

Preparation for Retrievals from Sellafield Legacy Ponds Installation of the Gantry Refurbishment System

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ABSTRACT

Retrieval of sludge and fuel from the First Generation Magnox Fuel Storage Pond, and its safe long term storage is one of the NDA's top priorities in the UK clean up programme. The plant is currently undergoing a series of major modifications in preparation for the retrievals operations. The most visible example of these modifications is the Gantry Refurbishment System (GRS), a major work platform which has recently been lifted onto the pond long travel girders used by the Skip Handler. This paper describes the design, manufacture, works test, and site installation of this major piece of equipment. The installation lift, involving the use of an 800Te crane was one of the largest lifts undertaken at Sellafield.

The GRS is a mobile platform structure which is designed to be pushed or pulled along the long travel girders by the Skip Handler. Its principle function is to provide a safe and shielded working platform from which to undertake refurbishment of the Skip Handler long travel girders and support structure.

The potential hazards and consequences resulting from the modification were fully understood and controls were put in place to ensure that the risk of carrying out the work was as low as reasonably practicable. The work was authorised by the NII, Sellafield Nuclear Safety Committee and an independent readiness review panel. Despite less than perfect weather in the run up to the lift, the GRS was successfully and safely lifted onto the pond on 18th October 2006, the culmination of three years of planning, engineering and construction.

INTRODUCTION

This paper describes one of the many projects which are underway at Sellafield to clean up and remediate the facilities that were used in the storage and reprocessing of nuclear fuel. These facilities were constructed in the 1950's and contain a significant quantity of nuclear waste. The facility which forms the topic of this paper is the First Generation Magnox Storage Pond (FGMSP), which is located in the centre of the Separation Area at Sellafield. The paper concentrates on the project tasked with the procurement of a large mobile platform, which in deployment, spans across the fuel storage pond, resting on the long travel girders that run the entire length of the pond. The platforms primary function is to provide an operating platform from which to repair or replace the long travel girders along which the Pond Skip Handler travels. This is a key enabler to allowing the skip handling machine to operate and undertake fuel management duties and retrievals within the pond.

OPERATIONAL HISTORY

The First Generation Magnox Storage Pond (hereafter refer to as the Pond) was constructed in the mid 50's and performed a vital role in the UK civil nuclear power programme. It operated safely for nearly 30 years, storing irradiated Magnox fuel in a concrete open air pond before stripping the fuel of its cladding (decanning) prior to reprocessing at a separate facility. The advent of commercial scale nuclear power demanded recycling facilities on a large scale, able to accept 500 fuel elements per day, to run the 26 Magnox reactors across 12 sites in the UK.

During operational service a massive 27,000te of fuel was stored, decanned and then exported from the plant. It received its last batch of fuel in 1992 before entering its post-operational cleanout (POCO) phase.

Its unique cleanup challenges were created in the mid 1970s due to a lengthy and unforeseen shutdown at the Magnox Reprocessing Plant and also through a vastly increased throughput of fuel due to electricity shortages.

These factors caused the spent fuel to be stored in the pond for longer than the designed period, resulting in the corrosion of the fuel's magnesium oxide cladding and degradation of the fuel itself. Ultimately this led to increased radiation levels and extremely poor underwater visibility in the pond.

EARLY DECOMMISSIONING WORK

Decommissioning of the older facilities at Sellafield has been underway since the early 1990's with notable skyline changes including the decontamination and dismantling of the 125m high Windscale Pile Chimney for Pile 2. Planning for decommissioning identified the inter-related nature of the facilities and the need for new processing and storage facilities to condition and store the operational wastes. In regard to the pond the key activities were the ongoing safe storage of the legacy materials, the identification of means to retrieve the wastes and the creation of suitable downstream plants to process and store the wastes, pending the creation of the long term storage solution. Early work on the plant concentrated on the ongoing safe storage of the materials, whilst detailed planning and engineering work was undertaken on the retrieval, processing and storage of wastes.

FORMING THE PONDS ALLIANCE

In June 2002 Sellafield Ltd, then known as British Nuclear Group, contracted with ACKtiv Nuclear to progress the work associated with the pond, focussed on the ongoing safe storage of the wastes, including tasks to reduce the risk associated with the facility, and projects providing early enabling work for the retrievals programme.

ACKtiv Nuclear is a Joint Venture (JV) which brings together three of the most respected engineering, construction and full life cycle service organisations in the UK, Aker Kvaerner, Atkins and Carillion. The JV offers an unbroken asset lifecycle chain from conceptual design through detailed engineering, construction, installation, commissioning, handover and post – handover operational support.

In order to develop a contractual arrangement which was a win-win, Sellafield Ltd contracted with ACKtiv Nuclear through an Alliance Agreement. This was an enabling contract that allowed Sellafield Ltd and the JV to work together to achieve common objectives. The framework enabled packages of work to be delivered under target cost or fixed price arrangements, with

incentivised fee, based upon a balanced scorecard of project achievements, quality and customer satisfaction.

Significant work was undertaken to form the Alliance team into a single entity, with a fully integrated management team, co-located in a single location. Objective setting and team building workshops were undertaken with the aim of creating a sustainable programme of behavioural development. The success of this is evidenced in the “no blame” culture that developed where it was difficult to identify a team members employing company, and where Sellafield Ltd and JV staff were in senior positions within the integrated team.

SCOPE AND OBJECTIVES OF THE ALLIANCE

The complimentary expertise of Sellafield Ltd and the JV was utilised over the full life cycle of the projects, from business needs assessment to final commissioning. The overall scope was divided into a number of geographical “Area Projects” for the purposes of efficient management of the portfolio. The overall portfolio was a major enabler to the retrieval of the historic inventory and the subsequent safe decommissioning of the plant. The projects were grouped under three main drivers, firstly, key retrieval enabling projects, secondly asset management and restoration and thirdly risk reduction. The following paragraphs briefly describe the main projects in the portfolio.

Export Building

This project’s objective is to convert the former Pond Inlet Building into an operational Export facility to facilitate the removal of the skips currently contained in the Pond. The work includes removal of redundant equipment, upgrading of the services and support systems, decontamination of the cells and the installation of new in-cell flask and skip handling equipment.

Pond Purge and Sludge Pipework Protection

This project consists of the design and development of proven systems for the permanent isolation of the pond effluent discharge route which has been redundant since the early 1970’s. The pipework is located in a radiologically challenging environment necessitating all the systems and techniques being off-site tested to ensure minimal “time at the workplace” for the installation and operations teams.

Fuel Storage Pond

This project encompasses remedial works to the pond facility, specifically the skip handling machine and associated gantry. To support retrieval operations the rail, racks, gantry beams and gantry legs are to be refurbished. To accomplish this work a Gantry Refurbishment System (GRS) has been designed, fabricated, tested and installed to enable the majority of the access and lifting necessary to complete the refurbishment programme. This project is the focus of the remainder of the paper.

POND PROJECT AND THE GRS

The overall objective of the Pond Area Project was to restore the asset to a fully operational condition, which in turn would enable the Skip Handling Machine to undertake duties associated with fuel movements around the pond. Asset restoration involved a number of interconnected sub-projects including refurbishment of the skip handling machine, refurbishment of the long travel girders on which the machine travelled the length of the pond, replacement of the pond side cladding on the adjacent buildings and the assessment of the structural capacity of the entire facility. Managing and co-ordinating this portfolio was a challenging task.

Early work on the refurbishment of the long travel girders concentrated on the extent of refurbishment needed and the practical solutions for gaining access to undertake the work. A significant driver for option selection was to minimise dose uptake to the workforce, which would be involved in working in close proximity to the surface of the pond. Options included localised repairs, replacing the entire rail and top flange channel sections or complete replacement of the girders. An early project decision was taken after consideration of these options, to opt for complete replacement of the girders. With regard to the supporting steelwork trestles, it was concluded that these were to be refurbished with localised in-situ repairs, except in cases where corrosion was severe, in which case, the trestle would be replaced.

There followed an option study (1) into alternative means of providing equipment to replace the girders, and allow safe and minimum dose access to the workface. The radiation levels from the pond liquor make what would otherwise be a straightforward plant refurbishment project into a significant plant access challenge to facilitate safe personnel and materials access to the workface to undertake the refurbishment work.

Options included the use of mobile cranes or tower cranes, a monorail system, scaffolding or the use of a purpose built high level working platform, running on the existing girders. Options were scored against criteria including technical, safety, programme and cost. Traditional options such as the use of a tower or mobile crane were discounted in favour of a purpose built working platform that could perform the dual function of providing a shielded working platform for personnel and a lifting capability to remove the existing beams and replace them with new beams. In parallel, work was progressing on one of the many innovations that were introduced on the project; the use of a water filled structure, to float on the surface of the pond and offer shielding to the workforce.

FUNCTIONAL REQUIREMENTS

The GRS is a mobile platform that is designed to undertake refurbishment of the long travel girders of the pond skip handler. It spans 18m across the pond and is supported on the rails of the long travel girders. It is pushed or pulled along the long travel girders by the Skip Handler. Its duties will vary from the replacement of complete beam sections (typically 6.5m long) to the localised repair of gantry beams and supporting trestles. The machine has two working platforms, one at the north side of the structure, and a similar one at the south side. These provide access to the north and south girders respectively. Each platform provides load carrying capacity for one removed girder and one replacement girder, a total payload for each platform of 6Te. To export old girders and import new girders the machine is equipped with two electric overhead hoists operating on overhead runway beams. Power for the hoists is obtained from a modified power supply on the Skip Handler.

DESIGN

ACKtiv Nuclear were responsible for the overall design solution, working closely with British Nuclear Group in their role as Intelligent Customer. The machine was designed for a 15 year design life. The key design requirements of the GRS were:

- The ability to remove existing long travel girders and replace them with new ones.
- Provide safe access to the work face
- Be constructed in such a way that minimised the time needed to install the machine on the Pond
- Provide shielding to the operators
- Maximise access capability

The machine was designed to withstand normal static and dynamic loads and in addition it was required to withstand a seismic event of 0.125g which was the requirement at Sellafield for existing structures.

A key consideration was that the machine was to be supported on the existing girders, located alongside the Skip Handler. The weight and configuration of the GRS loads applied to the girders was therefore required to avoid distress to the existing girders.

To align with the procurement strategy of early engagement of the Manufacturing sub-contractor, a joint British Nuclear Group /ACKtiv Nuclear team developed the functional requirements, performed the optioneering and developed the conceptual design. This was used as the basis for the enquiry for the manufacturing contract.

SAFETY CASE

From the earliest stages of design development, it was apparent that the installation and operation of the GRS would have a high nuclear safety profile. Installing the equipment on the pond would carry the risk of dropping a large load onto the pond and in particular, the risk of causing a fracture of the pond wall with the consequent loss of pond water, was of serious concern. It was therefore not surprising that the installation of the GRS was classified as a Category A Safety Case. A Pre-Commencement Safety Report (2) with its underpinning documentation formed the basis of the Safety Case which was taken through the Sellafield Site Nuclear Safety Committee and onward to the NII. Regular dialogue was held with the NII throughout the project and the visibility of the decision making process was key to obtaining the regulators buy in.

The key hazard was dose uptake to public and workforce resultant from a dropped or swinging load scenario. Significant contingency arrangements were required and needed to be deployed prior to the main lift.

Key Safety Case under pinning\documents were:

- Hazop studies.
- High Hazard Review.
- Command and Control hierarchy including Emergency Arrangements and Contingency Plans.
- Civil, Mechanical and CE&I Design assessment reports.
- Plant Modification Proposal and associated appendices.
- ALARP justification
- Dose uptake assessment.
- Operational safety memorandum.
- Pre Commencement Safety Report

A Readiness Review process used prior to work commencing using WANO style assessment criteria.

PROCUREMENT

An early project decision that was to have very positive consequences for the project was the early engagement of the manufacturer. It was argued that the engagement of the manufacturer at an early stage in the design development, allowed leverage of the manufacturers practical solutions to be embedded in the emerging design.

MANUFACTURE

The manufacture contract was awarded to Wellman Booth in February 2005. Their scope of work included the manufacture and full works testing together with a trial erection. Throughout the manufacture the Sellafield Ltd / ACKtiv Nuclear team worked closely with Wellman Booth to ensure that technical queries were resolved in a timely manner. One of the major design changes and improvements was initiated during the manufacture. This related to the installation method. During the design development it had been envisaged that the platform would be manufactured from a number of fabricated components, with the final construction of the platform being effected in situ on the pond. This allowed the use of smaller cranes and made best use of the restricted site around the pond. During manufacture, the trial erection illustrated the significant amount of time needed to complete the bolted connections joining each of the major components. The team turned back to the idea of a single lift and investigated the feasibility, size of crane, space on site and the challenge of getting a safety case approved. A decision was made to install the unit as a completed structure and modifications were made to the design to allow the unit to be lifted as a completed structure. A trial lift was successfully undertaken at the manufacturer's works. This was a good example of the close working arrangements throughout the project structure from Sellafield Ltd, through ACKtiv Nuclear and to Wellman Booth.

Completing manufacture was a time related critical milestone aligned to British Nuclear Group targets. There was regular stakeholder involvement by the client, NII and NDA, who were regularly briefed and undertook several visits to manufacturer's works. Targets were achieved due to close liaison and co-operation with the manufacturer (Wellman Booth) and involved the provision of additional labour, weekend working and Shift working. The GRS manufacture was successfully completed in 12th August 2005, achieving a time critical milestone.

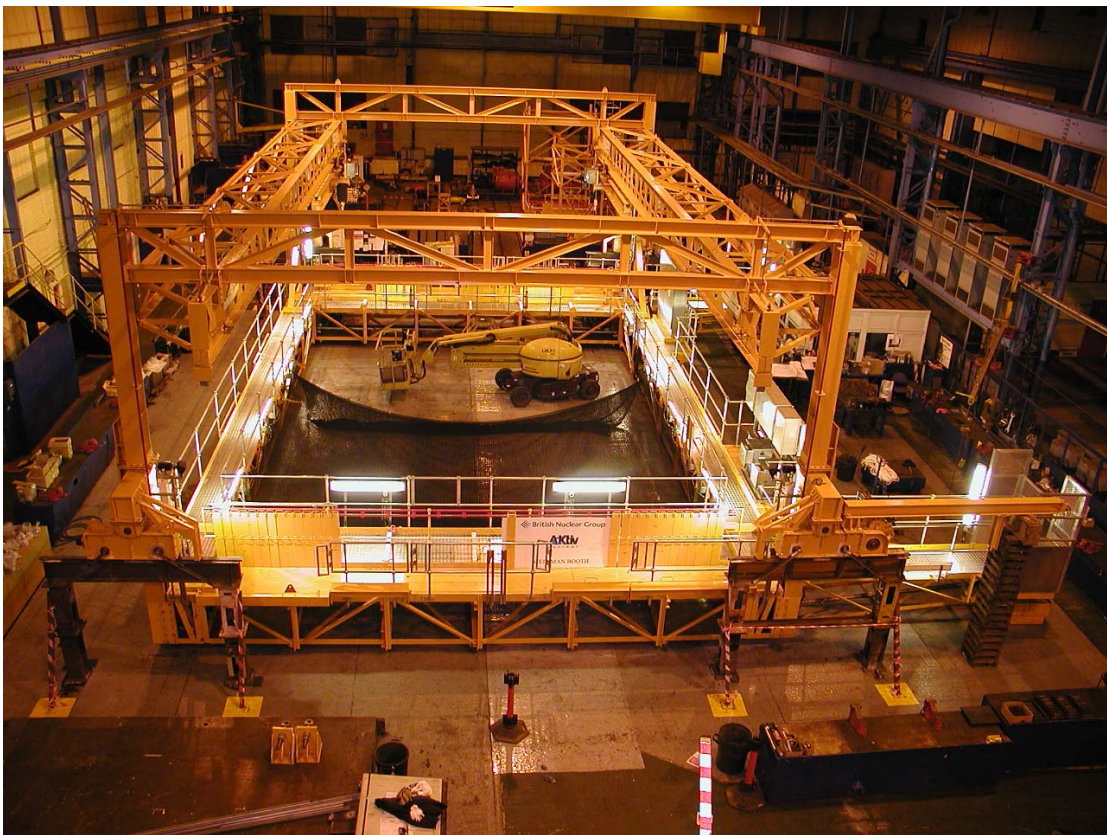


Fig. 1: GRS assembled at Wellman Booth factory

PLANNING FOR INSTALLATION

The safe installation of the GRS on the pond was recognised from the outset as a major challenge. Rigorous planning, engineering safety and management of all the issues associated with installation was required to satisfy the very high standards required of such an operation. Consideration was given to both tower crane and mobile crane options for assembling and lifting the GRS onto the pond and it was concluded that the tower crane option was less suitable due to its increased collapse radius and the requirement to utilise a mobile crane for its erection. Crane studies were undertaken to determine the size, layout and duties of the crane in order to both assemble and then lift the GRS onto the pond. It was concluded that the appropriate solution was the use of an 800Te mobile crane located to the NW of the pond.

FAULT SCENARIOS

Extensive investigations and assessments (3) were undertaken to determine the consequences of fault scenarios. A number of fault scenarios were considered involving collapse of the mobile crane, dropped loads, and swinging loads. The exact mechanisms by which the collapsing load impacted on the structure and subsequently propagated damage to the water retaining structure were complex due to the physical layout of the gantry girders, their supporting steelwork trestles and the reinforced concrete walls of the water retaining pond. Detailed analysis of the potential impact scenarios indicated that the likely consequences would lead to significant leakage, but not to a complete collapse of the pond wall.

Consideration was given to the installation of impact protection to the pond and other structures (e.g. Redundant Effluent and Sludge Pipework System). To fully mitigate the risk, any solution would have been very substantial, and its installation would create similar secondary hazards to those of GRS installation. This was therefore not pursued as an option.

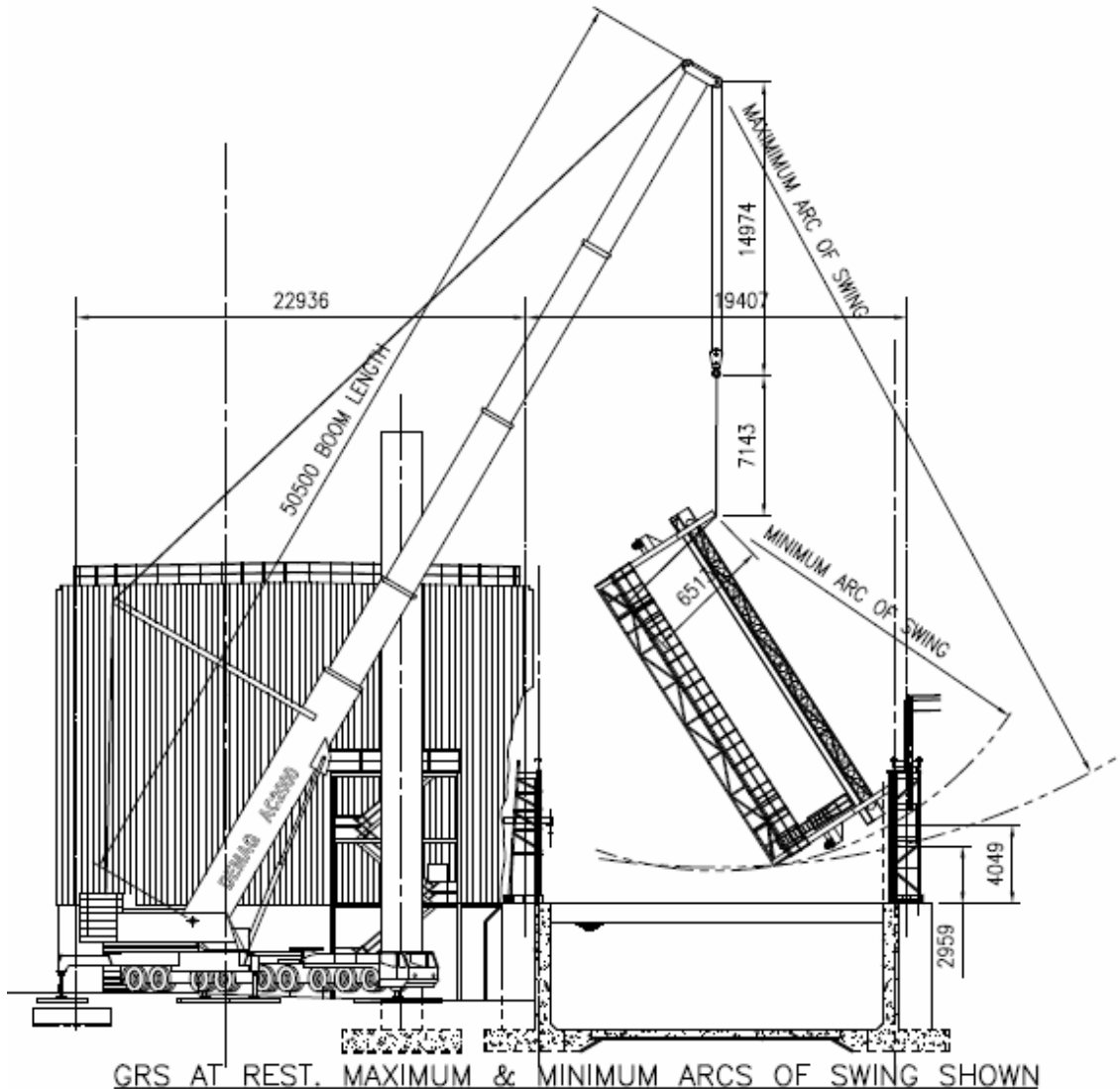


Fig 2: Fault scenario of a failed sling leading to a swinging load

EMERGENCY ARRANGEMENTS FOR THE INSTALLATION

Emergency arrangements were already in place for the pond to deal with the consequences of leakage due to fault loading conditions. The dropped load assessments were used to develop additional emergency arrangements, associated with the containment of leaking liquor and its pumping back into the pond. Rehearsals were undertaken on these arrangements prior to the GRS lift taking place.

INSTALLATION

Changing the lifting arrangements from a piece small plan to a single lift had implications for the site installation crew. Principal amongst these was the need for a large mobile crane to undertake the lift. In addition it was necessary to provide sufficient space adjacent to B30 where the GRS could be assembled from its component parts before the lift onto the pond. Space had to

be created in a very congested site and temporary levelling pads were constructed on the footprint of the GRS to eliminate uneven ground conditions.

The sections of the GRS were brought to Sellafield on large load wagons and parked in a holding area before being moved into the Separation Area and B30. Route studies were carried out to check the clearway for the lorries, particularly ensuring that overhead pipe bridges and services provided sufficient clearance.

Each piece of GRS was delivered in the pre-defined sequence to the erection area adjacent to B30 and bolted together with its adjoining sections. Temporary supports were required to some of the sections in the partially erected state to counterbalance eccentric centres of gravity and avoid overtopping of the partially completed structure. Once the structure was in place, the hoists were fully commissioned.

Despite less than perfect weather in the run up to the lift, the GRS was successfully and safely lifted onto the pond on 20th October 2006,



Fig.3: Lifting the GRS onto the pond



Fig. 4: GRS in position on the pond

PROGRAMME

The key programme dates were:

- Contact Award 08/03/05
- Manufacture Complete 12/08/05
- Trials Complete 25/04/06
- GRS Delivered to Site 02/10/06
- Assembly Complete 13/10/06
- Installation Complete 20/10/06

CONCLUSION

The paper describes the procurement of the GRS from initial concept through to its current status installed on the pond. It describes the design, manufacture, works tests, site installation and how this major plant item is key to the post operational clean out of the facility. The GRS was successfully lifted onto the Pond on 20th October 2006. This was the culmination of three years of planning, engineering and construction. The project was a major success, and was an excellent example of positive working relationships throughout the supply chain from Sellafield Ltd through ACKtiv Nuclear to Wellman Booth.

ACKNOWLEDGEMENTS

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Photographs are courtesy of Sellafield Limited.

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