Geological Disposal

Upstream Optioneering
Update January 2014

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Bibliography
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Upstream Optioneering: Update – January 2014

The Upstream Optioneering project was set up to help identify and support the implementation of opportunities for improved management of higher activity radioactive waste (HAW) in the UK. These improvements could lead to quicker and more cost effective hazard reduction, reduced environmental and safety impacts, and other benefits. The Radioactive Waste Management Directorate (RWMD) project team is currently:

- Delivering Year Two of the work programme.
- Engaging with other functions within RWMD, Nuclear Decommissioning Authority (NDA) Strategy, NDA Delivery and the Site Licence Companies (SLC) to support their ongoing work.

This work is being delivered by RWMD, supported by the ASSIST consortium of suppliers (Galson Sciences Limited, Areva RMC and Quintessa) and AMEC. Each opportunity in the work programme is sponsored by NDA Strategy, NDA Delivery or RWMD.

Regular updates\(^1\),\(^2\) are posted to help to inform interested parties of the progress of the work programme and of specific opportunities. Work completed recently and planned for the remainder of Year Two is described in this update.

Completed opportunities

Since the last update, we have been implementing Year Two of the work programme and have completed work within the following tasks:

- **Use of self-shielding packages**
  This task considered whether further opportunities exist for the use of self-shielding packages. A strategic examination of the key differentiators influencing the selection of robust shielded containers (RSC) was carried out leading to a study that identifies a range of possible scenarios involving varying levels of use of RSCs to package radioactive waste. This work is published and available on the RWMD bibliography\(^3\) and was also presented at the International Conference on Environmental Remediation and Radioactive Waste Management (ICEM’13) in September 2013.

- **Develop HAW lifecycle cost norms**
  Cost norms are generic estimates of the cost of waste management activities per unit volume or per unit mass of waste. This opportunity involved developing consistent cost norms for a range of waste types (e.g. activated and contaminated metals, concrete, metals etc). Cost norms for the full lifecycle of HAW management were developed (from retrieval of the waste through to disposal at the GDF, including treatment, packaging, interim storage and transport).

  This work facilitates options assessments and business case development by helping to ensure that approaches are comparable across the nuclear industry, and provides cost norms for benchmarking purposes. The cost norms are now being used as an input to other opportunities.

- **Decommissioning wastes**
  Decommissioning wastes are defined as solid wastes generated during site restoration and clean-up, including final site clearance. These wastes include core graphite and wastes generated through demolition and de-planting, predominantly


concrete and steel. This work provides high-level guidance for waste strategy managers and waste producers and identified differentiating factors that influence the selection of container types for these generic categories of decommissioning waste to help identify optimal packaging solutions.

- **Optimised management of orphan waste**
  
  Orphan wastes have properties that prevent them from being managed through existing or currently planned waste routes on the site of arising, or for which there is a lack of characterisation or provenance that prevents their management, or makes their management uncertain. This work identified opportunities for consolidated management of orphan wastes across the UK nuclear industry. A suite of deliverables have been produced including a summary inventory of orphan waste groups at UK nuclear sites, an interactive database containing all orphan waste inventory entries, a matrix and table of potential treatment technologies and a comprehensive set of wiring diagrams for all generic orphan types. These provide a toolkit for waste managers to use to develop management routes for orphan wastes.

A list of all the tasks that have been completed so far in the Upstream Optioneering programme is included in Appendix 1. Some outputs of the Upstream Optioneering project take the form of technical advice and recommendations that enable further action. Implementation of the recommendations in relation to actual waste management practice is mostly the responsibility of Site Licence Companies.

**On-going opportunities**

The following tasks are currently in progress and are due to be completed in the next few months.

- **Opportunities for lifecycle management of high-level radioactive waste (HLW)**
  
  This work considers the technical feasibility and lifecycle benefits offered by a range of potential options for storage, packaging, transport and geological disposal of HLW. The study includes options for disposal at earlier times than in the current baseline and the use of a range of geological disposal concepts. A scoping-level study, which addresses two Upstream Optioneering opportunities, is currently ongoing.

- **Low Level Radioactive Waste (LLW) / Intermediate Level Radioactive Waste (ILW) boundary tasks**
  
  LLW/ILW ‘boundary’ wastes are wastes for which it is possible that a safety case may be made that would allow final disposal to either ILW (geological, deep) or LLW (near-surface, shallow) disposal facilities. Four distinct but related opportunities concerning LLW/ILW ‘boundary’ wastes are being investigated in parallel. The opportunities and their outputs are listed below:

  - **Decay store short-lived ILW to allow disposal to near-surface facilities** – a report describing the main opportunities for decay storage, based on an analysis of the UK radioactive waste inventory.

  - **Waste management by safety case argument** – a report examining the potential for application of existing policy and guidance regarding the management of radioactive waste by safety case argument and not by classification.

  - **New routes for tritiated desiccants** – a summary paper of previous work on management of tritiated wastes.
Benefits and disbenefits of disposal routes – a report presenting potential candidate LLW/ILW boundary wastes, evaluating the benefits and disbenefits and presenting illustrative case studies.

This work is expected to be completed in April 2014, following which collaboration between RWMD, Magnox and the Low Level Waste Repository Limited (LLWR Ltd) on the management of LLW/ILW boundary wastes will be maintained.

- **Assess the value of size reduction of ILW**
  Size reduction of ILW may generate benefits in reducing the number of containers and consequent downstream costs for grouting, storage, transport and disposal. However additional size reduction also requires additional effort during the retrieval process with potential consequences such as worker dose, discharges, secondary waste etc. This work will consider cost savings resulting from additional size reduction (improved packing fractions) for a number of containers and waste streams. This benefit will be compared with the potential impacts resulting from additional size reduction incorporating the principles of BAT and the NDA Value Framework in as far as is practicable for a generic assessment.

- **Increased export rates of ILW offers benefits to be determined**
  The current scheduling of ILW receipt at a GDF is not optimised, and from the date of first waste emplacement at a GDF, the full capacity of the GDF is not being utilised. This work will seek to develop a more optimal schedule, which schedules waste export from sites to gain maximum benefit for the industry (e.g. earlier site closures where store emptying is the final activity on the site).

- **Use of reagents in waste management (e.g. decontamination reagents)**
  The original brief for this opportunity proposed developing an integrated approach to decontamination. It was decided that more value could be offered if disposability of the reagents could be demonstrated, thus permitting more widespread use. The scope was also expanded to include strippable coating, fixatives and flocculants.

  Waste Producers provided the project with information on reagents that, if they could be used, would offer benefit. A submission to RWMD’s disposability assessment process for these reagents has been prepared. The submission was completed in December 2013 and the subsequent assessment will take about six months.

- **Review of Container Requirements for the individual phases of disposal**
  This is a task being delivered within RWMD to ascertain the requirements on waste packages in order to identify whether any RWMD specifications could be optimised for the benefit of waste producers.

- **Use of polymers as an ILW encapsulant**
  A significant amount of research and development has been updated in the nuclear industry on the use of polymers for waste management. This work seeks to collate the work undertaken already to make the findings available across the industry and to avoid repeated work.

**Accelerated opportunities**

The following tasks have been accelerated from starting in the 2014/15 work programme to start during 2013/14:

- **Provision of a centralised ILW finishing facility**
  This opportunity will consider the potential functionality, constraints and lifecycle benefits/disbenefits of a centralised treatment facility for ILW.
• Optimised management of radioactive sources declared as waste

All UK waste producers have sources that require management. This work seeks to build on available guidance, and will also consider novel packaging concepts that could offer more optimum solutions than current packaging approaches.

Deferred opportunities

The following task has been deferred from the 2013/14 work programme into the 2014/15 programme due to other work within the RWMD technical programme that can inform the task:

• Earlier export of spent fuel to the GDF

Watching briefs on opportunities being delivered elsewhere

A number of opportunities are also being implemented outside of the Upstream Optioneering project by the NDA and SLCs. The Upstream Optioneering project continues to maintain watching briefs on these opportunities and updates will be provided when they are completed.

Additional tasks

The completed and ongoing tasks described above are those that form part of the Upstream Optioneering 3 year programme of opportunities. Upstream Optioneering also delivers additional, emergent, tasks alongside its planned work.

• Feasibility of using mobile plant across the industry (on-going)

The objective of this work is to consider the technical feasibility of mobile treatment and characterisation plants within the constraints imposed by the transport regulations and transport infrastructure.

• Solubility studies in the presence of bespoke superplasticisers

This work has been initiated following work undertaken in year one of the upstream optioneering programme.

If it can be shown through this work that superplasticisers do not promote the mobility of radioactive species, then this would open the potential for the endorsement of the use of superplasticisers through the Letter of Compliance process. This would enable waste packagers to take advantage of some of the operational advantages that superplasticisers offer e.g. higher fluidity, lower water content.

This task will study commercially supplied superplasticiser products (bespoke, to remove any components that are not required for encapsulation) as well as the individual components that make up those products. Additionally, a high purity superplasticiser component and a research material comprising a modified superplasticiser structure will also be studied. The task is funded through the NDA Direct Research Portfolio.

Planned work

In the last quarter of Financial Year 13/14, we plan to complete the tasks that have already been initiated in Year Two. We are now starting to plan for implementation of the Year Three work programme. The opportunities to be taken forward in Year Three are listed in Table 1 in Appendix 2.

Benefits realisation

During 2012/13 the Upstream Optioneering project developed a benefits management process, using the Office of Government Commerce approach to demonstrate that the programme is delivering value. A benefits realisation management plan was developed to ensure that identified benefits were effectively and actively managed. Workshops were held
with subject-matter experts to identify the benefits associated with opportunities within the Upstream Optioneering programme. The outputs from the workshops were benefits maps.

The benefits management process developed within Upstream Optioneering is currently being adapted for wider use across the RWMD programme.

**Way forward**

The Upstream Optioneering three-year work programme is flexible and will continue to respond to ongoing developments and needs in radioactive waste management across the NDA estate and more widely in the UK. The Waste Packagers Liaison meeting and the GDF Users Group is being used to keep stakeholders up to date with progress.

During Year Three of the work programme, we will be reviewing the completed work and assessing the benefits that have been delivered or are expected in future, in order to plan subsequent work.
Appendix 1: Completed opportunities in the Upstream Optieereing Work Programme

Table 1: Completed opportunities in the Upstream Optioneering Work Programme (as at end November 2013)

<table>
<thead>
<tr>
<th>ID</th>
<th>Name</th>
<th>Work undertaken</th>
<th>Outputs</th>
<th>Next Steps</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>The use of self-shielding packages</td>
<td>A watching brief has been maintained on the development of a strategic NDA position on the use of self-shielding packages. A project to review available RSCs and to evaluate the potential role of RSCs within the NDA strategy for the management of HAW was completed.</td>
<td>An RWMD report providing a strategic examination of the potential role of RSCs in ILW management across the NDA estate. Published report available on RWMD bibliography and paper presented at ICEM’13.</td>
<td>Continue to maintain a watching brief and update reports as necessary as the SLC and NDA positions evolve regarding the use of RSCs.</td>
</tr>
<tr>
<td>10</td>
<td>Development of an increased capacity reusable transport container</td>
<td>Development of the conceptual design of a LWTC has been completed. Following the review of the business case to progress this work, preliminary design work continues.</td>
<td>Business case for the continued development of the LWTC. Physical 3D models and conceptual designs for the LWTC. This work was used to inform the decommissioning opportunity (#92).</td>
<td>Continue to underpin the business case for the LWTC through engagement with Sellafield.</td>
</tr>
<tr>
<td>ID</td>
<td>Name</td>
<td>Work undertaken</td>
<td>Outputs</td>
<td>Next Steps</td>
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<tr>
<td>13</td>
<td>Use of superplasticisers in waste packages</td>
<td>A review was completed in July 2012 of the current state of development of superplasticisers for packaging applications and their use in general construction and vault backfilling in order consider their potential use in a GDF. Engagement with a commercial supplier of superplasticisers regarding a bespoke solution was undertaken.</td>
<td>Current status paper on the potential use of superplasticisers in a geological disposal facility published in July 2012.</td>
<td>Experimental trials started to assess the effect of bespoke superplasticisers on the solubility of key radionuclides.</td>
</tr>
<tr>
<td>15</td>
<td>Use of a higher fissile loading for IP2 packages (as per LLWR)</td>
<td>A review of the potential to use 6 Cubic Metre concrete Type IP-2 packages for non-fissile and/or fissile-excepted wastes has been completed. A review of WPS/911 (RWMD guidance on the application of fissile exception) was conducted by INS.</td>
<td>6 Cubic Metre Box guidance document produced.</td>
<td>Task complete.</td>
</tr>
<tr>
<td>16</td>
<td>Use of neutron poisons/absorbers to increase limits on the fissile material content of ILW packages</td>
<td>A review of the potential use of neutron poisons as a criticality control in waste packages was undertaken.</td>
<td>Report on the identification of potential opportunities regarding neutron poisons and their uses in waste packaging. Potential neutron-absorbing materials were identified, as well as business drivers and opportunities for future use of poisons (spent fuel packages, supercompacted PCM packages, and decommissioning wastes).</td>
<td>Task complete.</td>
</tr>
<tr>
<td>ID</td>
<td>Name</td>
<td>Work undertaken</td>
<td>Outputs</td>
<td>Next Steps</td>
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<tr>
<td>38</td>
<td>Develop Higher Activity Waste lifecycle cost norms (enabler)</td>
<td>A pilot study to demonstrate the methodology for cost norm derivation was carried out for concrete lined drums and activated metal from a reactor pressure vessel. A study was carried out to derive cost norms for various decommissioning, treatment and packaging tasks for common decommissioning waste streams. Storage and disposal cost norms were derived from earlier NDA work.</td>
<td>Suite of cost norms for retrieval, treatment and packaging of decommissioning wastes.</td>
<td>This work is complete.</td>
</tr>
<tr>
<td>64</td>
<td>Optimised management of orphan waste</td>
<td>A survey of the existing inventory and management of orphan waste across the NDA estate, and at other UK nuclear licensed sites has been completed. This has involved engagement with all UK major waste producers. Waste treatment routes have been identified by literature review and engagement with the supply chain and mapped to generic orphan waste streams.</td>
<td>A suite of deliverables have been produced including a summary inventory of orphan waste groups at UK nuclear sites, an interactive database containing all orphan waste inventory entries, a matrix and table of potential treatment technologies and a comprehensive set of wiring diagrams for all generic orphan types. These provide a toolkit for waste managers to use to develop management routes for orphan wastes.</td>
<td>Further steps to be agreed with NDA Strategy and NDA Delivery.</td>
</tr>
<tr>
<td>ID</td>
<td>Name</td>
<td>Work undertaken</td>
<td>Outputs</td>
<td>Next Steps</td>
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<tr>
<td>118</td>
<td>Optimisation of management of oils (and solvents)</td>
<td>Partly addressed in the orphans study (Opportunity 64). A survey of the existing inventory and management of oils and solvents was completed and waste treatment routes identified (also covered within the Integrated Waste Processing project completed in FY 11/12).</td>
<td>As part of the orphans study a summary inventory of oils and solvents at UK nuclear sites, a matrix and table of potential technologies to treat contaminated oils and solvents and a comprehensive set of wiring diagrams to illustrate such information has been produced. These provide a toolkit for waste managers to use to develop management routes for oils and solvents.</td>
<td>Further steps to be agreed with NDA Strategy and NDA Delivery.</td>
</tr>
<tr>
<td>130</td>
<td>Enable greater access to DIQuest software tool</td>
<td>Users from LLWR and the supply chain have been trained in the use of DIQuest and provided with access using NDA laptops. Work to implement a secure network to host a range of RWMD related needs is being delivered.</td>
<td>A short document outlining the functionality of DIQuest and a training course has been delivered. Roll-out of DIQuest has started.</td>
<td>The enabling and demonstration work is complete. Further roll-out is now business as usual.</td>
</tr>
<tr>
<td>135</td>
<td>Broadening of the feed envelope for WTC at Sellafield</td>
<td>The upstream optioneering project engaged with the Sellafield Limited team and assisted in the development of a submission to enable a disposability assessment for a wider waste envelope.</td>
<td>The outputs included a range of studies which were used by Sellafield to develop a submission for a disposability assessment.</td>
<td>Task complete.</td>
</tr>
</tbody>
</table>
### Appendix 2: Year Three Work Programme

#### Table 1: Year Three programme information.

*Opportunities are colour coded according to sponsor*

**Key:**

- **RWMD**
- **NDA Strategy**
- **NDA Delivery**

<table>
<thead>
<tr>
<th>ID</th>
<th>Opportunity Name</th>
<th>Extent of Benefit</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>Collaborative working to achieve benefits for transport and logistics</td>
<td>National</td>
</tr>
<tr>
<td>14</td>
<td>Review the requirement to minimise voids within ILW packages</td>
<td>National (UK)</td>
</tr>
<tr>
<td>48</td>
<td>Develop decontamination approach for pipework in Rad storage facility</td>
<td>Multi-SLC</td>
</tr>
<tr>
<td>71</td>
<td>Review packaged waste against current LLW acceptance criteria</td>
<td>National (UK)</td>
</tr>
<tr>
<td>77</td>
<td>Improved management of gravels</td>
<td>Multi-site</td>
</tr>
<tr>
<td>78</td>
<td>Improved management of filters</td>
<td>National (UK)</td>
</tr>
<tr>
<td>83</td>
<td>Co-processing of solid and liquid wastes</td>
<td>Single Site</td>
</tr>
<tr>
<td>95</td>
<td>Disposal of unconditioned waste from future decommissioning (Stage 3 final site clearance wastes)</td>
<td>National (UK)</td>
</tr>
<tr>
<td>105</td>
<td>Earlier export of legacy spent fuel to the GDF, pre-2075</td>
<td>Single Site</td>
</tr>
<tr>
<td>114</td>
<td>Segregation of LLW</td>
<td>National (UK)</td>
</tr>
<tr>
<td>124</td>
<td>Mobile characterisation laboratory</td>
<td>National (UK)</td>
</tr>
</tbody>
</table>