Recent Decommissioning Achievements at Sellafield, UK – 11132

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ABSTRACT

The decommissioning programme at Sellafield is extremely complex and challenging. This is due to a number of factors such as: the constraints caused by the proximity of other plants, the interconnectivity of plants, the age and physical condition and the residual radiation and contamination levels in the facilities.

The Decommissioning Directorate is responsible for decommissioning legacy facilities at Sellafield and its remit includes the decommissioning of former reprocessing and fuel fabrication plants, fuel storage ponds and silos, redundant nuclear reactors and stacks.

To reduce the hazard and risk at Sellafield, a prioritised programme of decommissioning has been established which focuses on accelerating the decommissioning in the highest hazard plants. This paper identifies some of the achievements to date in relation to decommissioning these plants and explains some of the techniques and solutions which have been developed and applied to decommissioning activities.

INTRODUCTION

Sellafield Ltd is responsible for decommissioning the numerous legacy facilities on the Sellafield site in a safe, secure and environmentally responsible manner, whilst simultaneously delivering value for money for the British tax payer.

In order to ensure that decommissioning of high hazard plant is given appropriate recognition in the United Kingdom in relation to profile, priority and funding, the Nuclear Decommissioning Authority has developed a Safety and Environment Detriment Score (SED Score) which ranks the priority high hazard projects.

Of the top ten priority plants at Sellafield Ltd, five are located within the Decommissioning Directorate and include the Magnox Swarf Storage Silo, the Magnox Swarf Storage Pond, the Pile Fuel Storage Pond and the Pile Fuel Cladding Silo, pictured in Fig 1. Decommissioning work is focused on these priority plants to meet the government, NDA and site’s strategic imperative to reduce hazards and risks at Sellafield.

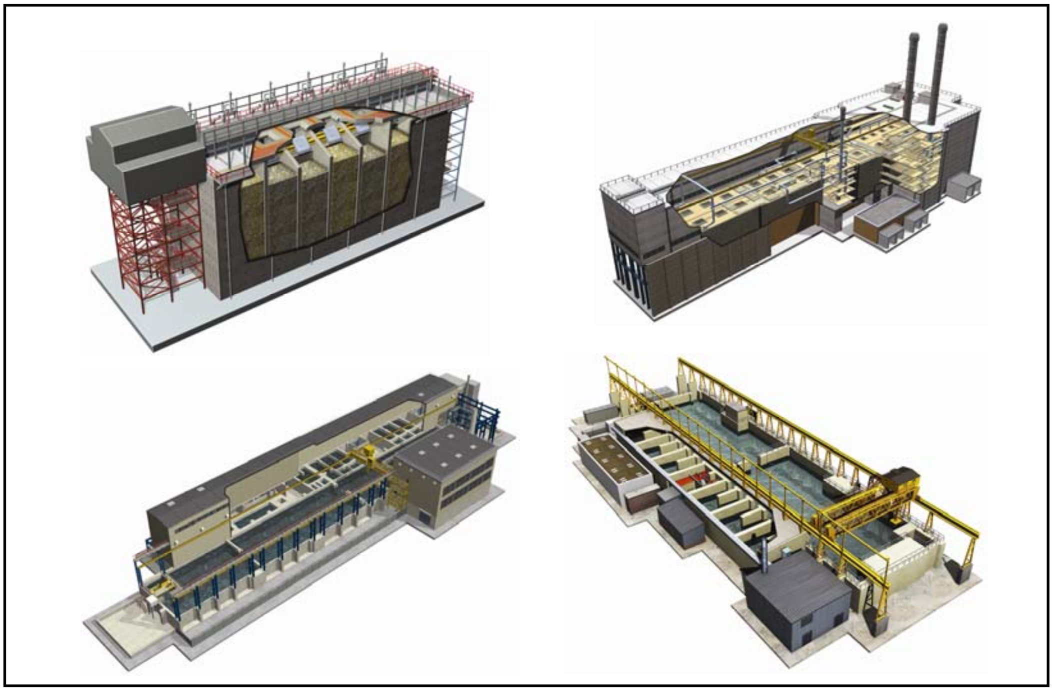

Fig 1 (Clockwise from top left) Pile Fuel Cladding Silo, Magnox Swarf Storage Silo, Pile Fuel Storage Pond and First Generation Magnox Storage Facility

This paper identifies some of the recent achievements associated with decommissioning these high hazard facilities and also explains the recent stabilisation work which has been carried out in the Primary Separation Plant, a redundant reprocessing facility.

In looking at each of these achievements, the paper will show how we are accelerating risk and hazard reduction on the site, addressing the historic legacy and learning from them to identify opportunities to further advance and improve through efficiencies and innovation.

THE START OF LIQUOR ACTIVITY REDUCTION IN THE MAGNOX SWARF STORAGE SILO.

The original Magnox Swarf Storage Silo was constructed in the early 1960s for the underwater storage of irradiated decanning waste and miscellaneous Intermediate Level Waste (ILW) arising from Magnox operations. Three extensions, each containing additional silo compartments were built to the original building by the mid 1980s, before it stopped receiving waste receipts in 2000.

Decommissioning of the building represents one of the most significant challenges at Sellafield and the liquid effluent activity arising from the silo emptying operations is the biggest liquid effluent treatment challenge within the Decommissioning Directorate's portfolio.

Scheduled Liquor Activity Reduction (LAR) transfers have recently started in one of the compartments in the building's third extension. LAR is a process which removes active silo liquor from the compartments and transfers to the Site Ion eXchange Effluent Plant (SIXEP) for treatment. Active effluent is treated at SIXEP, removing the activity from the liquid using Ion Exchange Technology before the clean water is discharged. Once liquor activity levels are driven down, the process will be repeated in the remaining compartments.

The primary objective of LAR transfers is to reduce the 3rd Extension silo liquor activity as far as reasonably practicable with the aim of achieving a reduction of approximately 80-90% over the next 3 years. The operation is repeated typically on a weekly cycle, gradually reducing the silo liquor activity through dilution, and will reduce the overall environmental risk from the facility as well as reducing the radiation source term resulting in improved ALARP (As Low as Reasonably Practicable) conditions for the workers.

The LAR programme has also demonstrated the use of “flexible permissioning”, developed to accelerate risk reduction through an expedited licensing process with the Nuclear Installations Inspectorate. This involved ongoing dialogue with the regulators, and meant that the period between handover of information and regulatory permission being granted was reduced to three weeks as opposed to the standard 18 weeks

The liquor transfer process is an important step towards emptying the silos, retrieving and processing the waste and eventual decommissioning of the facility and the team is currently on target to achieve the milestone of transferring 180m^3 of liquor by the end of the financial year 2010/2011.

At the same time, the programme teams have also carried out a number of other projects to maintain and upgrade the facilities in the aging building, including the installation of new cavity sump pumps and air monitors, as well as extensive housekeeping to remove redundant equipment and create space for the future installation of new Silo Emptying Machines.

HAZARD REDUCTION PREPARATION IN THE FIRST GENERATION MAGNOX STORAGE POND.

The First Generation Magnox Storage Pond (FGMSP) was commissioned in 1959/60 to receive and store irradiated fuel from Magnox reactors prior reprocessing. Fuel was stored in the main pond in open top containers (called skips) which were transported to the plant in shielded containers or flasks.

During the 1970’s corrosion of the Magnox fuel cladding and the fuel itself resulted in contamination of the water and an accumulation of corrosion products in the form of sludge. As a result, activity levels in the pond liquor are a significant source of dose uptake to the workforce and a significant constraint on worker productivity.

Pond Purge Unit

In preparation for retrievals, the radiation level in the pond needs to be reduced to ensure the dose uptake levels during installation and operations are acceptable to the workforce. To ensure this, the team has designed, installed and commissioned a Pond Purge Unit to purge the pond with a tightly controlled mixture of clean demineralised water and caustic soda.

The purge will continuously replace contaminated pond liquor with clean liquor, driving the contaminated liquor out to SIXEP where it can be treated prior to being discharged as clean liquor. The project team also expects the system to reduce aerial discharges from the pond liquor. The pond contributes significantly to site aerial discharge levels, so any reduction will positively impact the site annual discharges. The commissioning of the Pond Purge Unit is a key enabler to future retrievals.

Redundant Effluent & Sludge Pipework System Isolation

An additional preparatory task which will be a significant contributor to hazard and risk reduction at Sellafield will be the isolation of the Redundant Effluent & Sludge Pipework System (RESPS) system.

The RESPS system was the original effluent and discharge route for FGMSP desludging operations, and operated until the mid 1970's. Due to the degraded condition of the mild steel RESPS lines it was decided to stabilise them prior to any further decommissioning work being undertaken. This will be achieved using a resin spray head deployed via a powered remote manipulator (PRM). A layer of hard-drying resin compound will be sprayed over the whole area of the lines to provide the required structural stability.

Once the lines are stabilised a 'Hot Tapping' tool will be deployed by the PRM to drill in to the pipe. The tool allows drilling and valve insertion into the pipes with no associated loss of containment. After this initial entry to the pipe has been made, expanding foam will be injected into the lines to provide a permanent pipe seal (plug). After pipe section removal the plugged stub ends will be capped and 'spray' sealed.

This technique has previously been utilised in harsh subterranean and sub-sea environments by the petrochemical industry and has been further developed for this specific use. The assembly and erection of a Hot Tap Test Rig has recently been completed, which fully replicates the plants and RESPS physical geometry and this will be extensively used during substantive trials and training phases to provide operatives with a true feel for the constraints which they will encounter during the on-site isolations.

Other key activities contributing to the overall decommissioning programme in the FGMSP are the isolation of a number of in-bay weirboxes and the gantry refurbishment system.

Weir Box Isolation

Building on the success of the isolation of the Magazine Transfer (MT) Bay weirbox in February 2010, a further four wet bay weirbox isolations were successfully completed during September 2010.

Essentially an overflow system for the wet bays, the weir boxes (Pictured in Fig 2) are connected into the Redundant Effluent and Sludge Pipework System (RESPS) and were an early mechanism for helping ensure the interlinked bays and main pond can be maintained at a constant depth.

The team became aware of a potential issue with the RESPS downdropper pipe connected into the MT Bay. Following a period of increased surveillance which identified the need to isolate the pipework, a strategy for isolation and repair was developed. This involved coring an access hole in the MT Bay internal floor and filling the line with grout, successfully conducted in February 2010.

The risk reduction team then began a series of plant investigations to ascertain the conditions of all other weirboxes on the plant. The information from these investigations was used to develop the existing designs and substantiation and modify them for this particular task, thus saving time on the front end of the project. These techniques were then deployed to execute the isolations for a further four weir boxes without incident despite challenging radiological conditions. In addition, the work was carried out using a 'fit for purpose' Category B Safety Case which followed a streamlined approval process.

Fig 2 –Image of Weirbox inside wet bay, showing its position relative to the waterline and top view of weirbox prior to and post isolation.

The team is now focused on isolating the three remaining weirboxes on the plant which will be completed by the end of the financial year 2010/2011.

Gantry Refurbishment System

A major refurbishment project on the FGMSP was also completed in October 2010. The gantry frame steelwork, constructed over 50 years ago, had suffered from a lack of regular maintenance and constant exposure to the harsh Cumbrian salt laden environment. The gantry system was in need of a complete overhaul to allow the building's Skip Handling Machine, necessary for the removal of hazardous bulk sludge and solid waste inventory from the pond, to be brought back into service.

The Gantry Refurbishment System (GRS) was used to carry out the refurbishment project, as well as allowing an engineered means of inspection and repair if required. In addition to bringing back the Gantry Framework into a useable condition, the aim of the refurbishment work was to resolve structural seismic and static performance issues.

Due to access issues, pre inspection of the structure was not possible so before refurbishment work started, PVC suited workers cleaned all of the accessible steelwork and monitored it for contamination. This identified that the majority of the corrosion was caused by exposure to the prevailing weather and poor maintenance of associated building rain water gutters. A number of areas were so severely corroded that replacement was the only solution. More positively, some of the more sheltered areas of steelwork were found to still be structurally sound.

Fig 3 – Position and condition of the Gantry Structure

A number of common defects were also identified with the Skip Handler rail system, including missing or lose rail fixing bolts, cracks in the crane rails and damage to the rack drive system resulting from historic operations. The team developed a number of innovative techniques to address these including optimising the thickness of materials used for patch repairs, reintroducing the use of burning operations to remove damaged sections of steelwork and a technique which allowed damaged/cracked sections of rail to be repaired rather than replaced. As well as significantly reducing the dose uptake to workers, this work also enabled significant programme accelerations to be achieved. A four coat paint system was then applied to the gantry structure, to reduce future maintenance requirements.

In addition to the challenging radiological conditions above the pond, with dose levels approaching 200 micro sieverts (20 mrem) per hour in some areas, a number of conventional safety challenges had to be managed: the main one being working at height, as well as extreme climatic conditions during late 2009 which caused delays. Despite these, the project was completed with over 700 days without a nuclear incident or accident.

The coordination of many workgroups was required to deliver this programme of work. Key to the achievement was team working, with over 300 individuals working for over 2 years to ensure delivery to meet a challenging programme completion date.

The GRS is now being used to repair and replace the building cladding systems adjacent to the pond.

PROGRESS ON THE PILE FUEL STORAGE POND DECOMMISSIONING.

The Pile Fuel Storage Pond was built between 1948 and 1952 to provide the storage and cooling facility for irradiated fuel and isotopes from the two Windscale Pile reactors. The facility continued to operate as a storage facility until waste movements ceased in the early 1970s and the facility was put under a programme of surveillance and maintenance.

In 1981, refurbishment work started to bring the facility up to modern standards to enable waste retrievals. The facility is now undergoing a programme of decommissioning.

An important recent hazard reduction activity within the facility was to desludge the decanning and withdrawal bays of the pond before eventual desludging.

Fig 4 - Water jet lancing in the Decanning bays and removal of skips from main pond

To date, the team has de-sludged 6 of the facilities decanning/withdrawal bays. The sludge has been moved from the bays into the main pond area using water jet lances and underwater impellors. In addition to this, 22 redundant skips have been exported from the main pond at the time of writing, 16 of which have been during the last financial year. This has been done via the new skip wash and tipper machines which were installed as part of the sludge retrievals project.

The skips were then wrapped in purpose built PVC bags prior to being sent to Waste Monitoring and Compaction Plant (WAMAC) for size reduction and disposal. This has made room on the pond floor for further desludging and clean up operations, and the next challenge for the team is to collect and transfer the sludge from the pond into the in-pond corral before it is removed from the facility and sent for storage and ultimate treatment

ADDITIONAL HAZARD AND RISK REDUCTION ACHIEVEMENTS

THE PILE FUEL CLADDING SILO

Fig 5 - Installation and commissioning of the Passive Off Gas System for the Pile Fuel Cladding Silo.

The Pile Fuel Cladding Silo was commissioned in 1952 as the storage facility for Intermediate Level Waste. The facility was designed as a dry silo and waste was tipped into the silo compartments using a bogie.

Much of the inventory in the silo is pyrophoric chemically reactive material so an intensive programme of modifications was initiated to improve the containment and safe storage of the waste. One of these improvements has been the inerting of the facility with argon gas, and a seismically qualified argon inerting plant was successfully commissioned in 2001 - a major step forward in reducing risk in the facility.

More recently, the plant team has introduced a new passive off gas system to replace the previous forced ventilation system. The Off Gas System provides a ventilation route from each of the buildings silo compartments to atmosphere such that argon gas used to inert the silo compartments can be discharged at a safe height into the atmosphere via HEPA Filters and a ventilation stack This will bring about a significant reduction in argon gas usage of at least 50% a year with resulting cost savings. This prepares the plant for the start of waste retrievals from the Silo.

To achieve permission from the Nuclear Installations Inspectorate (NII) to actively commission the system, the team put in place a proactive approach to communicating including the NII in early discussions about the programme of work and the work methods. This approach, often referred to as flexible permissioning, brought about an early inspection date from the NII with approval being granted.

STABILISATION OF THE PRIMARY SEPARATION PLANT HIGHLY ACTIVE NORTH OUTER (HANO) CELL.

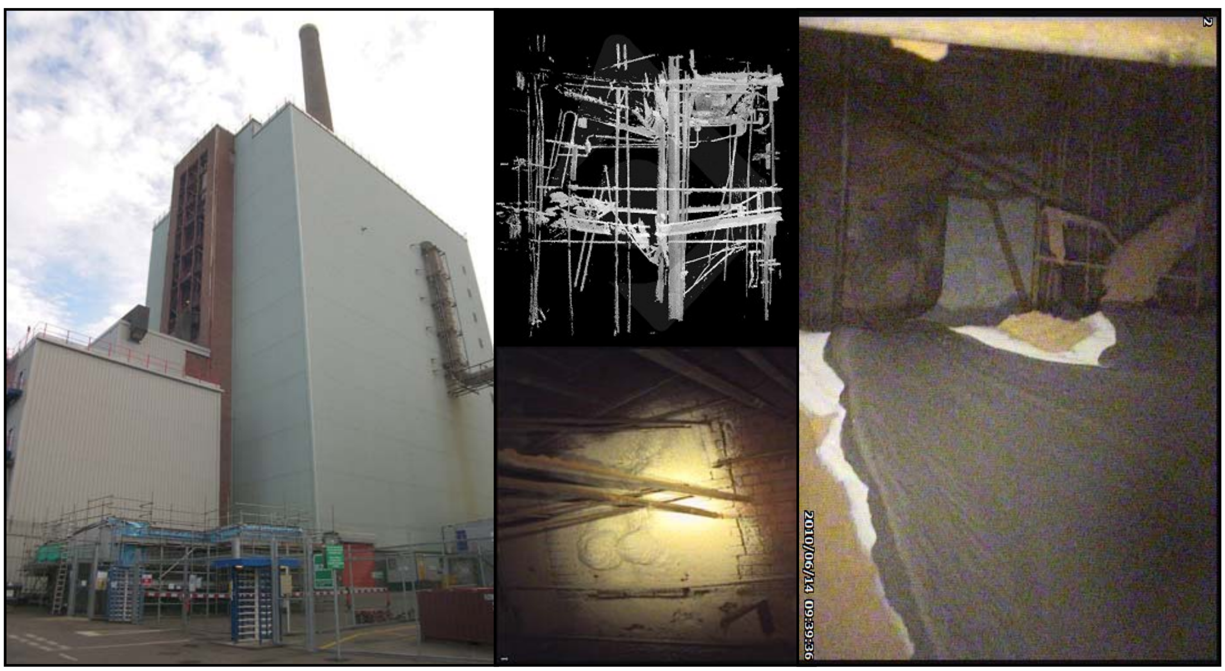

Fig 6 - Primary Separation Plant, showing in cell scan of degraded steelwork, wall stabilisation work and grout pour.

The Primary Separation Plant was constructed in the early 1950s to carry out the first stage of reprocessing fuel from the pile reactors. It was subsequently modified to accept oxide fuels following the opening of the Magnox Reprocessing Plant before ceasing operations in the 1970s. The Highly Active North Outer (HANO) cell was adapted as a ventilation route and was used for a number of years, however recent laser scans carried out to ascertain the condition of the cells identified that many of the mild steel beams within the cell had been severely corroded by the acidic ventilation effluent. In addition, there was evidence of partial collapse of some of the vessels and pipework.

The cell was in need of stabilisation to allow safe decommissioning operations in the MAN (Medium Active North) cell below, so preparatory work was carried out which included the re-routing of the HANO ventilation extract route and the stabilisation of a section of brickwork wall between the Inner and Outer High Active cells.

Following extensive research and development, the project team worked with the University of Dundee, Concrete Technology Unit and Westlakes Engineering to develop a solution to stabilise the cell. A lightweight foam grout with an air bubble consistency was developed, which minimised the weight on the building, and is crushable to 30% of its original volume when full decommissioning of the building takes place.

The first phase of grouting, filling the cell shaft, was completed in late 2007, however because of the ‘inverted L’ shape of the cell, additional work had to be undertaken to confirm the integrity of the roof above the Medium Active Cells and demonstrate its ability to support the weight of the grout. This led to the development and use of an even lower density grout at 300kg/m^3 to minimise weight loading and required a further safety case and off site trials.

Grouting the top 12 metres of the cell; consisting of floors 7 to 10, started in June 2010 and the last of the 55 pours was completed on 6 September. The maximum depth of each pour was 25 cm and each layer took 24 hours to complete and set. Strict quality controls were followed to ensure that the grout was of the correct density and strength to ensure that each layer did not collapse under its own weight until it had time to fully cure and harden.

The Highly Active North Outer cell (HANO) has now successfully been filled with 505m^3 of light-weight foaming grout resulting in the conclusion of a significant piece of work to stabilise the internal vessels and pipework in the facility. This mitigates a significant safety risk of vessel collapse in the cell and concludes stabilisation work leaving the cell in a fit state for care and maintenance pending full decommissioning and is an excellent example of the team applying innovative thinking to a simple technical solution to see the stabilisation project through to completion.

CONCLUSION

Acceleration is key to risk and cost reduction – the best way to deal with risk is to eliminate it as soon as possible and decommissioning the Legacy Ponds and Silos is the highest priority at Sellafield.

More than ever we need to be able to demonstrate that we can safely, efficiently and cost effectively decommission facilities that were built without due consideration for the challenged involved in Decommissioning. The projects highlighted in this paper are excellent examples of how together, Sellafield Ltd and Nuclear Management Partners are accelerating the decommissioning of the site, and helping make Sellafield cleaner, safer, more productive, more cost effective, and a better neighbour each and every day.

By accelerating these, and other future missions on the site, it will make Sellafield fit for purpose and help build the bridge to the UK's green and safe energy future.