

The Establishment of Treatment Options for the United Kingdom Low Level Waste Inventory Specifically Metallic LLW Recycling – 10033

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ABSTRACT

The National Low Level Waste Repository (LLWR) is situated near to the village of Drigg in West Cumbria. It is currently the only facility in the United Kingdom (UK) dedicated to the disposal of solid Low Level Radioactive Waste (LLW). The site is owned by the UK Nuclear Decommissioning Authority (NDA) and operated by LLW Repository Ltd.

The disposal capacity at LLWR is finite and if historic practices are continued current inventory predictions indicate that the LLWR volumetric capacity will become very much constrained in the future. A fundamental change in LLW management practice is required in the UK to extend the working life of this unique national asset. Current estimates for building and operating a replacement for the LLWR, with similar volumetric capacity, have been independently assessed at a value of £2 billion. LLW Repository Ltd believe that the only way to mitigate risks for both the volumetric capacity and radionuclide capacity currently predicted is to use alternative options for LLW management. If these options are utilised correctly the construction of a replacement facility may be avoided.

This paper provides detail on the importance of implementing a timely plan to establish best use of waste treatment options for LLW and the expected extension to the working life of LLWR as a consequence. Using the options established for metallic waste decontamination and treatment, this paper demonstrates how the plan has been implemented specifically:

- How waste for the trial demonstration was identified, and explain how availability of technology influenced decision making on disposal options.
- How the procurement process was initialised including selection criteria and technical capability audits of proposals, as well as duty of care audits to confirm that processes to be used are in line with proposal bids.
- Detail communications with the regulators to change authorisations for both LLWR and the consignors. Also how local stakeholders were engaged.
- How issues relating to nuclear material accountancy will be managed.
- How issues relating to packaging and transport of waste to LLWR, then to a treatment company and finally how secondary waste returned to LLWR will be managed, including plans to streamline this in the future.
- What treatment technology will be used, estimates of volumes that will be reduced and free release criteria for treated waste.
- How disposals of secondary waste arising from treatment will occur, along with methodology and regulatory requirements for waste disposals at LLWR.
- Lessons learned to take forward for future projects.

CONTEXT

In March 2007 the UK Government and devolved administrations (for Scotland, Wales and Northern Ireland, published the policy for the management of solid low level radioactive waste [1].

UK strategy for the management of solid low level radioactive waste from the nuclear industry has been developed to reflect and implement Government Policy. The aim is to provide a high level framework within which low level radioactive waste (LLW) management decisions can be taken flexibly to ensure safe, environmentally acceptable and cost-effective management solutions that reflect the nature of the LLW concerned.

To deliver this aim three strategic themes have guided the development of this strategy:

- Application of the waste hierarchy;
- The best use of existing LLW management assets;
- And the need for new fit-for-purpose waste management routes.

The strategy advocates the application of the waste hierarchy, with a preference for managing LLW at higher levels, where practicable (i.e. waste prevention, reuse, recycling).

This approach will facilitate continued waste management, hazard reduction and decommissioning operations. Using a broader number of options for managing LLW rather than focusing on disposal will lead to continued capability and capacity for the safe, secure and environmentally responsible management, treatment and disposal of LLW in the UK, for both the nuclear and non-nuclear industries

Given the strategic themes above a vital component of the NDA's implementation plan is to ensure that waste treatment services above are available to United Kingdom consignors of Low Level Waste (LLW) (both nuclear and non nuclear sectors) as soon as possible.

This paper describes how LLW Repository Ltd have introduced new waste treatment services, specifically how metallic waste treatment is now part of a range of options, all of which are key enablers to deliver the UK LLW Strategy

INTRODUCTION

The Low Level Waste Repository (LLWR) is located in West Cumbria and is the only dedicated disposal route for solid Low Level Radioactive Waste (LLW) available in the United Kingdom (UK). Volumetric capacity at the facility is limited and there is insufficient capacity at the site to meet the future needs of UK consignors. Analysis of the latest UK Radioactive Waste inventory forecast waste arisings [2] indicate that a potential capacity gap of 3.5 million m³ exists between the maximum capacity of the LLWR site and the volume of waste currently identified for disposal there. This paper describes one project within an overarching program of work currently being undertaken by the site's operators, LLW Repository Ltd, in conjunction with the Nuclear Decommissioning Authority, to make best use of this existing asset and extend its operational life. The project described in this paper is the introduction of the metallic waste recycling service including a case study on the first consignment of waste for treatment under this new service.

The current focus of the overall program is to prevent disposal capacity being taken up at LLWR by waste types which lend themselves to alternative treatment and/or disposition routes. Proposed alternatives include offering metallic and combustible waste treatment services and diversion of Very Low Level Waste (VLLW) to alternative disposal facilities. A range of packaging and transport services is being developed in parallel to facilitate this new approach. The aim of the program is to ensure that only appropriate wastes, which require an engineered barrier for environmental or personnel protection, are consigned to the vaults at the LLWR site. Application of the waste hierarchy in this way ensures that the aims of the UK Government's Policy for the long term management of solid low level waste in the United Kingdom are met [3]. If all these alternative routes are established it is expected that the working life of the current LLWR site will be extended to support the UK's nuclear decommissioning strategy. Although another repository may be required in the future, it would be a much smaller facility. A reduction in the

volume of LLW to be disposed would result in a lowering of the Nuclear Decommissioning Authority's (NDA) LLW liability, using best practices and latest technology in line with regulatory expectations.

ESTABLISHING A METALLIC WASTE TREATMENT SERVICE

Metallic Waste Treatment Service Project

Analysis of the current inventory indicates that 90% of metallic LLW currently planned to be disposed of in the UK is potentially suitable for treatment [2]. To take advantage of the potential volume reduction opportunities, LLW Repository Ltd, in partnership with the NDA, established a project to develop and implement metallic waste treatment services for all UK consignors of low level waste. The intention of the service is to make use of supply chain facilities through contracts for treatment with suitable suppliers. The project scope included interfacing with stakeholders, completing procurement activities, making authorisation changes, developing the management system, training personnel and commissioning the service by completing the first consignment. On completion of the first consignment, the project team handover the system to LLW Repository Ltd's customer team who will operate the service on a day to day basis for all consignors in the UK.

Interfaces with Stakeholders

Effective stakeholder management was a prerequisite for the successful implementation of the metallic waste treatment service project.

The Nuclear Decommissioning Authority, as owners of 19 nuclear licensed sites across the UK, including the LLWR, is a key stakeholder and partner in changing the way LLW is managed, recognising the business benefits as well as the opportunity for appropriate waste management that will reduce impact on the environment. Their remit includes an interest in all operations and ensuring value for money while remaining consistent with relevant government policies. In this instance, observing the waste hierarchy and maintaining the lifetime of LLWR.

The Environment Agency (EA) are the environmental regulator for the nuclear industry in England and Wales (in Scotland this role is performed by the Scottish Environmental Protection Agency). They regulate by setting out authorisations for holding and disposing of nuclear materials under the Radioactive Substance Act 1993(RSA 1993) [3], including the authorisation to dispose of LLW at LLWR. In order to implement the additional treatment services, authorisations required a variation to allow solid metallic low level waste to be either consigned from the consignor's site to LLWR for future transport to a treatment company or directly consigned from the consignor's site to a treatment company. This would allow treated metal to be recycled for reuse by the supply chain and avoid any unnecessary disposal. The variation also made the provision for temporary storage at LLWR of metal, combustibles and very low level waste.

The Nuclear Installations Inspectorate (NII) regulates all nuclear licensed sites that have a site licence issued by the NII. Each site licence has a number of conditions that must be adhered to in order to maintain the licence to operate. One such condition is to ensure that all operations are completed safely. The initiation of this metals treatment service will result in new operations on LLWR site and as a licence holder LLWR must satisfy the NII that all safety aspects have been considered and adequately mitigated as appropriate.

UK Safeguards regulate all nuclear accountancy in the UK and are part of the Health and Safety Executive (HSE). Discussions were held to establish if any nuclear material accountancy issues would result from executing the metal segregation and treatment service. The protocol agreed for metallic waste treatment via LLWR is that the consignor terminates safeguards coverage prior to transferring waste to LLWR. UK Safeguards advice was that this should continue when this and future services are utilised. Advice was also sought on waste management of nuclear accountancy when waste is being consigned overseas for treatment. In this instance, accountancy should terminate prior to shipping to LLWR or to the treatment company direct. The only scenario where this will change is if subsequent handling of waste were to include recovery of any nuclear material. As this is not part of the current treatment plans, no change to safeguards coverage at LLWR was required.

Cumbria County Council and Copeland and Allerdale Borough Councils and Drigg and Carleton Parish Council, as the local authorities of the area in which the LLWR site is located have various roles in implementing the planning

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process and as stakeholders to other regulatory processes. LLWR work closely with the Parish Council to minimise disruption to community life from the daily operations of the site. Drigg and Carleton Parish Council represent the interests of local residents with a particularly focus on activity/services at the site and the impact they will have on community life. Specific areas of concern include noise, pollution, impact on flora and fauna, increased traffic movements including large goods vehicles, the implications on emergency planning and changes to the security plan with resulting new measures. Communication was handled through the West Cumbrian Site Stakeholder Group specifically the Low Level Waste sub-committee. This sub-committee's role is to provide the forum for representation of local community interests. It also acts as the interface between the local community, interested stakeholders and the site operators. It is used to inform the site operators and the Nuclear Decommissioning Authority (NDA) about community concerns and proactively feed community views into the decision making process thus enabling them to influence strategies and plans [6].

As with all major projects at LLWR, consultation with stakeholders was undertaken at regular intervals during the project. This was to ensure that all stakeholders were satisfied that their interests have been maintained at all key stages. As the project matured regular meetings were established at a three monthly interval and stakeholders have been kept informed of progress throughout.

Procurement Process

In order to place contracts for the supply of goods and services with the supply chain, LLW Repository Ltd is required to comply with NDA and European Union procurement and commercial requirements with regard to competitive tendering [7]. All contracts let by LLW Repository Ltd for the supply of treatment services are subject to NDA approval. LLW Repository Ltd was aware that these services were potentially available in the UK and other countries and was therefore keen to engage with the supply chain to identify potential treatment options.

In order to reduce lead times for the introduction of the new service, the initial invitation to tender was issued under an existing decommissioning framework contract to provide a metal treatment service. The use of an existing contract enabled a prompt response to the issue. The invitation requested that a preferred option for treatment was both the Best Practicable Means (BPM) and the Best Practicable Environmental Option (BPEO). The procurement process was operated in the form of a competition between the companies who formed part of the existing framework contract. The tender required the contractor to demonstrate the best way to treat metallic waste with the following governing principles [8]:

- To strive to optimise the project feasibility with innovations to a designed solution with the latest robust technology.
- An applicable solution and underpinned as necessary substantiation to this project.
- Enable a process that will minimise costs but accelerate progress with improved data and information quality, and supplied with documentation to justify the approach and a list of subcontractors that will be used.

The following deliverables were also included in the procurement process in order to satisfy this project:

- Provide a detailed process diagram for consignors explaining how to consign metal to the appropriate facility and how secondary waste will be consigned to LLWR for disposal.
- Explain optimum arrangements for metals recycling using only currently available tools and techniques which should include details of transport requirements and capability of process in both volumetric and a radiological capacity.

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Site visits and assessments also took place to ensure that successful applicants met the criteria above and to gain confidence that proposals in the tender submissions could actually be met by the contractors. Examples were sought to demonstrate that similar packages of work have been delivered in the past, along with suitable copy of company's Conditions for Acceptance (CFA) and quality systems. The procurement process concluded with the selection of two separate companies to enter into a framework contract with LLW Repository Ltd to provide metallic waste treatment services to LLW Repository Ltd and its customers. The two companies selected, and the treatment facilities offered, were:

- Cumbria Nuclear Solutions Ltd – providing access to Siempelkamp's metal melt facility in Germany and Energy Solution's Bear Creek metal treatment facility in the United States
- Studsvik UK – providing access to their metal recycling facility in the UK and Studsvik AB's metal treatment facility in Sweden

The establishment of the framework contract allowed LLW Repository Ltd to begin work on developing and implementing its new metallic waste treatment service for consignors to support waste being diverted away from the LLWR.

Duty of Care

In order to comply with nuclear site licence condition five, consignors of nuclear matter (with the exception of exempt waste) must ensure the receiving site is suitably authorised and operated by personnel able to deal with the waste and in all cases records must be kept detailing all nuclear waste.

The Environmental Protection Act 1990 (EPA 90) Section 34 also imposes a duty of care on persons dealing with controlled waste [9]. Although this act doesn't extend to radioactive waste it is prudent to follow the principles of this, conventional waste, legislation when dealing with the movement of radioactive waste for treatment. EPA 90 require that waste producers take responsibility to ensure that waste disposals are described as accurately as possible with a clear reference to describing the safe handling and treatment of waste. Consignors and LLWR should therefore ensure treatment companies are appropriately licensed and sanctioned. The responsibility is on the consignor site to ensure waste is correctly packaged in line with relevant treatment company's requirements prior to consignment to LLWR and / or onto the treatment company. In all cases, when waste is accepted onto the LLWR site, or an agreement is given on treatability of waste, LLWR accept risk and title to the waste. However, consignors still retain a duty of care to ensure that waste they have consigned to LLWR is managed appropriately.

With the expansion of treatment services, consignors look to LLWR to provide reassurance that the companies and facilities that are used to complete treatment activities meet relevant standards. It is for this reason that LLWR complete a duty of care audit prior to the first shipment to any treatment company. The audit scope at this point includes visibility of authorisations and any other legislation in place for operation of a treatment facility, management systems which include treatment options, assaying, how exemption criteria are achieved, how tracking of the waste is controlled to ensure all secondary waste is accounted for and individual arisings can be tracked to individual batches and / or consignments. The audits also cover basic management procedures ensuring all operations are safely controlled, including calibration of instruments, training requirements of individuals completing metal treatment operations, review of all responsibilities and accountabilities and that the processes are controlled by suitably trained, experienced and qualified individuals. As LLWR receives secondary waste from treatment services for disposal, they have a duty of care to ensure that they are confident that all operations are completed accurately and safely with a clear and transparent process on how treated metals will be made available for recycling post treatment.

METALLIC WASTE TREATMENT CASE STUDY

Waste identified for metal treatment

In late 2007 two hundred and four 400 litre drums which had been used as overpacks for plutonium contaminated waste (PCM), which is a classification used in the UK that covers purely alpha contaminated intermediate level waste (ILW), were identified as waste on the LLWR site. As the waste belonged to LLW Repository Ltd, discussions took place on the best way to deal with them to avoid disposal at the LLWR. This was a priority wastestream as the facility that stored these drums was due to be decommissioned. Radiological surveys of accessible areas highlighted varying amounts of alpha activity at levels that would potentially allow the waste to be treated.

From initial discussions it was decided that the best way to manage this issue was to complete a BPM assessment [10]. As part of this project, a major hurdle was confidence in the radiological assessments to ensure that correct levels of activity were identified so that appropriate management decisions could be made and the drums could be consigned to another controlled site for treatment and / or exemption. Specific areas of concern were inaccessible areas for probes which included areas of corrosion areas, nooks, for example small recesses and cracks around the lid and the annulus of drums, all of which could mask activity. It was believed that in order to be 95% confident that material is below the exemption threshold limit, drums would have to be stripped down to bare metal [10]. At the time of completing the BPM assessment, LLW Repository Ltd had not yet established a metallic waste treatment route.

The highest score as a result of the BPM was to store the drums elsewhere at LLWR until future treatment solutions were established. It was then agreed that as this was not a disposal option, which was a success criteria requirement of the BPM, the storage option had to be discounted. The next highest scoring option was to compact the drums in an appropriate facility on LLWR and dispose of the drums as LLW. Whilst the option to compact the drums and dispose of them was progressed, LLW Repository Ltd was also starting work to establish a metallic waste treatment service. As the service was developed, the findings of the original BPM assessment were reviewed and the option to store pending treatment was now viable as the technology was available and contracts were being put in place with companies that were able to offer metal decontamination and treatment options. The PCM drums were therefore selected as an ideal commissioning consignment for LLW Repository Ltd's metal treatment service.

Metals Recycling Facility (MRF)

Studsvik UK won the package of work to decontaminate and recycle the PCM drums, through a competitive tender process, at their new metals metal recycling facility (MRF) at Lillyhall in West Cumbria. The MRF is a nuclear licensed site and was officially opened on the 6th May 2009. The first active shipment, the PCM drums, was received on the 3rd September 2009. The MRF's purpose is to recycle metals outside the nuclear industry. In order to achieve this, the metallic waste needs to be decontaminated and monitored in order to prove that the residual activity is such that regulatory controls are no longer required resulting in metals being recycled into the scrap market for reuse [11, 12].

The radioactive component is still disposed of at LLWR, but will be condensed as the volume is reduced but the total activity will be consistent with the waste sent to the MRF for treatment. This minimisation of volume is in line with the UK policy to implement the waste hierarchy as stated in the UK Nuclear Industry Low Level Waste Strategy and the Policy for the long term management of solid low level waste in the United Kingdom [3].

Packaging and transportation

Once the treatment route had been selected, it was agreed that the drums would be packaged into half height IP2 ISO containers, the UK standard for low level waste transportation. The drums underwent intensive monitoring as they were loaded into twelve containers. The relevant consignment documentation was completed and approved by LLW Repository Ltd and Studsvik UK. For this project, waste was consigned to MRF from LLWR's railway sidings. Trains were used to transport waste from LLWR to the port of Workington. From the port, the consignments were transported to the MRF by road transport.

Acceptance of waste at MRF

When waste arrives at the MRF, prior to unloading, the containers will be checked with regard to relevant external transport and dose reading to verify the declaration by a consignor. Once external verifications are complete, the ISO Container is opened for visual inspection to ensure MRF's Conditions for Acceptance have been achieved. Sorting of metal will then be completed to determine if treatment is achievable and, if so, utilising which treatment method. If metal treatment is not an option it will be repacked and returned to LLWR as LLW [12].

Technology used for decontaminating

Once it has been established that metal can be treated, relevant size reduction methods will be utilised in order to be able to decontaminate the metal, by blasting, in the most efficient way. The secondary waste produced from decontamination will either be in the form of blasting residues, removed oxide and parts of the blasting media, dust from the ventilation system or Personal Protective Equipment used by Studsvik's employees undertaking these operations. Assay of the metal will then take place to determine if it can be exempted from regulatory control and be released into the UK metal market for recycling [11]. If this not achievable, options exist for metal melt or for non-treatable waste to be consigned to LLWR as LLW [12].

Free release criteria and regulatory requirements to allow secondary waste back to LLWR

In order to meet exemption levels guidance from the Nuclear Industry Code of Practice for clearance and exemption [10], a 95% confidence that material is below exemption the threshold limit has to be demonstrated. This requires experience and knowledge of how treated material was initially utilised in order to establish potential depth of penetration by contamination as a result of operation. This helps establish best treatment methods and potential numbers of operations required. This information is usually established in the wastestream characterisation document required to meet LLWR requirements. Excellent communications are required between Consignor, LLWR and MRF. Waste Acceptance Criteria will ensure that the activity and radiological fingerprint of the waste being consigned for treatment is known at all times of the process. Best methods for characterisation should be used to ensure maximum confidence in the final clearance and exemption technique.

Any secondary waste generated as a result of treatment would be re-consigned back to LLWR as LLW meeting all conditions for acceptance and authorisation requirements of LLWR. All secondary waste is packaged in appropriate 200 litre drums and adequately labelled then placed in the appropriate IP2 container. Samples will be taken for gross alpha and beta analysis to ensure accuracy of supplied relevant wastestream characterisation and consignment documentation. Wastestreams are accounted for by establishing a fingerprint and a ratio of activity each radionuclide will contribute to the total activity. Assay instruments, in most cases consisting of a high resolution gamma spectrometry system, then assess the easily recognised dominant gamma lines e.g. Cs-137 with energy lines at 661.7keV or Co-60 with an energy line at 1173 keV and one at 1332keV [13]. Other isotopes are derived from the ratio of these of isotopes as stated in the relevant wastestream characterisation documents that are fed into the waste tracking system at the start of the treatment process. Drums are then weighed and dose rates taken at one metre to meet transport regulations. Once the IP2 container has been filled using this method, activity figures from all the drums are added together so a waste container may contain multiple fingerprints but can still demonstrate compliance with LLWR's CFA, Disposal Authorisation and all relevant transport regulations [11].

Volume reduction

Twelve half height ISO Containers filled with the redundant PCM overpack drums were sent from LLWR to the MRF for treatment. This amounted to approximately 215m³ of waste. Post treatment, the volume to be disposed of was reduced to 0.5m³, a volume saving of 98 % [14]. 4.4 tonne has already been released to the market place with 11 tonne considered to be the expected amount released back to the market place for recycling.

LESSONS LEARNT

Once the first shipment had been accepted for treatment, key personnel involved in this project critically evaluated the process to highlight any learning from experience to support improved implementation of future services.

It was agreed that the project was a success however there were some minor lessons learnt that included:

- Container Licensing – Current containers are currently only licensed for a single use. The process to amend the licence to be able to use the containers more than once has started and is now well on the way to being completed.
- Instructions – Improvements to forms and instructions have been identified and are now being incorporated into LLW Repository Ltd's Management System.
- Project – Any future segregated waste belonging to LLW Repository Ltd, should be consigned and receipted to LLWR as would occur with any other customer as this would enable forms and procedures to run more smoothly and avoid confusion.

CONCLUSION

Metallic waste treatment, by decontamination and / or melting, is the first of a range of new services currently being implemented by LLW Repository Ltd to make best use of this existing asset and extend its operational life. The processes established in bringing this treatment service on line are expected to be repeated for all other services as they are developed.

Stakeholder support has enabled this project to be established in a timely fashion allowing all consignors to LLWR to now utilise this new treatment option as an alternative to disposal.

Overall, the first treatment consignment under the new metallic waste treatment service was a resounding success but some lessons were learnt that will support the implementation of future treatment services as they are commissioned and brought on line. This consignment has seen a 98% reduction in the volume of waste to be disposed of at the LLWR.

The commissioning consignment is now completed and the metallic waste service is being integrated into day to day activities. LLW Repository Ltd is now working with other consignors to identify metallic waste that could be suitable for treatment. LLWR has initiated a screening programme for metallic waste that follows general waste hierarchy principles of reuse, decontaminate and metal melt prior to disposal. The aim of the screening process is to identify potential metallic waste for treatment to reduce the volume and weight of waste to be disposed and to recycle as much material as possible. Diversion of metal from disposal continues to be a key element in preserving capacity at the UK's Low Level Waste Repository to reduce the Nuclear Decommissioning Authority's LLW liability.

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