

DEVELOPMENT AND IMPLEMENTATION OF A PROJECT TO PROVIDE A WASTE RECEIPT, ASSAY, CHARACTERISATION AND SUPERCOMPACTION FACILITY AT UKAEA'S DOUNREAY SITE

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ABSTRACT

A new facility has been designed and constructed at the United Kingdom Atomic Energy Authority's (UKAEA) Dounreay site to maximise efficiency of long term management arrangements for the solid Low Level Waste (LLW) stream arising from ongoing nuclear operations and the site remediation and decommissioning programme.

The Waste Receipt, Assay, Characterisation and Supercompaction (WRACS) project involved the development and implementation of several main task areas. Firstly, an existing redundant building was refurbished and upgraded to accommodate the new plant. A characterisation and assay line was designed, within the constraints of the available space. Simplicity/efficiency of operation was identified as a key design factor. The plant comprises a number of new "state of the art" assay and characterisation systems, combined with upgraded and refurbished existing equipment, all interfaced via a fully logic controlled material handling system.

The investment in the new plant was driven by the need to maximise the efficient utilisation of existing LLW disposal capacity on site. In addition, the new plant provides an optimised systems layout at the top end of modern standards which minimises operating costs, operator dose uptake and any potential for material accountancy errors.

The paper will describe the evolution of the project and the logical process steps addressed from conception, through implementation, to completion. The facility will be described in detail and the "modus operandi" discussed and evaluated.

INTRODUCTION

Solid LLW is generated at Dounreay through a combination of decommissioning activities and ongoing fuel reprocessing operations in support of the site's overall decommissioning mission.

Waste is accumulated at source in mild steel 200ℓ drums. The drums are subjected to a regime of non destructive assay prior to volume reduction by supercompaction. The resulting supercompacted "pucks" are consigned for disposal in the site's shallow burial facilities.

The existing LLW disposal facilities are close to capacity holdings and plans have been developed to provide interim storage arrangements and subsequent additional disposal capacity. The new facilities will utilise ISO freight containers as the disposal package and direct consignment of 200ℓ drums will no longer be permitted.

The WRACS Facility has been designed and constructed to provide a modern standard compliant plant to assist with effective management of the LLW stream. The main drivers which resulted in the initiation of the WRACS project are described in PROJECT DRIVERS. The project Work Breakdown Structure is pictorially represented in Appendix 1 and describes eight main task areas. The plant comprises a number of standalone components integrated through a drum handling and Supervisory Control And Data Acquisition (SCADA) system. These components include a combination of existing equipment which has been extensively modified, and a number of new systems. These are described in Section 3.

PROJECT DRIVERS

BNFL operates a shallow burial facility for LLW at Drigg in Cumbria. This provides a disposal service to all areas of the UK nuclear industry. The only other radioactive waste disposal facility in the UK is that operated by UKAEA at its Dounreay site. This LLW disposal area is licensed by the Scottish Environment Protection Agency (SEPA) and is used to provide a dedicated service to address Dounreay site arisings. The Dounreay facility is small compared to Drigg and the current complex has limited remaining capacity.

A revised disposal authorisation has been under negotiation with SEPA for some time. The new authorisation will include specific limits for both alpha and total activity contained within the disposal area. With due consideration of the alpha inventory accumulated to date, there was a realisation that strict management of the future alpha contribution would be essential.

Due to the limitations of the existing neutron assay systems employed on site, there was potential to assign pessimistic trace plutonium values to each drum consigned for disposal (due to the relatively high lower limit of detection capabilities of the current systems). The need was therefore established to invest in a new alpha assay system with significantly improved lower limits of detection; this would prevent over allocation of alpha activity values and allow maximised utilisation of the available physical capacity.

In parallel with the establishment of the need for a sensitive alpha assay system, a strategic decision was made to invest in a new “real time” x-ray inspection facility to allow non-intrusive inspection of the contents of 200ℓ LLW drums.

Additional interim storage and disposal facilities for LLW at Dounreay will use Half Height ISO freight containers as the waste package. However 200ℓ drums will still be used at the point of arising. Once the 200ℓ drum is supercompacted the containment integrity is lost. A need was therefore established to provide a Half Height ISO (HHISO) container loading facility to allow hygienic and controlled transfer of supercompacted drums into the HHISO container.

Considering the operational logistics associated with the existing systems, combined with the need to integrate the new facilities, it was clear that a much larger building was necessary than that which housed the existing equipment. An options study was carried out and a business case presented and approved to convert a redundant facility to provide the WRACS plant.

PLANT DESCRIPTION

The WRACS Facility comprises a series of assay and process stations arranged in a production line type layout. The equipment is housed in a converted and refurbished building with the following dimensions:-

Length	47m
Width	15m
Height	9m

The conversion involved the construction of two extensions to the main building, one at the front end of the plant to allow waste drum receipt and the other at the back end to allow HHISO container monitoring and inspection.

An existing 5 tonne overhead travelling crane was retained and refurbished to assist with maintenance operations associated with the various individual systems.

The ground floor includes two plant rooms, the control room and barrier change facilities. The first floor comprises 5 offices and a spacious conference room currently configured to provide a visitor centre.

The main functional systems are identified and described as follows:-

Waste Drum Uprinder

The sole function of this component is to receive 200ℓ waste drums and transfer them (in threes) from the horizontal to the vertical orientation and present the drums to the conveyor feed.

Real Time Radiography

This system utilises a 420Kv, 15mA X-ray set, a Charge Coupled Device (CCD) detector and a large format imaging system to generate a real time visual display of the interior of a 200ℓ waste drum. High resolution images are presented on the operator's monitor showing the whole drum, without the use of "electronic stitching". The real time nature of the information presented allows easy detection of free liquor within the drum. The average gross weight of a LLW drum is 75kg. At this density no significant problems are experienced resolving areas of detail.

Segmented Gamma Scanner

This is an existing high throughput system comprising four vertically mounted 20% efficient germanium detectors. The detectors are provided with cryo-electric cooling and attenuation correction is achieved using Europium sources. The original specification used to procure this system was very demanding in terms of throughput requirements/assay time, requiring the potential to complete the drum assay in three minutes. This was driven by the need to feed the supercompactor in line with its throughput capabilities. The WRACS operating methodology is based on batch throughput, placing less time demands on this system. The software has therefore been re-configured to allow longer assay times and improved accuracy of measurement.

Alpha Assay System

The system comprises a highly efficient Passive Neutron Coincidence Counter (PNCC) and a Cf^{252} shuffler unit. Two rings of (66) ^3He neutron detectors are provided in an optimised layout. The shuffler unit is included to meet the requirements of the specification which included a need to detect and measure quantities of U^{235} . The assay system is located within a 1.2m thick concrete performance shield. The system lower limit of detection (200ℓ drum) is around 1mg of total Pu in a 15 minute assay time (reals mode). The U^{235} LLD is around 500mg in a similar assay time. This performance represents a fifteen times improvement over the best of the PNCC systems previously used at Dounreay.

The selection of both contractor and technology to meet the identified performance requirements for this system was a complex and time consuming process. The challenge was to ensure that 'state of the art' performance could be achieved without the need to incorporate an R&D element within a time constrained project. Both traditional PNCC technology and the developing Differential DieAway (DDA) techniques were considered in detail. While the latter promised significant performance advantages over the former, it was concluded that the PNCC approach could satisfy the minimum performance needs. This factor combined with risk and reliability concerns drove the decision towards the technology selected.

Supercompactor

The supercompactor is essentially a substantial hydraulic press to enable significant volume reduction of 200ℓ LLW drums contained within a fully ventilated, high integrity containment unit. The supercompactor exerts 2000 tonnes on the waste drum in two stages; an initial burst which applies around 1000 tonnes followed by a progressive application of the remaining force. The volume reduction achieved is typically around 5:1.

The supercompactor has been in operation at Dounreay since 1990 and has processed around 30,000 drums since initial commissioning. Extensive modifications were needed to align this facility with the WRACS operating methodology. During the system downtime, the opportunity was taken to replace all badly worn components and carry out a thorough maintenance of the unit.

The timing and planning associated with the supercompactor modifications was crucial to ensure minimal down time. As soon as the supercompactor was taken off line the site's LLW disposal operations were suspended and accumulated waste placed in temporary storage until the WRACS plant was operational. As only limited temporary storage capacity was available there was significant pressure on the project team to ensure the planned downtime window was not overrun. In the event, the time contingency installed in the programme was utilised due to additional work required on the supercompactor. This scenario was in line with the risks identified and incorporated within the risk management plan for the project.

HHISO Loading Facility

This final processing station has been designed and constructed to allow the hygienic transfer of supercompacted 200ℓ drums, from the high force compactor to the HHISO container. It comprises a substantial stainless steel box which is fully ventilated and hermetically seals to the top of the HHISO container. The facility includes an internal crane assembly used to lift the

HHISO lid into the containment during loading operations. The operator drives a separate 'puck pick up' hoist and grab assembly using a remote pendant control, while looking into the facility through the high level viewing windows. A three puck selective pick up station is provided to allow the operator to visually identify appropriately sized pucks, with due regard to the available space, as the HHISO container is loaded.

When the HHISO container is full, the lid is replaced and the container lowered from its interfaced position. It is then driven out to the monitoring and inspection area, using a dedicated electric platform running on floor level rails.

Full health physics inspection of the container exterior is carried out, prior to dispatch to the LLW disposal (or interim storage) area.

OPERATING PHILOSOPHY (METHODOLOGY)

All Solid LLW at Dounreay is packaged and sealed at its point of origin into 200ℓ mild steel drums. Each drum is uniquely identified by a barcode label which is also provided by the waste originator. One of the driving principles behind the WRACS project was to provide a facility which would enable the accurate recording of data relating to waste arisings on site, **in a hygienic non-intrusive manner**. The availability of such a facility would enable the Dounreay Site to maintain an inventory of all waste consigned for disposal and also characterise the products of the decommissioning programme. The non-intrusive manner of data acquisition significantly reduces the potential for dose uptake by plant operators, adhering closely to the objectives of 'As Low As Reasonably Possible' (ALARP). The provision of the WRACS Facility has changed the traditional management and handling of LLW, providing a largely hands-off approach.

None of the assay techniques employed within the WRACS Facility require drums of waste to be opened. Drums which successfully satisfy all assay checks and are fully compliant with LLW disposal criteria will be volume reduced within the WRACS supercompactor. This operation maximises the efficient use of the available volume within the final disposal destination. Once supercompacted, drums can no longer be guaranteed to have full integrity. The act of crushing will split the drum containment. From this operation the drums are conveyed within a contained tunnel designed and built to glovebox standards. WRACS has a fully contained remote handling device for the packaging of supercompacted drums into a ISO container, prior to sentencing for final disposal.

Should drums fail any of the success criteria set by any of the stations, that drum is returned intact to its point of origin to be dealt with by the original consignor. Any non-conformance with LLW policy, identified by WRACS, is still the responsibility of the originator. The WRACS Facility only monitors and accepts or rejects waste depending on the performance of the drummed material against a strict set of parameters. The adoption of this 'policing' operating policy will encourage originators of waste to comply in full with the Quality Assurance requirements associated with this waste stream.

Each of the stations was designed to assay a 200ℓ drum in a vertical aspect. The transfer of vertical drums between the stations is readily accomplished using existing material handling equipment technology. The conveyor system installed into the WRACS Facility is fully automated and controlled by System Control And Data Acquisition (SCADA) software package. This package not only tracks each drum but collates and stores all the data resulting from each of

the assay stations for each drum, providing lifetime records for the LLW management through the WRACS Facility. The barcode attached to each drum by the waste consignors is utilised to identify drums at each assay station and monitor the data produced as a result of assay. As drums are loaded into an HHISO disposal container, an accurate inventory of the contents of that container is produced. If for any reason the drum barcode is unable to be read, the drum will be rejected by the SCADA. Rejected drums will require to have a new barcode label and the drum will need to be processed again.

The layout of the plant was constrained by the geometry of the available building and the characteristics of each station. However the final configuration of the facility was derived from consideration of the functions of each station and the overall objectives of the facility.

If drums are going to fail any of assay inspections, for whatever reason, the failure should be identified as soon as practically possible to prevent any unnecessary assaying and loss of time and resource.

In the event of a drum failing to satisfy the requirements for LLW disposal, it is removed from the appropriate conveyor reject spur using a small electric fork lift truck.

The rejection options are as follows:-

• Barcode reading	BC	Unable to be read
• Real Time Radiography	RTR	Failure to meet criteria
• Segmented Gamma Scanner	SGS	Failure to meet criteria
• Alpha Assay	AA	Failure to meet criteria

Each of these options was considered and a 'priority' established to reduce abortive assay time. The conclusions were as follows:-

- Barcode reading should be the undertaken immediately after drums are loaded onto the conveyor. Should any drum fail barcode reading check it will be immediately rejected as further assay will be abortive. As a result, a barcode reader and reject line were installed immediately after the drum upender.
- The Real Time Radiography system would provide experienced operators with the confidence that the contents of the drum are suitable for solid LLW disposal. RTR will reveal if drums contain free liquid, not permissible through the solid LLW disposal route, or any dense unidentified material which could suggest local shielding to reduce high γ from out of spec waste. To assay before establishing the presence of any physical non-conformance would be abortive. For the reasons above, assay at the RTR station would generally be undertaken first.
- A risk analysis on the possibility of alpha contaminated material being present without accompanying fission products was undertaken. This provided strong evidence that SGS assay should be undertaken prior to AA. The frequency of an occurrence of failure to meet the SGS parameters for LLW outweighs any possibility of a SGS success followed by an AA failure. It was concluded that SGS assay should be undertaken prior to AA assay.

The plant layout was then derived. An illustration of the final facility is attached as Appendix 2. It should be noted that the WRACS Facility has total flexibility with regard to the use of the stations within it. Each station has a reject facility and the operators have the ability to bypass any one of the assay stations. The experience which will be gained through the continual use of the WRACS Facility will provide the operators with the knowledge to assay material using methods which retain accuracy and minimise time. Decommissioning of any building that never historically contained alpha material may result in the operators deciding to assay only a representative sample through AA, especially if the material is homogeneous. This necessary flexibility was recognised early on in the definition of the plant and has been built into all aspects of the design.

PROJECT AND CONTRACT STRATEGY

Consideration was given to a number of management options to address the detailed design and implementation phases of the WRACS project. Initially there was a strong preference to document the UKAEA requirements in a performance specification and seek a 'turnkey' solution from suitably pre-qualified contractors, via competitive tender action. The logic behind this approach hinged on risk transferral from UKAEA to the selected contracting organisation.

Detailed consideration of the various sub-elements of the project, combined with the use of formalised qualitative and quantitative risk assessment concluded that while the turnkey approach remained an option, it was likely to be considerably more expensive than the alternative of UKAEA assembling its own project management team and sub-contracting the various work packages. This is largely due to the range of different specialisations involved in the overall project. It was perceived that a prime contractor would accept the risk but increase his price to take account of his lack of specialisation in this area. In addition, UKAEA best understood its requirements and was well placed to co-ordinate the main tasks.

An "in house" professional project management capability had been progressively developed since the late 1980s and it had been demonstrated that this expertise had developed to the point that a project of this complexity could be effectively managed. The strategy was approved having negotiated due process and the project moved out of the definition phase into project initiation.

The approach adopted was to "keep it simple"; minimum complexity to achieve the functional requirements combined with maximum plant operating flexibility. Each individual system was developed as a standalone facility, with status outputs to the WRACS SCADA system. The control room was designed to blend the operating stations associated with the main assay systems into one control desk for ease and efficiency of operation.

Following the detailed design of the plant layout and functionality, a specification was tendered for the building conversion works and a fixed price contract awarded.

Detailed specifications were developed for the alpha assay and the real time radiography systems. These documents were subjected to rigorous peer review using appropriate experts in each area to ensure robustness. Independent experts were also involved in the pre-qualification of contractors wishing to bid for the supply of these systems. The responsibility for the provision of the performance shield required for the alpha assay system was clearly identified within the scope of supply. Similarly, the design and construction of the biological shield needed for the Real Time Radiography system (RTR) was placed as requirement on the RTR supplier. Subsequently, both

of these suppliers selected the building refurbishment contractor to provide these components on a sub-contract basis. This avoids the obvious complications which would have arisen with different civil contractors working in the same area, at the same time.

The existing supercompactor required extensive modifications and refurbishment to enable installation in WRACS. Following a period of negotiation, the manufacturer of this facility was contracted to carry out the work. However, the internal decontamination of the supercompactor and the packaging and disposal of redundant components was undertaken directly by UKAEA personnel.

Competitive tender action was taken to identify a preferred contractor to detail design, supply, install and commission the Drum Handling System (DHS) and WRACS control room. This task area included the SCADA, mechanical handling system and status monitoring/control interfaces with the various WRACS systems. Modifications were needed to an existing high throughput Segmented Gamma Scanner (SGS) to enable compatibility with the WRACS concept. This involved the provision of a remote operating station (control room) and the associated software modifications. Due to the identified risks associated with this relatively small (but influential) element of the project, the decision was taken to include this within the scope of the DHS contract, on a nominated sub-contract basis.

Design of the HHISO loading facility turned out to be one of the major engineering challenges within the overall project. Although the concept was simple, development of the detail to ensure effective contamination control arrangements was difficult and had been underestimated at the project definition phase. A separate design contract was awarded based on an agreed target price, with incentivisation arrangements. UKAEA engineers and operators worked closely with the designer to develop a fit for purpose solution. The final solution turned out to be significantly more complicated than had been envisaged by both the designer and UKAEA.

A tender exercise was undertaken to allow selection of a suitable contractor to build the HHISO loading facility, in accordance with the design developed. The facility was fabricated, assembled and tested at works prior to dismantling and transfer to Dounreay. The containment tunnel which connected the HHISO loading facility to the output of the supercompactor was manufactured and installed by the company which provided the DHS.

A specification was developed for the WRACS Facility heating and ventilation requirements following completion of the ventilation system design. Again this was competitively tendered and a single contractor selected to provide this package. This included the red active ventilation system serving the supercompactor, HHISO loading facility and the transfer tunnel as well as the heating and ventilation for all plant areas and air conditioning for the control room.

The environmental monitoring system for the plant was designed by UKAEA and contracts placed for the procurement of various proprietary components. Installation, configuration and testing was overseen and co-ordinated by the WRACS project team.

Overall the project strategy adopted has been a success, providing maximised client control during implementation and a minimum cost solution. A summary of the contractors employed to address the requirements of the various work packages is given in Appendix 3. The overall cost of the project was just less than seven million pounds; the contract strategy adopted is estimated to

have provided total savings of between one and two million pounds compared with a “turnkey”, prime contract alternative.

FORWARD PROGRAMME

The management of LLW on the Dounreay Site has improved through the provision of the WRACS Facility. Dounreay now has an improved ability to ensure that solid LLW is completely within specification, and can accurately control waste inventory to ensure that final disposal facilities comply fully with authorisations.

Waste Minimisation

Around 5000 200ℓ drums of solid LLW is generated at Dounreay annually. This will increase during implementation of major decommissioning programmes. The WRACS Facility is well placed to contribute to the overall LLW challenge through its monitoring for compliance and accurate data control. However, the Dounreay site will contribute more to improving the situation through the adoption of policies to minimise waste production. A strict policy for the reduction of waste arising from supervised and controlled areas will be formulated and implemented with conviction.

Future Disposal/Storage Requirements

The future of final disposal on site is another challenge currently being addressed. All disposal capacity on site is nearly exhausted. Before any further disposal facilities can be constructed an authorisation from SEPA will have to be granted. Planning permission will be required before construction can proceed and a comprehensive Public Enquiry will be necessary.

In the meantime, while the project to provide a new disposal facility is progressing, interim above ground storage is the only available option. Efforts are progressing to define and progress a project to provide above ground storage.

A significant challenge relates to the management of public opinion regarding LLW disposal arrangements. Education about LLW and demonstration of good management techniques will be necessary to develop a confidence within the public domain towards the intentions of Dounreay. The proactive development of the WRACS Facility demonstrates UKAEA's commitment to best practise and should assist in building public confidence as Dounreay moves forward with a case for additional disposal capacity on site. The LLW issue is a critical success factor if UKAEA is to achieve its mission and goals.

Appendix 3

MAIN CONTRACTORS PROVIDING THE VARIOUS COMPONENTS OF THE WRACS PROJECT

<u>Contractor</u>	<u>Area of Project Supply</u>
D M Geddes Ltd	All building and civil works associated with conversion and refurbishment. Construction of Alpha Assay System performance shield.
AEA Technology - Harwell Instruments	Alpha Assay System
OIS Engineering Ltd	RTR system
Canberra Nuclear	Modifications to SGS system
Scotts Ltd	All electrical installations
JGC Welding Ltd	Stainless steel installations and active drains
NNC Ltd	Ventilation system design
JRSA Ltd	HHISO Loading Facility Design
Excel Automation Ltd	DHS design, supply and installation
Capstead Systems Ltd	SCADA design and installation
NSG Engineering	Decommissioning of redundant LA drain
M M Miller Ltd	Construction of HHISO/LF inspection area
Jordan Engineering Ltd	Fabrication and construction of HHISO loading facility
Lodematic Ltd	Waste drum upender - design and supply
Lab Impex Ltd	EMS component supply
Scottish Power	Design of breathing air supply system of airline suit operations
Motherwell Bridge	Supply of breathing air system
Nicolson Engineering Ltd	HVAC system supply and installation
Datalogic	Bar code reader supply
AEA Technology PRA Ltd	Facility Safety Case