Low Level Waste (LLW) Management: Consolidate R & D on Orphan and Hazardous Wastestreams

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1 Introduction, Scope, and Assumptions

1.1 Introduction

The Low Level Waste Strategic Review[1] published in October 2008 described 54 strategic initiatives that are intended to improve and integrate the low level waste (LLW) management throughout the Nuclear Decommissioning Authority (NDA) estate. Additional strategic focus was to treat the Low Level Waste Repository (LLWR) as a national asset for the disposal of LLW. Of the 54 initiatives, one aims to review and consolidate all R & D activities associated with orphan and hazardous wastes and to provide recommendations to the NDA if it is appropriate to undertake R & D on behalf of all sites with similar issues. This initiative is designated "WT7" in the UK Nuclear Industry LLW Management Plan[2] that was developed by the LLWR National LLW Strategy Team and followed on from the Strategic Review. As part of initiative two strategic technical briefs were prepared by the National LLW Strategy Team and incorporated into the Compendium of Strategic Technical Briefs[3]. One examines the issues around orphan wastes and potential suitability for LLWR disposal and the second focuses on hazardous wastes.

1.2 Scope

The issues surrounding the management of orphan and hazardous wastes were outlined in the two strategic technical briefs. This paper is a review of the work undertaken within the NDA estate on orphan and hazardous waste management and summarises the history surrounding orphan and hazardous wastes, the types of wastes, completed R & D and any planned future R & D. This paper also makes recommendations on how to take forward R & D into orphan and hazardous waste management.

2 Background

Orphan wastes are defined as 'materials for which no final treatment or disposal route has been identified, i.e. there is no underpinned disposal route or agreed transfer established. Hazardous wastes are wastes which display hazardous properties arising from their chemical or physical nature. Many hazardous wastes are also orphan wastes due to hazardous properties which may prohibit treatment by existing waste management routes.

Almost all sites within the NDA estate have orphan and hazardous waste inventories of some description. These inventories typically cover all known orphan wastes expected to arise over the

[1] LLW Strategic Review, D Rossiter, LLW Repository Ltd, NLWS/LLWR/01, October 2008
[2] UK Nuclear Industry LLW Management Plan, A Laker, LLW Repository Ltd, NLWS/LLWR/03 Rev 0, July 2009
[3] Compendium of Strategic Technical Briefs Vol1, LLW Repository Ltd

lifetime of the site. As a result these inventories may contain orphan or hazardous wastes that are classified as PCM or ILW. Although strictly outside of the scope of this report and its impact on LLW management higher activity orphan and hazardous wastes are included here for completeness. It should be noted however that where wastes have been classified as PCM or ILW within inventories this has typically been on the basis of provenance, location or best estimate rather than actual characterisation and once characterisation is undertaken wastes may be re-classified accordingly.

3 Site Summaries

3.1 Sellafield

Sellafield has a significant orphan waste inventory. The original orphan waste project was established in 2001/02 and collated an inventory of orphan wastes. This inventory consisted of 783 individual entries which were subsequently grouped into 136 waste groups based on similar chemical or physical properties. These waste groups consisted of known and potential future orphan wastes and were allocated to 46 Operating Units across the Sellafield site. The information collated was largely qualitative and stored on a database. An estimated financial liability was applied to this inventory. The project also reviewed orphan waste streams arising within the UK nuclear industry as a whole and identified that there were a number of wastestreams common to a number of sites. Several reports were published outlining potential synergies between a number of sites with regard to collaboration on solving orphan waste issues[4] [5].

The original orphan waste project completed in 2004 and reduced to minimal inventory maintenance. In March 2007 the Characterisation & Clearance group took ownership of the orphan inventory to revalidate the inventory in line with the requirements of the NDA's Lifecycle Baseline Improvement initiative to produce underpinned cost estimates. This work resulted in a review of the inventory with the intention of challenging the classification of the wastes listed in the inventory and an attempt to improve the accuracy of the inventory. In order to underpin the cost estimates of the inventory baseline, treatment methodologies were identified and costed using site norms where possible to produce an estimate to the NDA Class D requirements, (+100 -50%). The baseline treatment methodologies were also assigned Technology Readiness Levels, TRLs in line with the NDA TRL definitions. In parallel with this task a new database was designed which is able to store all information associated with the inventory in a format that is accessible and easily reviewed and updated.

The outcome of the review was a reduction in the inventory to 130 entries in 32 generic groups with an estimated lifetime funding associated with each waste and operating unit. Orphan wastes at Sellafield are managed on a project by project basis currently with each OU responsible for managing the treatment and disposal of the waste. Many orphan wastes are a relatively low priority and in many cases no firm plans or timescales for resolution. This represents an inefficient way in which to manage these waste types.

3.2 Magnox Sites

Magnox sites consist of a group of several sites, Magnox North consisting of Hunterston A, Chapelcross, Wylfa, Trawsfynydd and Oldbury, and Magnox South consisting of Bradwell, Berkeley, Sizewell A,

[4] UK Orphan Waste Synergies Summary Report RP_ORPHAN_PROJ_00175 October 2003
[5] UK Orphan Waste Synergies – Areas for Discussion March 2004

Dungeness A and Hinkley Point A. Due to the nature of these sites, i.e. mostly nuclear power plants, either still operational or under decommissioning, the wastes arising from these plants, in general, tend not to be as complex or as active as the majority of the Sellafield wastes arising from reprocessing operations. However for orphan and hazardous wastes there are a number of generically similar wastes, with similar waste management challenges.

Magnox, as well as having orphan wastes under the definition used above, also have an additional definition, WRATs, Wastes Requiring Additional Treatment. These wastes are defined as 'wastes that will need treatment or processing to enable them to be either disposed of or subsequently processed with other wastes to enable final disposal.'

During 2008/09 Magnox commissioned two reports, Magnox WRATS & Orphan Wastes Disposition Project[6] and Review of Chemically & Biologically Hazardous Wastes Arising from Decommissioning[7].

The hazardous waste review resulted in the production of a generic spreadsheet model listing 11 hazardous material families, further sub-divided into 90 individual categories. The key outcomes of the project are that variable forms and quantities of hazardous materials will be generated during decommissioning of Magnox sites, of the 90 sub-categories listed in the generic model 42 are likely to occur in significant quantise, with only 28 of these wastes having a recognised management option or disposal route, leaving 14 substances with uncertain management arrangements. The report recognised that there was some uncertainty associated on the concentration of hazardous substances within the decommissioning wastes and highlighted the benefits of further sampling and characterisation.

The WRATS & Orphan (hereafter referred to collectively as orphans) report objectives were to:

- Identify potential orphan wastes at Magnox North & South sites
- Identify proven or potential disposal routes for orphan wastes for inclusion in future Magnox waste management strategies
- Identify those wastes for which there are no appropriate disposal routes and so inform future R & D projects

The scope of the reports was primarily wastes arising from the Care & Maintenance Preparations phase of the Magnox decommissioning programmes. Wastes arising from Final Site Clearance were excluded. The report stated that many of the wastes were identified as potential future arisings rather than 'genuine' orphans and that significant progress had been made in identifying treatment and/or disposal routes. The report noted that volumes were relatively small; however that information on waste volumes was limited. The report also reviewed the experience of other SLCs to identify where other SLCs have identified strategies for similar wastes. The treatment and disposal techniques reviewed were assigned to 5 categories, Chemical, High Temperature, Immobilisation, Physical and Others. Overall 39 techniques were reviewed and the report states that there were no wastes within the scope of the project for which a potential treatment technique had not been identified however recognising that some of the techniques may be prohibitively expensive for relatively small volume wastes.

[6] Magnox WRATS & Orphan Wastes Disposition Project NT/P722500290/R529/Fina/Issue 1
[7] Review of Chemically & Biologically Hazardous Wastes Arising from Decommissioning 22-2007/08N

The project identified a total of 66 orphan wastes within the scope of the project, i.e. within the care & maintenance phase. The 66 wastes were assigned to one of three waste types:

- Generic – defined as potentially arising at more that one site
- MCI/MAC – these are major Magnox waste streams (Miscellaneous Contaminated Items/Miscellaneous Activated Components), which occur at all sites but there are components within theses streams that are orphan wastes
- Site Specific – arising at only 1 site

The list of orphan wastes were compiled into a spreadsheet format which allows sorting and grouping of wastestreams by categories such as site and waste type. The detailed information stored in the spreadsheet is similar to that stored in the Sellafield database, i.e. waste category, volumes, location, containment, baseline treatment options etc.

3.3 Former UKAEA Sites

The former UKAEA consists of a group of sites which included Dounreay, (now DRL) Culham, Harwell, Winfrith, (now collectively known as RSRL) and Windscale, (now part of the Sellafield Site).

Based on earlier work carried out as part of the original orphan waste project[8], the former UKAEA sites have a range of orphan wastes which can be grouped into similar groups to the Sellafield and Magnox arisings. During the LCBLi process UKAEA stated[9] that overall there were a limited number of items with minor LTP impact and no 'showstoppers'. The majority of the sites had issues with either sources and exotic fuels and fuel wastes which are in the ILW category. Dounreay and Windscales in particular have inventories of oils, zinc bromide and mercury which are common to almost all UK nuclear sites.

4 Major Waste Groups

Almost all UK nuclear sites have similar groupings of orphan wastes with identical issues such as limited data on volumes, arising profile and characterisation data. In general most orphan wastes are relatively low volume materials and do not have a particularly high priority for progressing as they are not impacting on decommissioning or other hazard reduction programmes.

A summary of the major waste groups across the UK nuclear estate is shown in table 1 below:

[8] UK Orphan Waste Synergies – areas for discussion with other consignors, March 2004
[9] NDA LCBLi Orphans Exotic Task Group Meeting No. 7 Note for the record September 2007

Generic Group	Sellafield	Magnox	UKAEA (Now DSRL & RSRL)
Oils & Solvents	Several hundred cubic metres of oils and solvents, mostly LLW, a specific ILW oil contaminated sludge stream and smaller volumes of PCM/ILW wastes	Tens of cubic metres of oil contaminated sludge's supernates and resins. Most sites have existing incineration outlet for LLW oils.	Tens of cubic metres of oil and solvent wastes, some sites have access to existing incineration outlets
Silts & Sludge's	Range of contaminated materials either high end LLW or PCM/ILW	Small quantities of wet wastes with high solids loading	None declared
LLW Lead	Several thousand tonnes of lead across the site. Unknown characterisation data, however expected to be exempt or LLW	None declared in the WRATS & Orphan Waste project report	Several thousand tonnes of lead mostly at Dounreay
ILW Lead	Anticipated arisings of several hundred tonnes expected to arise	None Declared in the WRATS & Orphan Waste project report	None declared
Resins	Small quantities of contaminated resins particularly in the PCM range	None Declared in the WRATS & Orphan Waste project report	None declared, potentially some molecular sieves
Mercury	Several hundred tonnes of contaminated mercury	Small quantities identified in some sites	Several hundred tonnes of mercury present in the DFR reactor seals
Chemicals	Large quantities of suspect contaminated lab chemicals	Small quantities identified	None declared
Encapsulated wastes	Several hundred cubic metres of out of spec encapsulated product drums	None Declared in the WRATS & Orphan Waste project report	None declared
Uranium metals & exotic fuels	Wide range of uranium bars, depleted, natural & enriched plus a number of exotic fuel rods, fragments & dusts	Fuel fragments separated from FED	Some DFR breeder debris
Zinc Bromide	Bulk of Sellafield stocks treated, tens of cubic metres from Windscale to process	Tens of cubic metres of contaminated and potentially clean material	Tens of cubic metres of contaminated and potentially clean material

Table 1 – Generic Group Summary

There are a number of other waste groups which are more specific to certain sites, particularly the Magnox sites which have some identified orphan wastes from reactor operation such as:

- Burst cartridge detection (gas stream coolers)
- Boron balls/dust (ternary reactor shut down system)
- Ternary Eutectic Chlorides
- Cobalt cartridges
- Asbestos sludges
- LLW bird droppings (high alpha putrescible waste)
- LLW Freon gas

5 Current R & D Programmes

Currently there does not appear to be any site wide R & D initiatives investigating orphan wastes at any of the NDA sites. Magnox did have a project investigating Non Aqueous Phase Liquids[10], (NAPLs), which looked at the application of Nochar polymers for the treatment of oil wastes. The current status of this work is not known, Sellafield have also previously investigated this technique for the immobilisation of small volume heavily contaminated oil wastes.

Within Sellafield there is no consolidated R & D work carried out on orphan wastes. Historically work has been undertaken on a number of specific wastes streams such as mercury, zinc bromide and oils. There has been some success with this work, particularly with zinc bromide which resulted in a project which removed the bulk of the Sellafield inventory. Additional trial work has been undertaken on oils and lead with consignments despatched to supply chain treatment routes. R & D work on orphan wastes is currently carried out on a project by project basis with priority assigned only when the presence of orphan wastes impacts on another higher priority project. This lack of priority can result in the orphan wastes having the potential to cause delays to other projects as investigation and optioneering is started late. This is compounded by the lack of suitable storage facilities able to receive orphan waste.

Within the Magnox sites, several sites have generic work identified in the 2008/09 TBURDs.

6 Recommendations

There are clearly areas where consolidation of R & D between sites with similar issues would be beneficial both in reducing duplication of work and costs. Within the Magnox sites there are a number of wastestreams specific to a number of the sites, such as redundant reactor instruments, fuel fragments, boron balls/dust, highly tritiated waste items, contaminated or activated heavy metals and nimonic springs. Waste types common to all sites are zinc bromide, oil contaminated supernates and oil contaminated sludges. Sellafield and DFR have large lead and mercury wastestreams and also Sellafield has a number of small volume wastestreams which could potentially be contaminated to PCM or ILW levels.

[10] Magnox Project Ref. 02-2008/09N

Currently these wastes are either stored or will arise at some point in the future. The challenge therefore is how to manage these wastes and plan the R & D requirements within the current funding constraints. Certainly at Sellafield there are only a small number of orphan wastes which have the potential to impact on important hazard reduction programmes and these streams are managed on a project by project basis.

As there are several generic wastestreams common to a number of sites there is a benefit in undertaking basic R & D requirements at a centralised level to underpin route development. The output of the R & D work would then enable individual sites to progress the treatment and disposal of the orphan waste.

It is therefore recommended that:

- The inventory of generic wastestreams for each NDA site is reviewed
- A number of sites are identified and selected to undertake consolidated R & D programmes
- R & D plans for each wastestream is constructed and funding identified
- A mechanism for sharing information and reporting between NDA sites on orphan waste development is devised and implemented
- R & D programme initiated