

**Challenge of Replacing Obsolete Equipment and Systems
on Brownfield Sites - 9077**

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ABSTRACT

The Nuclear Decommissioning Authority (NDA) is responsible for the decommissioning and clean-up of the UK's civil public sector nuclear sites. One of their top priorities is the retrieval of sludge and fuel from the First Generation Magnox Fuel Storage Pond (FGMSP) at Sellafield site which is one of the most complex and compact nuclear sites in the world. The FGMSP plant is currently undergoing a series of major modifications in preparation for the retrievals operations. One of the most challenging modifications undertaken in the facility has been the Control and Surveillance Project which covered replacement of the existing Environmental Monitoring System, this presented the complex challenge of replacing an existing system whilst maintaining full functionality on a live radiological safety system with a constant radiological hazard.

The Control and Surveillance Project involved the design, procurement, installation, changeover and commissioning of a new Radiological Surveillance System (alpha, beta and gamma monitoring) along with Building Evacuation Systems within the FGMSP complex to replace the existing obsolete system. This Project was a key enabler to future FGMSP retrievals and decommissioning activities. The project objective was to create and maintain a safe radiological working environment for over 450 personnel working in the plant up to 2020.

INTRODUCTION

This paper describes some of the many projects which are underway at Sellafield site 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 radioactive 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 changeover of existing obsolete equipment that was required within the facility to provide a firm basis for which future retrievals projects could build upon.

OPERATIONAL HISTORY

The First Generation Magnox Storage Pond (hereafter refer to as the Pond) was constructed in the mid 1950'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 site 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 Solutions, 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 mutually beneficial, 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 facility. 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.

ASSET RESTORATION PROJECT – CONTROL AND SURVEILLANCE PROJECT

The Control and Surveillance Project involved the site survey, consultation, scope definition, design, procurement, works test, installation and commissioning of a new control system for the First Generation Magnox Storage Pond facility. The control and surveillance system incorporates a control desk, Supervisory Control And Data Acquisition (SCADA), radiological surveillance and building evacuation systems within the Ponds complex. The project is a key enabler to future Legacy Ponds retrieval activities. The project comprises of two parts; the radiological surveillance/building evacuation system and the control and monitoring system.

The Radiological Surveillance System (RSS) consists of new radiation monitors, Programmable Logic Controller’s (PLC) and Input/Output (I/O) hardware along with a dedicated SCADA system with duty / standby servers. The RSS not only provides a method of viewing current radiation levels and actuation of the evacuation system; it logs and trends alarms and radiation levels for later analysis – a feature which was previously unavailable. The two servers are situated in different buildings, one in the building control room and one in the Incident Control Centre. The purpose of this is to be able to monitor the facility remotely so that in the event of an emergency requiring building evacuation, a structured re-entry can be planned and executed.

A major challenge of the RSS implementation was the installation of the monitors and control desks, which was achieved with the right strategy and input from all Stakeholders. The changeover involved the installation of the control room control desk, 60 gamma monitors, 59 Alpha / Beta in air monitors, 4 Stack Alpha / Beta in air monitors as well as over 2000 metres of cable rack and over 17000 meters of cable. The entire changeover had to be implemented whilst maintaining full functionality of all systems.

Why was a new RSS/BES system required?

- The existing RSS, BES equipment was very old and in a poor state of repair. Most of the equipment was obsolete and no longer supported by the manufacturers. There were very limited spares for this equipment remaining.
- The old equipment did not meet modern safety/technical standards.
- The old equipment was becoming increasingly unreliable causing intermittent building evacuations.
- The old system had very limited capability to view, store, or trend plant data.
- No radiological status was available in the control centre.



Figure 1: Old control desk

What is the new RSS/BES system and what does it provide?

The new environmental monitoring system consisting of 56 new alpha/beta iCAM (intelligent Continuous Air Monitoring) monitors and 60 G64 gamma monitors located around the complex which are monitored by the new RSS. The area monitors have local audible and visual alarms. Monitors with remote detectors have a remote warning devices i.e. door warning signs, alarm integral units.

The RSS consists of two zones, one for the Main building and one for the Inlet/Export Building. The RSS has 2 Operator workstations one in the Main Control room and one in the Incident Control Centre.

Figure 3: Existing 3230



Figure 4: New iCAM alpha/beta



The iCAM alpha/beta monitor measures airborne alpha and beta particulate activity. Air is drawn through the instrument by means of an external pump and airborne particulate material is deposited on the removable card-mounted filter. The filter is monitored by a PIP (Passivated Ion-Implanted Planar silicon) radiation detector, which allows simultaneous measurement of both alpha and beta radioactivity in the material deposited on the filter. Measurement results are presented on the graphical display on the instrument's front panel. Results are reported via the RS-422 network connections to the new RSS. In addition, Level 2 and 3 alarms are indicated locally by visual and audible signals (local indication is the safety function of the system), level 2 alarms remotely by relay circuits connected to an annunciator and Level 1, 2 and 3 centrally by connection to the RSS/SCADA.

Gamma radiation interaction in the G64 gamma monitor deposits units of charge whose magnitude and frequency are proportional to the incident energy and dose rate. These charge pulses are amplified and shaped to produce a series of voltage pulses. Results are reported via the RS-422 network connections to the new RSS. In addition, all alarms are indicated locally by visual and audible signals and (local indication is the safety function of the system), remotely by relay circuits connected to an annunciator and centrally by connection to the RSS/SCADA.

The RSS provides the following functions at the SCADA workstations in the Control room and Incident Control Centre:

- Display, monitor and alarm signals from alpha/beta monitors and gamma monitors.
- Provide a building evacuation signal to the BES in the event of abnormal airborne activity.
- Display, monitor and alarm Stack discharges.

In addition to the RSS alarm function, the following monitor alarms are now available on alarm annunciators in the Main Control Room.

- High activity (level 2) and equipment failure for alpha/beta monitors.
- High radiation and equipment failure for gamma monitors.
- Level 1, 2 and 3 for stack alpha/beta monitors.

The replacement Building Evacuation System (BES) accepts evacuation signals from the RSS and also manual inputs via panel mounted key-switches. The system output initiates dedicated loudspeakers located within the complex to warn personnel to evacuate and to warn against entry.

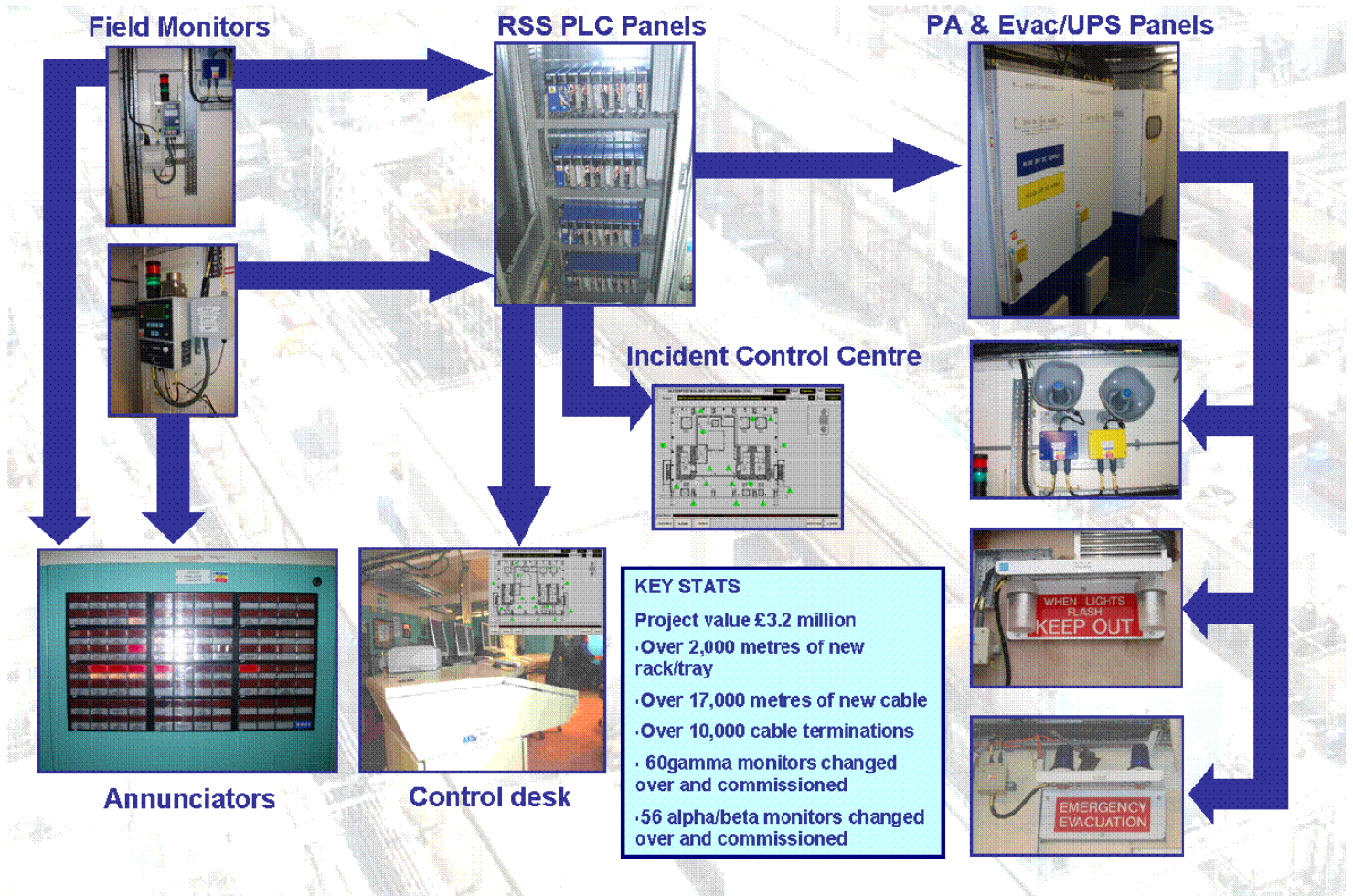


Figure 5: Control & Surveillance System Overview

Project Management

The project was successfully managed by a team consisting of Sellafield Ltd and ACKtiv Nuclear. Sellafield Ltd placed a contract under an existing alliancing agreement with ACKtiv Nuclear who produced the detailed design and managed sub-contracts for the RSS and BES manufacture and supply with TYCO control systems and BNFL Instruments. Supply of alpha/beta and gamma monitors came from Canberra Harwell with installation by Balfour Kilpatrick / Shepley Engineering.

Sub-contracts;

- RSS Tyco Control Systems
- BES BNFL Instruments
- Installation Balfour Kilpatrick / Shepley Engineering Ltd
- Monitors Canberra Harwell

ACKtiv Nuclear provided a package manager to deliver the contract on behalf of Sellafield Ltd.

The delivery programme was extremely demanding and was further challenged by the inclusion of additional scope to enable alpha monitoring. The inclusion of alpha monitoring required major modification to the design, installation and RSS system manufactured by TYCO control systems.

ACKtiv Nuclear maintained the focus on sub contractors during the alpha modification, by holding regular progress meetings and establishing a dedicated team to ensure that the programme was maintained and technical difficulties managed out at source. Both the RSS manufacturers and the installation sub-contractor demonstrated a positive attitude and showed commitment from early on in the alpha mod programme with accelerated pro-active working.

The Sellafield Ltd Legacy Ponds Project Team together with their contractors ACKtiv Nuclear, proved to be committed and flexible in meeting their promised and contractual completion date on an extremely challenging target to safely deliver the RSS/BES system including alpha monitoring on time.

Reasons for the success of the project

Much of the success of the project was due to a proactive approach in the early design stages involving all the stakeholders to identify and drive solutions minimising the degree of design queries during the manufacturing and commissioning stage.

A major contribution to the success of the project was ensured by the singularly focused and sustained commitment of a core project team involving members of Sellafield Ltd and ACKtiv Nuclear from the beginning of the optioneering through the design, manufacturing and testing stages of the RSS/BES System. All these tasks were completed by close teamwork between Sellafield Ltd project, stakeholders ACKtiv Nuclear and their sub-contractors.

RETRIEVALS ENABLING PROJECT – EXPORT BUILDING

The Export Project involves the modification and refurbishment of the redundant First Generation Magnox Storage Pond Inlet Building in order to provide a new Export facility which will enable the retrieval of legacy ponds inventory. In its original role the facility received consignments of fuel and transferred the fuel into the pond via one of three cells. The building is old, deteriorating and contains life expired plant and equipment.

The building has been renamed the Export Building and the project has been initiated with the aim of:

- Enabling safe, reliable and sustained control and surveillance operations.
- Improve environmental and radiological conditions within the building.
- Maximise the use of the existing asset.
- Mitigate the risk associated with establishing an engineered export route.

The Export Project has been implemented in a two phased approach:

- **Phase 1** - The upgrade of the Export Building basic infrastructure which consists of two main tasks:
 - 1a) Rationalisation of the CE & I systems, consisting of design, procurement, refit, commissioning and the strip-out of redundant CE & I equipment
 - 1b) Cell clean-up, involving the cell decontamination and strip-out of all redundant equipment.

The completion of both tasks acts as an enabler to Phase 2 of the project.



Figure 1: Export Building interior

- **Phase 2** –Design, procurement, refit and commissioning of the Export building. The phase 2 section of the project aims to replace all the mechanical plant handling items and other associated equipment. The successful completion of this part of the project will provide a facility capable of retrieving skips of pond inventory, transferring the waste into flasks and exporting these flasks from the building to be stored in a more permanent location.

During the execution of Phase 1, particularly Phase 1b, considerable knowledge was gained about the plant condition and confirmed facts that were previously known but not substantiated. This was achieved by undertaking in-cell and underwater surveys to develop an inventory for each cell. This information was used to underpin the redundant equipment strip-out methodology. Prior to strip-out the cells were decontaminated to reduce the future dose burden when re-fitting the cells. This was achieved by ultra-

high pressure water jetting. To support the decontamination a temporary ventilation system had to be installed and commissioned. This had an impact on the secondary containment requirements which had to be upgraded to provide an airtight seal. The results of the decontamination reduced the dose burden by 50% with a subsequent increase in the in-cell working times.



SUMMARY

The Legacy Ponds at Sellafield represent one of the biggest challenges in the civil nuclear clean up portfolio in the UK. Retrieval of sludge and fuel from the First Generation Magnox Fuel Storage Pond (FGMSP), and its safe long term storage is one of the NDA's top priorities. In June 2002 Sellafield Ltd contracted with the ACKtiv Nuclear Joint Venture to progress the risk mitigation, asset restoration and the early enabling works associated with preparation for clean up. Since then significant progress has been made in preparing the facility, and its support systems, for the clean-up operations. This has been achieved by breaking down the scope, within an integrated framework, to manageable and definable elements, detailed planning and preparation, undertaking site works to an exemplary safety record by the introduction of a pro-active safety management culture.

CONCLUSION

The complexity of the changeovers was vast with multiple interfaces and numerous constraints and challenges. The changeovers have been implemented successfully without any radiological or Safety incidents within cost and programme targets. The success of the projects can be attributed to the detailed planning and preparation undertaken, along with the early involvement of key stakeholders and interfaces.

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