Operational Experience and Challenges Associated with Bulk Waste Retrievals from a Legacy Decommissioning Site – 14095

Graham Buck *
* Atkins Limited

ABSTRACT

This paper covers the Low Level Waste (LLW) retrievals phase of the Berkeley Chute Silo project and tells the story of the journey from first retrievals of LLW using the largest piece of retrieval equipment to be commissioned and operated within the Magnox Limited fleet, through the challenges and opportunities faced when retrieving waste from a notoriously difficult decommissioning project, up to the point of completing bulk retrievals. The paper will cover the retrievals strategy, the lessons learnt, techniques and methods adopted and how the retrievals targets were achieved despite being deemed ‘unachievable’ by many experts. This includes the ‘just do’ and ‘trial and error’ attitude, combined with a philosophy of not unnecessarily overcomplicating the final solution - both of which are often ignored within the decommissioning sector. The paper will also cover the advantages and disadvantages associated with the refurbishment and reuse of existing legacy equipment and plant infrastructure.

INTRODUCTION

Berkeley Power Station was constructed between 1957 and 1962 and, after approximately 30 years of operational life, is currently undergoing a programme of decommissioning. During the course of operations, Intermediate Level Waste (ILW) such as Fuel Element Debris (FED), Miscellaneous Contaminated Items (MCI) and Miscellaneous Activated Components (MAC) were stored on site in three underground Vaults and a Chute Silo. Quantities of Low Level Waste (LLW) were also stored in these locations.

Magnox Ltd (Magnox) has formulated a site waste management strategy for retrieving and disposing of the wastes from the Chute Silo. The Chute Silo contains ILW MAC, a variety of vault furniture and gravel. The strategy is to retrieve and package the ILW MAC in Ductile Cast Iron Containers (DCICs), which are self-shielding IP-2 containers, and then store the containers on the Berkeley site until the UK Geological Disposal Facility (GDF) becomes available. It is anticipated that the packaged ILW MAC may need to be stored on site for at least 40 years. The inventory of Low Level Waste (LLW), and potentially some Very Low Level Waste (VLLW), will be packaged in a suitable container and disposed of via the current routes that are available to site.

The Active Waste Vault building (AWV) or ‘Berkeley Vaults’ is notorious for being one of the most challenging and technically difficult retrieval projects within the UK decommissioning industry. The waste in Berkeley Vaults not only includes debris from the power station but also sizeable amounts of MAC from Berkeley research and development laboratories. Since generation ceased and both reactors were defueled and put into care and maintenance, the project to retrieve, process and package the waste within the vaults has been difficult to complete for a number of reasons. The waste itself causes the most problems, but combined with the building design and structural aspects, the retrievals have always posed significant challenges. These problems, along with other factors, have led to the cancellation of several previous retrieval projects.

The current decommissioning approach has recently been to simplify decommissioning activities without over engineering, a trait plenty of other decommissioning projects succumb to. The Magnox approach looks at utilising equipment which is fit for purpose, without compromising safety, functionality or reliability, but still maintaining value for money.

PROJECT SCOPE

The Chute Silo Project is split into two phases of waste retrievals: LLW and ILW. This paper covers the LLW retrievals phase of the project and tells the story of the journey from first retrievals of LLW, up to the point of completing bulk retrievals. This includes the refurbishment and reuse of the largest piece of retrieval equipment to be commissioned and operated within the Magnox fleet, and the challenges and opportunities faced when retrieving waste from a notoriously difficult decommissioning project.

WASTE

The waste within the Silo is made up of LLW, ILW and items of vault furniture (assumed to be LLW or even free release). There is a number of characterisation documents and posting records which underpin the inventory within the Silo. However, this historic documentation has a few discrepancies about the quantity of waste and the associated dose rate, which have been traditionally pessimistic.

The waste within the silo is layered due to the nature in which it was deposited from the top of the silo. On the base there was a layer of railway ballast which was used to act as a cushion for falling waste and provide a blanket to protect the base structure. The MAC, made up of control rods, charge chutes and thermocouple chutes, was then posted into the roof posting mechanism before being allowed to drop onto the gravel. Finally, as part of a previous retrieval campaign, the posting vault furniture was gas axed from the ceiling and allowed to drop on top of the other MAC, causing a ‘birds nested’ pile of waste.

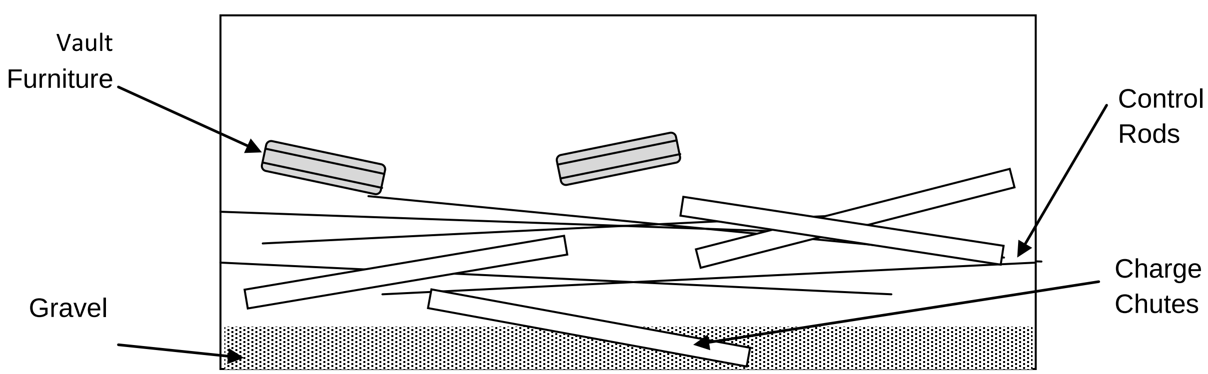

Figure 1: Layering of waste pile

The waste is categorised into LLW and ILW. The waste inventory for the site gives an indication as to the categorisation of each waste stream, combined with data from dose rate surveys and minimal sampling. There is a proportion of the waste which is also believed to be free release but the exact quantity will only be known once retrievals have taken place.

CHALLENGES

The biggest challenge associated with the project is the waste within the silo. The quantity of unknowns arising from legacy waste is considerable, not only the quantity, but the dose rate and other characteristics. The waste is difficult to sample and categorise due to the diversity of waste streams within the Silo. The orientation and size of the waste produces several challenges where items are bent, fixed in an open position, long and heavy.

Other challenges include preconceptions and attitude towards retrievals based upon the fact that this is a new, unique operation requiring untested technology. This cautious approach meant the project had to utilise pessimistic operating rules and restrictions associated with the equipment, therefore making the initial retrieval process more difficult and prevented momentum being gained whilst the stakeholders bought into the retrieval philosophy.

ATTITUDE AND PHILOSOPHY

With legacy nuclear facilities there is justifiably a fear of the unknown, particularly if the information surrounding the facility and inventory is incomplete or non-existent. This approach is cautious and should be adhered to, but if the decommissioning process is to progress a certain element of ‘can-do’ attitude needs to be applied otherwise it is too easy to do nothing.

The history of this building and previous retrieval campaigns played a large part in the challenges associated with this project. There was a perception that previous project failures made the retrievals too difficult and complex to achieve, installing limited confidence and spreading the mentality and attitude of ‘it can’t be done’. Changing this attitude and installing confidence in the stakeholders, both internally and externally, is the key to project success.

The shadow of previous failures lead to increased emphasis and pressure on the project to get things right first time and given the unknown nature of the waste pile and concern over machine capability, this led to restrictions being put in place and over complications in methodologies, ultimately stalling and reducing retrievals. The result of this was a reduction in throughput and risk of missing the imposed performance targets. These were challenged during operations and throughput improved from 1 drum of gravel per day to 10 drums of gravel per day.

One of the biggest hurdles with retrievals is actually starting the job and subsequently keeping up sufficient momentum when challenges arise to keep going. It is extremely easy to install barriers which inhibit the work and although these might be justified on grounds of safety and cost, sometimes the preconceptions of what is achievable are overly cautious and inhibit progress. Creating a decommissioning mind-set amongst all stakeholders is vital to successful delivery.

RETRIEVAL STRATEGY

The waste within the Silo was layered with the bulk of the LLW at the bottom of the waste pile and the ILW on top of it. There was also other LLW and vault furniture entwined within the ILW. The most logical approach would be to adopt a 'top-down' retrieval methodology given the complexity and entanglement of the waste pile. This would involve either unpicking the pile or size reducing the pile into manageable sections to access the LLW underneath. However, during this size reduction, the LLW beneath the ILW would become contaminated with ILW, therefore increasing the overall quantity of ILW to be retrieved and significantly reducing the LLW. This would completely contradict the overarching philosophy for retrievals and would not be considered good practice.

The aim of the first phase was to retrieve as much LLW as possible in order to avoid contaminating the LLW with ILW during size reduction. This meant untangling the waste pile, separating the waste streams, retrieving the LLW and organising the remaining waste within the vault to aid the ILW retrieval phase of the project.

RETRIEVAL EQUIPMENT

When the contract was let for the Chute Silo project, one of the options (which took full advantage of the simplified approach) was to investigate and potentially utilise the existing retrieval machine already within the building. This retrieval machine was the legacy of a cancelled retrieval project and had never been used since installation, but sat dormant for over 15 years without being mothballed.

There were two Chute Silo Manipulators (CSM) built for the previous retrieval campaign. These were bespoke manipulators designed for remote handling of the radioactive waste within the Chute Silo and the other 4 subterranean vaults within the Active Waste Vault building. They weigh approximately 16tonnes each and were designed to work as a pair, with a reach of 5.5m and ability to access the bottom of the silo and vaults 9.6m deep.

The re-use of existing equipment has advantages and disadvantages. There are opportunities to reduce the cost and delivery schedule due to not having to re-design or construct equipment. However, the correction of latent errors and inheritance of previous design shortfalls, known or unknown, can also have significant effects on cost and delivery schedule. Subsequently, excessive caution was applied to the operating rules in order to protect the equipment.

There is also the advantage of utilising existing infrastructure, which can often be overlooked and cause substantial delays and increased costs. The decision was taken to utilise the manipulator and combine this with other new and conventional off the shelf auxiliary equipment to aid the retrieval process.

All of this equipment was then tested inactively off site in a full scale test facility. Off-site testing is a key element of working on nuclear projects. It allows the equipment to be proved, thoroughly tested and adjusted before installation on-site and highlights opportunities for the equipment to be improved in a safe and accessible environment. It also provides a safe environment for training of personnel, including overcoming failure modes and carrying out recovery operations.

Figure 2: Refurbished and reused CSM retrieval machine.

OPERATIONS AND LESSONS LEARNT

The retrieval process involves lowering an auxiliary 500 litre drum within a loading basket down into the silo and using the CSM to grab loose gravel with a petal grab and deposit the contents into the drum via an attached funnel. The filled drum was then removed from the silo, monitored, weighed, packaged and disposed of via the standard LLW routes available to the site.

This process started off being extremely time consuming and precise because such aids as a guide funnel were not originally part of the retrieval equipment. However, with repeat operational experience the process became more fluent and allowed for a greater throughput rate, along with the addition of tools and aids to streamline the process.

This approach applied to all aspects of the retrieval equipment due to its bespoke nature. Operators were employed who had used manipulators and remote operational equipment before, but this historic piece of equipment, coupled with its inherent design flaws meant each individual had to learn from scratch. As the operators became more familiar with the equipment and processes the throughput rate increased.

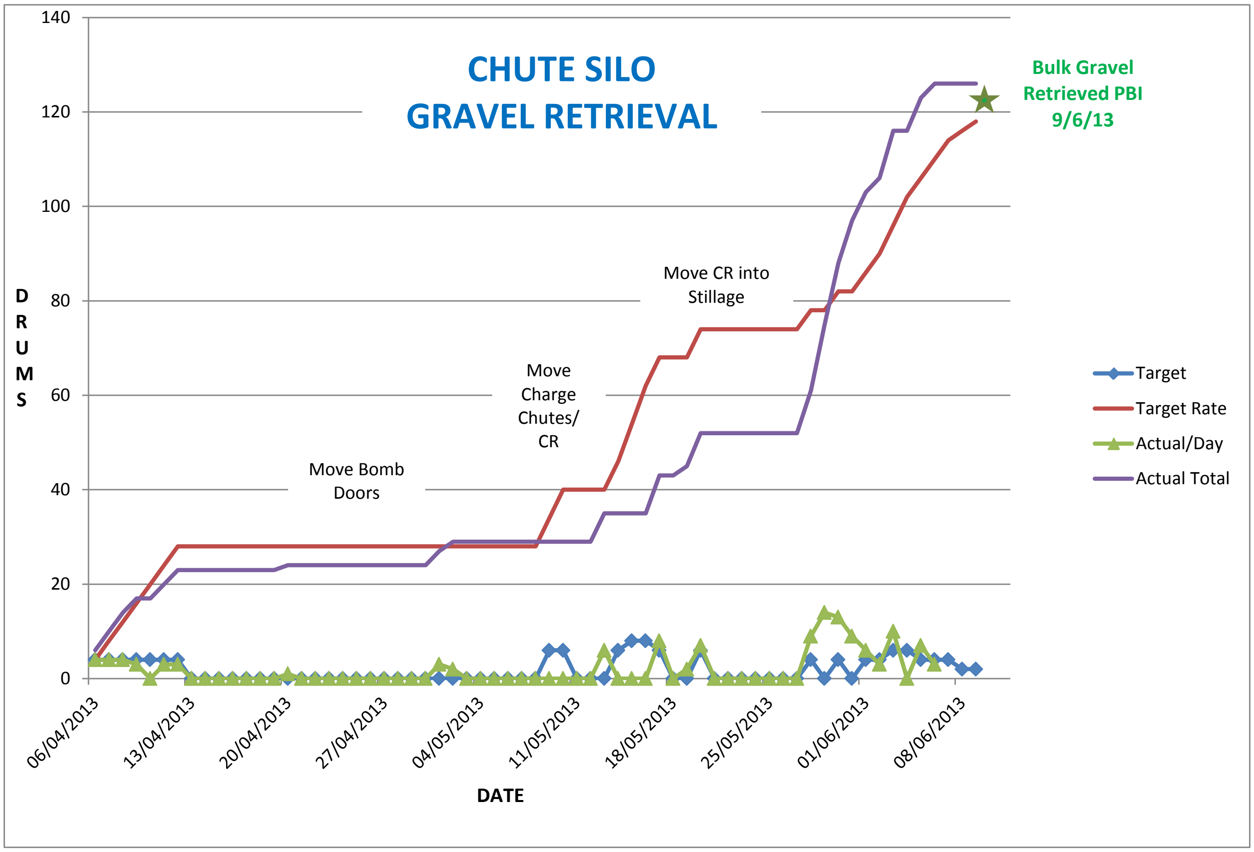

Figure 3: Chute Silo throughput graph

The throughput graph indicates the change in retrieval rate as the project pushed to meet the regulatory target. At the beginning of retrievals the throughput rate was slow and under the required rate. There were also periods where certain movements of waste within the silo had to be done before retrievals could continue, as shown in figure 3. Also, the graph does not highlight where machine breakdowns occurred and periods of inactivity meant the target rate increased without any retrievals occurring.

However, once all required movements were complete and the manipulator was running and available, the operators quickly became fluent in the process and there was a sharp increase in the actual retrieval rate. This fluency and momentum meant the target rate was overtaken considerably.

Inevitably, when retrievals are undertaken there are things which will go well, things which will be unexpected and things which provide a much greater challenge than first anticipated. These provide a good basis for lessons learnt which can be applied elsewhere across the wider project, other stations within the Magnox fleet and potentially the decommissioning industry as a whole.

The operational phase of this project had a large number of unknowns, in particular the waste pile and the equipment capabilities. The waste strategy was formulated using survey information from a birds-eye view of the silo contents and an understanding of how the waste was deposited into the Silo. These birds-eye camera surveys taken from the roof of the silo indicated a relatively uniform and linear arrangement of the waste. However, before operations commenced another camera was introduced at low level (approximately 1 metre from the silo floor) to gain some depth perception within the silo and upon further inspection these views gave a completely different profile of what was in fact a significantly entangled and complex waste pile.

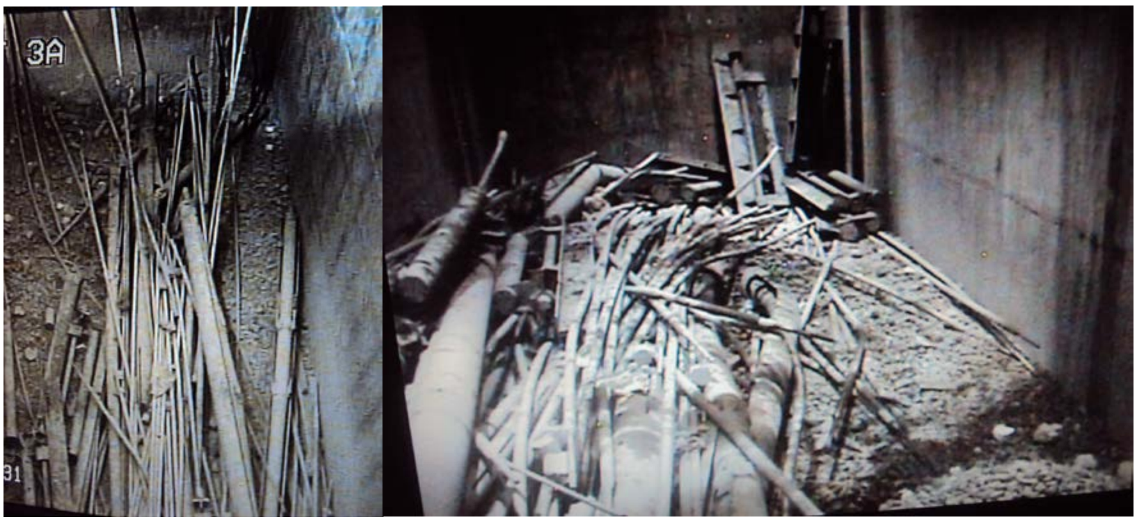

Figure 4: Plan view of waste showing 'linear' arrangement (left), Low-level view showing entanglement of waste (right)

Bulk retrieval operations were relatively new to the site and infrastructure, processes and permits were not readily available and had to be tailored to the project needs.
Once retrievals were underway operators became more efficient with the equipment and the techniques used within the Silo, thus making the entire process more efficient and retrievals easier.

In the nuclear industry equipment and methods are usually employed that are tried and tested. However, it can be pertinent to use an element of trial and error when the implications of failure are significantly small or inconsequential. This ‘make do and mend’ philosophy can greatly reduce the concept design phase, which historically has proved expensive and can lead to over complication.

During operations tasks were encountered which required equipment and procedures outside of the underpinned design. The decommissioning philosophy adopted by the site was to reduce and eliminate over engineered and elaborate solutions, whilst encouraging and increasing simple techniques and practices. This approach increased output, reliability and operability of equipment.

During retrievals several things were encountered which were unplanned. One particular example was detaching a purpose built lifting hook from the lifting equipment and managing to get it stuck within the silo. At the time this was deemed as an incident and failure, but when the risks and solutions were explained to stakeholders we were able to utilise a secondary hook to remove the initial piece of waste and the stuck hook at the same time.

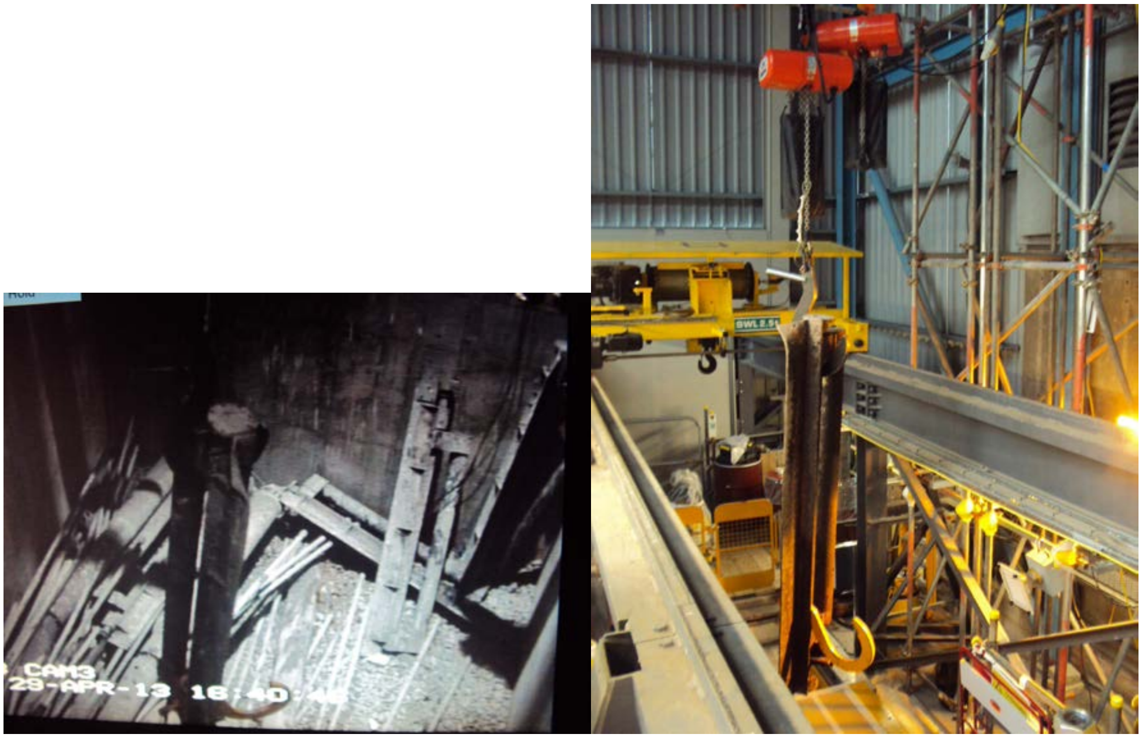

Figure 5: 'Lost' hook retrieving with waste (bomb door) using secondary equipment.

Several machine and equipment breakdowns also stopped retrievals. However, momentum and progressing fixes meant that downtime could be minimised. This was further supplemented by having 2 shifts and working 12 hour days meaning breaks could be rotated and staggered to keep retrievals constant.

The CSM had operational limitations and restrictions which meant certain activities and movements were inhibited. The waste pile was significantly tangled that attempting to pull or push waste to free and release it caused the alarm limits and relief settings on the machine to trip. However, the slow 'one bit at a time' approach ensured the integrity of the machine was maintained and we didn't exceed the operational restrictions, and more importantly, damage the equipment.

The operators who perform the retrievals are a key and essential part in making sure that progress is made and the task is achieved. The operators need to be given sufficient freedom to be able to learn to optimise the process and gain sufficient confidence so that the restrictions and intricacies of the machine are known, understood and become second nature. Keeping the momentum of the retrievals going is vital to ensuring the operators perform at the highest throughput possible. Interruptions, over supervision and not listening to ideas from the 'coal face' will prevent tight deadlines from being achieved.

Over the course of retrievals we managed to find extra waste inventory that we were not aware of and other unexpected items within the waste pile.

CURRENT PROGRESS AND THE FUTURE

The entire LLW retrievals, including both the vault furniture (approx 5 tonnes) and gravel (approx 25 tonnes), has now been removed as LLW and is being processed through the standard site waste streams.

Figure 6: Current status of the waste pile, organised and ready for phase 2.

The future of the project will focus entirely on the ILW remaining within the Silo and finally Post Operational Clean Out (POCO). The remaining ILW is made up of control rods and charge chutes.

Previous assessments of the waste indicate that the entirety of the control rods and charge chutes are all ILW, but since the initial characterisation this might have changed due to the decaying nature of the waste. A study is currently being undertaken to establish whether sections of this ILW might in fact now be at a level where it can be removed as LLW, thus reducing the number of shielded containers required and ultimately saving time in process and packaging, but mainly the cost to the project.

CONCLUSIONS

Decommissioning and legacy waste retrieval projects have a tendency to stagnate. The application of importing simple techniques and practices into waste retrieval can have significant benefits, especially combined with a questioning attitude.

Within reason, a questioning attitude combined with a trial and error or ‘just do’ attitude can accelerate projects and achieve results. The most common problem with retrieval projects is over complication of design and not fully understanding the challenges and requirements associated with the waste. The pessimistic approach is valid given the material within the industry, but the techniques used should be freely available and adoptable from other industries where applicable.

Provided the right control measures are in place, it is often much more beneficial to attempt retrievals rather than wait for the optimum solution. There will be things which are unexpected, unplanned and unforeseen during the operational phase, but these all give a better understanding of the problem and allow the project to progress with fewer unknowns.
The re-use of existing equipment has advantages and disadvantages. There are opportunities to reduce the cost and delivery schedule due to not having to re-design or construct equipment. However, the correction of latent errors and inheritance of previous design shortfalls, known or unknown, can also have significant effects on cost and delivery schedule. There is also the advantage of utilising existing infrastructure, which can often be overlooked and cause substantial delays and increased costs.

Off-site testing is a key element of working on nuclear projects. It allows the equipment to be proved, thoroughly tested and adjusted before installation on-site and highlights opportunities for the equipment to be improved in a safe and accessible environment. It also provides a safe environment for training of personnel, including overcoming failure modes and carrying out recovery operations.

ACKNOWLEDGEMENTS

Magnox Limited, ILW programme.

Magnox Chute Silo Project