types not present at Sellafield or Hanford are included for completeness.

- Production Reactors

Windscale Production Piles 1 & 2 were shut down in 1957 following a fire. One reactor (the undamaged one) was defuelled on shut down, the other was stabilized and placed into surveillance and maintenance. In the early 1990s, a project to remove damaged fuel from Pile #2, to remove unstable structural facilities and to recover fuel and debris from the cooling/decanning facility commenced.

- Power reactors

Berkeley, Hunterston and Trawsfynydd Magnox power stations in the UK are currently in varying stages of decommissioning.

The Windscale Advanced Gas-Cooled Reactor shut down in 1981 and is currently undergoing full decommissioning to restore the site to green field status.

- Tritium facilities

Sellafield housed facilities that extracted tritium from specialized irradiated fuel and purified the gas for further processing. This extraction line was cleaned out and dismantled in the mid-80s. Other UK tritium facilities have been cleaned out and dismantled since then.

- Irradiated fuel storage pools

Irradiated fuel from the original production reactors was discharged into an open pool and, after cooling, stripped of its magnesium alloy cladding before dissolution. The earliest of these pools dates from 1952 and, until recently, still contained fuel debris and significant accumulations of sludges. This pool has recently been part refurbished (e.g. with a new skip handler) and recovery of the fuel is in progress. Pool desludging is also in progress.

- Plutonium processing

The earliest function of Sellafield was to produce plutonium for the UK defence program. Consequently, many of the earliest plutonium processing facilities on site dated from the start of reprocessing in 1952. The earliest plutonium finishing facilities were cleaned out and removed in the early 1960s to make way for newer finishing and product recovery equipment. Many components of the first facilities were crated up and stored pending future recovery. The second generation plutonium-processing facilities are now being decommissioned. Work is underway removing the gloveboxes of the 3rd plutonium finishing line. Plutonium slag dissolution, evaporation and recovery facilities have been removed.

- Plutonium recovery

With the value of weapons grade plutonium so high, recovery of the material from scrap or off-spec solutions was carried out. Solids were dissolved and blended with solutions for recovery and subjected to solvent extraction resulting in pure plutonium solutions for return to the finishing plant. The D&D of the recovery plant is now ongoing with vessels and pipework being cut out, size reduced and packaged as TRU waste.

- Intermediate/high level waste handling facilities

A cesium extraction facility for isotope separation from high level liquid waste is being decommissioned using a remote dismantling machine considered necessary due to the intense radiation levels in that facility. The dismantling machine has been constructed and is being prepared for installation into the plant.

A solid waste silo is also in the process of being decommissioned. The silo was used to dry store intermediate level waste arising from fuel reprocessing operations. Preparations are in hand for the installation of the machine which will recover the solid waste ready for encapsulation.

- MOX fuel fabrication

Between 1985 and 1992, a MOX powder production plant was decommissioned at Sellafield. This was the second facility to be decommissioned from this location, the previous one having been removed in the early 1960s.

A MOX dry recovery facility was removed in the early 1990s and work is currently underway for the decommissioning of a MOX blending plant and a MOX fuel element production plant.

- Analytical labs

BNFL is currently in the process of decommissioning several development laboratories at Sellafield. These have been used, amongst others, for development work for reprocessing operations, MOX fuel fabrication, americium separation and TRU waste washing and incineration.

- Irradiated Fuel Reprocessing Plants

The First Separation Plant at Sellafield dissolved irradiated fuel and carried out a solvent extraction process from 1952 to 1964 before being refurbished and used again from 1969 to 1973. The Plant is currently being prepared for decommissioning. Remote operated vehicles will be used to enter highly active cells, and to disconnect and size reduce pipes and vessels. The project will also involve recovery of residual in-process materials.

- Research Reactors

In the early 1990s, BNFL decommissioned the University of Manchester Research Reactor. The D&D project involved the removal of all reactor structural components (including the reactor core) and all ancillary processes and buildings resulting in the site being de-licensed as a green field site.

- Gaseous Diffusion Plants

The 1,900,000 ft² Gaseous Diffusion Plant at Capenhurst was decommissioned in the 1980s/90s. The 4,800-stage plant was decontaminated and dismantled with >160,000 tons of metal and concrete free released for unrestricted reuse.

The above list represents some, but not all, of the varied decommissioning operations currently ongoing at BNFL sites in the UK. Other organizations such as the UKAEA and the MOD are also carrying out decommissioning work on radioactive facilities.

RELEVANCE TO HANFORD/OTHER SITES

Much of this UK experience is directly applicable to nuclear sites within the US. Taking into account the similar age and functions of the Sellafield and Hanford sites, it is possible to make comparisons between those two sites as shown in the table below:

Sellafield Facility	Function	Hanford Facility
Plutonium Finishing Lines	Metal/oxide Production from Nitrate	Plutonium Finishing Plant
Plutonium Residue Recovery Plant	Plutonium Recovery from Solid Residues and Liquids	Plutonium Reclamation Facility
Plutonium Product Stores	Interim Storage of Plutonium Products	Plutonium Storage Vaults
Plutonium Product Evaporator	Concentration of Plutonium Nitrate Solutions	233-S Plutonium Facility
First & Second Separation Facilities	Dissolution and Separation of Spent Fuel	B, U & T Plants, REDOX, PUREX
Plutonium Production Piles 1 & 2	Production of Plutonium for Weapons Manufacture	Hanford Production Reactors
Spent Fuel Storage Basins	Storage for Irradiated Fuel Pending Reprocessing	Spent Fuel Storage Basins (K Basins)
Highly Active Liquid Evaporation and Storage	Handling, Concentration and Interim Storage of Fission Product Solutions, Vitrification Trials	300 Area Facilities, Single and Double Shell Tanks
TRU Waste Incinerator Plant	Incineration of Combustible Waste Containing TRU	Plutonium Waste Incinerator Plant, 232-Z
Uranium Finishing	Conversion of Uranyl Nitrate to UO_3	U-Plant

Comparison of Sellafield, UK and Hanford, US Facilities

The above table indicates several of the facility similarities between the two sites. Many of these facilities use similar operating processes to achieve their output. Many of the Sellafield facilities have been or currently are being decommissioned. Other sites in the UK have similarities with other US sites, particularly in the areas of fuel manufacture, fuel enrichment and tritium operations.

In view of the similar operating histories of each site, the nature of legacies remaining from weapons production and the drivers for D&D at each location, the question can be posed “Is there anything to be learned from Sellafield experience which can be applied at other US DOE sites e.g. Hanford?” Although there are differences of scale and in specific facility designs, in view of the basic similarities of facilities, the answer should be yes. It would be wrong to assume that all UK developments of D&D methods and technologies have been 100% successful. They haven't. However, there is a significant source of experience available from the UK which should help US D&D organizations avoid some of the pitfalls out there. This experience may relate to equipment developments which improve decontamination, size reduction or characterization processes or to systems of work which can be used to improve D&D work efficiencies and hence costs.

METHODS OF CO-OPERATION

How can this experience be transferred from the UK to the US? There are some links between the UK and US but these do not provide a means for transfer of experience in all the required areas. Two transfer methods currently exist:

Large Scale Demonstration & Deployment Projects

Financed through DOE EM-50, the D&D Focus Area has initiated a number of Large Scale Demonstration & Deployment Projects (LSDDPs) throughout the DOE complex. These projects seek innovative technologies that are already proven elsewhere, which will improve efficiencies and effectiveness when applied to US D&D projects. LSDDPs are ongoing at Hanford, Idaho, Fernald, Mound, Los Alamos and Chicago. At most of these, representatives from the UK assist in seeking new technologies to import to the US.

Site contracts

Another method of transfer of technology and work methodology comes from the presence of others as contractors on DOE sites. As an example, BNFL is importing experience and technology into Rocky Flats Environmental Technology Site (RFETS) through its subsidiary company, Rocky Mountain Remediation Services (RMRS).

Both these methods purposefully exist to transfer technology and experience from one organization to another. They are successful in that aim but they are only scratching the surface of what experience could be transferred to the DOE with the resultant cost savings during D&D.

Other methods of learning from others' experience should be sought. Conference papers and site visits serve some purpose in that they can act as a showcase for accomplishments of others but they are severely limited in what they can actually achieve on their own. The use of mechanisms such as the LSDDPs appear to be the most successful way at this time to transfer information. Such projects should be encouraged and sufficiently financed to allow them to successfully seek and select transferrable technologies.

CONCLUSIONS

Both the UK and the US have a substantial legacy of redundant nuclear facilities connected with the military weapons programs following World War II. Many of the processes used in the US for producing and extracting fissile materials are very similar to processes used elsewhere, particularly in the UK. In fact, it is possible to make close comparisons between UK and US facilities particularly Sellafield and Hanford. Differences can be found between similar function facilities although in most cases, these are outweighed by common processes and designs.

Many of these facilities are now redundant having completed their missions. They now await D&D, which is perceived as a very costly and complex process. Since D&D drivers in the UK have been different from in the US, the UK has been forced to tackle D&D problems sooner than in the US. As a consequence, many of the issues involved with the D&D of these facilities have been addressed and, as a consequence, there are valuable lessons to be learned from organizations with such experience. Many lessons may have been learned from the mistakes made by others-these are as valuable as those learned from successes.

With the expected cost of DOE D&D now being quoted as in the region of \$400Bn, it makes sense to use the experience that others have amassed in cleaning up the legacy of weapons programs. There are some examples of how this experience can be imported from those who have 'been there and got the T-shirt'. The DOE Focus Area of EM-50 uses the concept of Large Scale Demonstration and Deployment Projects at a number of DOE sites specifically to seek improvements to current D&D baselines. There is scope for further cross-fertilization of ideas between operators of similar facilities, such as those at Sellafield and Hanford, which can avoid much of the cost involved with reinventing the D&D wheel.