

## Memorandum

To: Dr Darrell Morris      Date: 9<sup>th</sup> February 2010      Your ref:

NDA

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Subject:

04070 Recycled Concrete Aggregate (RCA) Stakeholder Dialogue – Interim Update

### Introduction

The use of Recycled Concrete Aggregates (RCA) as a component in new concretes for civil engineering applications is an established technology within the overall UK civil engineering community. It is anticipated that during the decontamination and decommissioning of building within the NDA estate, substantial amounts of concrete (both contaminated and exempt materials) will be generated which could potentially be used to produce RCA for re-use in applications such as infilling and annulus grouts or waste packages. This has the potential to reduce both the environmental impact (through reduced overall waste volumes and reduction in the use of virgin materials) and cost.

An initial study performed in FY08/09<sup>1</sup> indicated that all of the work performed on the use of RCA to date has concentrated on providing data to satisfy the requirements for civil engineering applications. These differ from the types of information which are required for the use of grouts for encapsulation of waste.

It was therefore recommended that if additional work is performed on the use of RCA for use in encapsulant grouts the following trials should be carried out:

- Samples of non-radioactive RCA, principally fine materials (less than 2mm) should be obtained from concretes which are representative of those used on nuclear sites. These

materials should be sourced from a range of different concrete samples, which have been decontaminated and size reduced with applicable techniques.

- A review of the nuclear issues (such as contaminated dust management, equipment operations within a process cell environment) should be performed.
- These materials should be graded and used to produce a range of formulations to assess grout fluidity, bleed, setting and strength. This will provide primary data on the properties of grouts containing fine aggregates as potential encapsulants.

However, prior to the commencement of any practical trials it was recommended that the stakeholder community was consulted to elicit their views on the viability of the use RCA for waste management applications. The purpose of this interim update is to record the comments which have been collated to date and identify any initial common themes.

#### Stakeholders Feedback

The stakeholder feedback presented below represents the notes of discussions with each stakeholder, the contents having been agreed by each of the stakeholders.

#### **Environment Agency – Dr Paul Abraitis (PA)**

- the use of the RCA aligns with the waste minimisation aspects of the HSE NII/EA/SEPA Joint Guidance on Radioactive Waste Management Section:  
<http://www.hse.gov.uk/nuclear/wastemanage/minimisation.pdf>
- This is also consistent with the Waste Management Hierarchy (WMH) as it enables reuse (as a wasteform component).
- PA also noted that an analogous approach is being considered at the Sellafield site with the direct activation of the pozzolanic clinoptilolite and sands, to allow them to be incorporated in wasteforms at higher concentrations and/or use of these materials as pozzolans during encapsulation of other wastes. This method of waste minimisation is regarded as a positive approach by EA.
- It is however important that the use of RCA is not used as a means for the disposal of higher activity wastes, through dilution with lower or non active wastes in order to allow disposal as lower active waste.
- A discussion took place concerning the timing of the coordination of RCA being produced, which may be later in the decommissioning cycle compared to the need for materials for use in the waste management grouts

- Storage of RCA – the storage and accumulation of RCA at any nuclear site, falls within the HSE NII remit, and will require their consultation
- EA will clearly expect that suitable storage of RCA is put in place to prevent to the release of activity, from processes such as rainwater leaching or airborne release (e.g. via particulates produced during crushing).
- PA indicated that work has been reported at KONTEC in 2004/05, on methods for segregating and characterising crushed contaminated concrete.
- Overall the concept of the use of RCA in grouts for either infilling of other wastes or as part of an annulus backfill would be supported by EA as being worth further development.

**Nuclear Installations Inspectorate – Dr Ollie Okeke (OO)**

- OO indicated that the NII high level strategic view is that recycling of materials should be encouraged and NII would support the re-use of materials within the nuclear industry. However the detailed characteristics of the RCA, and in particular factors such as the activity levels of different RCA according to their source and the implications of this for dose to the site operations staff and off-site does to the public would need to be considered
- EJB noted that as noted in the NNL (09) 10076 report, the use of RCA within the wider UK civil engineering community is relatively developed, with a British Standard (BS8500-1:2000) in place, along with guidance from the Building Research Establishment (BRE 433). The BRE document recommends parameters to be tested such as the sulphate and chloride contents and the water absorption of the RCA.
- The use of RCA will have safety case implications, relating to the requirements to ensure that the materials can be safely produced, characterised, stored, mixed and emplaced. The long term impact of the use of the RCA will also require assessment. This will clearly dependant on the application –the re-use of RCA in, for example annulus grouts in waste packages presenting different safety case issue to those where the RCA is used for civil engineering applications such as part of concrete plinths. OO noted that the safety case requirements for the production, re-use and characterisation of the suitability for concretes containing RCA would be dependant on the activity category of the RCA. The responsibility for either modifying existing safety case or production of new safety case would lie with the site licence operators. Clearly VLLW/free release materials would be require less rigorous safety measures compared to when dealing with LLW and ILW, which would need increasing levels of control.

- Intra and inter site transport of RCA will require different regulations to be considered – clearly intra site will avoid the need for transport on public highways. There will be a requirement to develop or modify an safety case for transportation of the RCA
- OO noted that UK LLW is now transported to companies such as Studsvik to allow decontamination operations to be performed. This approach (rather than only transporting wastes to LLWR for disposal), will provide some precedent for inter site transfer of wastes
- EJB indicated that a lifecycle cost/safety/environmental impact approach to assess the options for contaminated RCA would be a useful approach. Direct disposal of grouted RCA alone – e.g. in discrete waste packages alone with no other waste present will be an added cost, whereas using the RCA either as a component in concrete for civil structures or as filler in waste packages would reduce the cost/environmental impact
- OO indicated that in order to attempt to achieve a consensus amongst the stakeholders and regulators concerning RCA, a workshop format would be a good approach. This would allow discussion on all aspects which need to be addressed, to allow agreement to be obtained.
- OO suggested that if in future years the use of RCA was progressed the NII might devote some resources (via a consultancy contract) to assessing the impact and issues relating to the use of RCA, to allow NII to develop a more detailed view on the materials.
- OO suggested that the NNL report should identify the regulations which would need to be addressed and what types of data would be required if the use of RCA is to be progressed further. This will allow site operators to clearly understand the regulatory issues and work required in order to progress the use of contaminated RCA further.

**NDA Radioactive Waste Management Directorate (RWMD)**

**Dr Steve Williams (SWm), Dr Simon Wisbey (SWy), Dr Mike Board (MB)**

- In response to a question from SWy – EJB confirmed that the scope of the materials being considered in the project are limited to recycled concrete aggregate only, and do not include rebar
- EJB also confirmed that the programme was principally concerned with contaminated RCA arising from plant decontamination/decommissioning operations

- SWm indicated that one of the major areas which would need to be considered was the Quality Assurance of the RCA in terms of the inter-batch variability of the materials. RWMD would be particularly concerned with ensuring that consistent quality wasteform grouts could be guaranteed to be produced
- SWm also noted that given the location of nuclear sites in coastal areas, the presence of chloride in RCA would also need to be monitored. This is of particular importance because chloride could accelerate the internal corrosion of steel waste containers
- MB indicated that there is a well established precedent for the use of RCA in the production of roadbase in accordance with UK Specification for Highway Works and for other civil engineering applications; and also noted that WAMAC utilises LLW crushed concrete and LLW contaminated soil as fill for compacted puck waste packages (ISO freight containers). These packages then are grouted at the LLWR; the use of the crushed concrete fill significantly reduces the volume of grout required by LLWR to infill each container.
- It was noted that an advantage of grouting contaminated RCA as a cement bound material is the fixation of the contaminants and the reduced permeability of the cemented RCA containing concrete, both of which will reduce the rate of contaminant leaching.
- The re-use of contaminated RCA as a component in concretes for the production of civil structures such as hardstands was noted by all three RWMD participants as being a more preferred option than the re-use of RCA in grouts for waste immobilisation or as annulus grouts in waste packages
- It was noted that by using contaminated RCA, issues relating to active concrete mixing operations would need to be considered including the storage and dispensing of the RCA and the maintenance of the equipment
- EJB noted that there is now some precedent for active mixers, because this is the current reference option for the Sellafield Direct encapsulation Plant (SDP)
- MB noted that RCA is being used extensively in UK civil engineering construction work because of the increased cost of using virgin (primary) aggregates due to the aggregate tax, the requirement to use primary aggregates sustainably and the environmental impact of the extraction of the aggregates
- SWy noted that alignment of the timeframes for the production of RCA with projects to allow its use, such as roadway for LLWR or within the Geological Disposal Facility (GDF) will need to be considered
- MB indicated that use of RCA for civil engineering applications for Nuclear Site C&M infrastructure, site regeneration infrastructure and the reactor New Build programme needs to be considered.

- SWm indicated that the option of using RCA as a void filler within waste packages containing large items, could also be considered.
- SWy noted that the potential for using aggregates as part of the grout used for closing up of the access drifts of the GDF, after completion of waste emplacement, should be considered. Based on the current baseline plan this in the long term future. SWy also suggested that RCA could be used for the production of overbuildings to reduce the visual impact of headworks for the GDF
- If the option of using the RCA for the GDF was pursued, alignment of the long term stewardship programme would be required. Keeping the buildings intact in the period prior to the RCA being required might be considered by the local community to be a better alternative than the presence of large spoil heaps of (non contaminated) RCA
- It was noted that the sourcing of aggregates for concrete is very price sensitive and that the availability of cheaper (or zero cost) RCA is a driver for their use on nuclear licensed sites and free release material for local civil engineering applications. .
- Factors that need to be considered are the potential for selling surplus free release RCA e.g. it is a material asset for the NDA, and whether the volumes of material could have an effect on local businesses supplying secondary (recycled) and primary aggregates.

#### Overall Summary of RWMD Points

- Use of RCA for civil engineering applications on the existing nuclear sites, as fill for LLW packages and as construction material at the LLWR / GDF was considered to be a preferable option to the use of RCA as a component material of a grout to be used in waste packages. Principally due to the lack of control on the quality of the RCA e.g. chloride contamination, the requirements for significant processing of RCA material before it can be utilised in such an application, and the relatively small volume of material that is likely to be utilised by such an application.
- It should be recognised that RCA is a significant material asset, and if used in suitable applications on nuclear sites, could result in significant cost savings and improved environmental sustainability particularly in terms of reduced grout and aggregate material costs.

#### **Dounreay Site Restoration Limited – Alan Mowat (AM)**

An initial brief discussion has taken place with Alan Mowat concerning the options for RCA use within DSRL. This indicates that the site is currently at an early stage of considering RCA and is principally concerned with the use of non active RCA. This interview will be expanded for inclusion in the final report.

**Sellafield Ltd – Paul Kelly (PK)**

- Sellafield Ltd have sent batches of exempt (non active) concrete from the Sellafield site to Lawson's (Beckermet) for crushing to produce RCA. Some of this material has been returned to site for use, whilst the remaining material has been consigned to the external RCA market.
- The best practice guidance indicating whether RCA is suitable for re-use is in the WRAP Quality Protocol [http://www.wrap.org.uk/downloads/0083\\_Quality\\_Protocol\\_A4.d17b5622.87.pdf](http://www.wrap.org.uk/downloads/0083_Quality_Protocol_A4.d17b5622.87.pdf). This is not legally binding document, but advice received by SL from Environment Agency indicates that materials produced which adhere to this protocol will probably be regarded by EA as being suitable for re-use.
- An alternate recycling company – Nick Brookes Recycling based in Cheshire is fully utilising the protocol – however the logistics and economics of transporting concrete from Cumbria to Cheshire for re-use would need to be addressed.
- PK has already started discussions with SL Risley Civil, Structural and Architectural (CS&A) concerning use of exempt RCA for non structural projects. CS&A are fairly resistant to the idea. Objections are being raised on the basis that a higher standard is required on nuclear sites compared to off –site civil engineering applications. Issues still remain for significant re-use of the materials from site. Decisions would be required on who would do crushing (on-site or off/subcontractor or SL facility), storage of crushed materials and testing of materials prior to re-use and alignment of supply & demand.
- CS&A have agreed to modify the specification for non-structural concrete work to include the use of RCA but this has not yet been done.
- WRAP (Waste and Resources Action Programme) – have provided info to SL with examples of how other industries with a need to produce high quality concretes have successfully used RCA in various applications, not all structural.
- Concrete foundation materials from medical block have been size reduced/recycled into RCA by Thomas Armstrong (main contractor Kiers) and returned for use in the same project as foundations and landscaping material.
- An investigation was initiated by Sellafield Characterisation & Clearance where redundant concrete (ex Sealine Pipebridge covers) from site could be turned into RCA and trialled. This work was facilitated by Eric Miller and was found to be generally successful. However, one of Eric's recommendations was for further trials on different concrete materials found on site.
- Approx 600 bags of RCA were produced by the Active Area concrete crusher from concrete ex B310 foundations. This material was earmarked for use as the base layer in the onsite landfill CLESA. However, after a small volume of this material had been

placed in the landfill cell, the pH levels of the leachate increased over the Discharge Authorisation limit. The remaining bags were not allowed to be used and they had been crushed to such a small size as to render them unsuitable for most applications. However, following a discussion with the EA, they asked us to find a use for it on site rather than send to Lawson's for recycling and the material was eventually used to refurbish contractors compounds to the South East of site.

#### Overall Summary of Sellafield Ltd Discussion

- SL have attempted to generate RCA from exempted concrete for re-use in on-site applications. There is however fairly significant resistance from CS&A in particular to the use of these materials in any civil structures on site because of the perceived need to operate to a higher standard than within the overall external civil engineering community. Many issues still remain unanswered but are not seen as insurmountable.

#### *Magnox North Hunterston Site – John Miller (JM)*

(note this is an email from JM rather than an interview)

Hunterston were originally intending to encapsulate our solid ILW wastes using a purpose built facility located on the site and our Lifetime Plans currently reflect this strategy. However in recognition of the evolving Scottish Government policies on Waste Management it has been decided to revisit the BPEO to identify possible alternative solutions, e.g. non encapsulation, dissolution, etc. As a consequence of this decision the project to build our Encapsulation facility has been put on hold and the scope re-scheduled to re-commence, if still required, later in our Care and Maintenance preps phase.

Therefore the information provided below will only be appropriate if the outcome of the study identifies re-commencement of solid ILW encapsulation as the appropriate solution.

Based on the assumption that we would encapsulate, our encapsulation operations commence Q3 2014 with a planned completion by Q2 2018.

The most significant project to generate concrete wastes will be the Cartridge Cooling Ponds (CCP) demolition. The creation of concrete wastes will not commence until early 2018, well after most of our ILW will already be encapsulated. In addition there is an assumption that gross wastes can be used as in-fill for any voids created by the demolition, hence not releasing anything for other purposes.



Another candidate is the demolition of our Charge Machine Maintenance Building (CMMB). This is due for demolition in 2015 and would generate both clean and possibly small quantities of LLW contaminated concrete wastes.

Demolition of other buildings and tanks is scheduled across the timeframe for encapsulation but are unlikely to generate significant quantities of suitable material.

Note – contacts for a number of other Magnox sites have been identified, but have not yet been interviewed.

## **Discussion**

### Key points

- Positive response from EA, NII and RWMD on the re-use of RCA within nuclear sites. The approach is seen as being consistent with the aims of the Waste Management Hierarchy
- Sellafield Ltd are the most advanced of the SLC's interviewed to date in terms of carrying out work to assess the use of RCA for civil engineering applications. However there is significant resistance to re-use on nuclear sites at this time.
- RWMD have expressed the view that use of RCA for civil engineering applications on the existing nuclear sites, as fill for LLW packages and as construction material at the LLWR / GDF was considered to be a preferable option to the use of RCA as a component material of a grout to be used in waste packages. Principally due to the lack of control on the quality of the RCA e.g. chloride contamination, the requirements for significant processing of RCA material before it can be utilised in such an application, and the relatively small volume of material that is likely to be utilised by such an application.
- All work performed to date has used non active (exempt) materials, use of VLLW and LLW by overseas organisations is being investigated further.
- If required for practical trials in the next phase, materials could be sourced from Lawson's or Nick Brookes Recycling.

## **Ongoing Work**

- Site visit to Nick Brookes Recycling arranged for 9<sup>th</sup> February 2009, to allow an assessment of dusts arising from concrete size reduction operations.
- More detailed interview to be performed with Alan Mowat at Dounreay, and interviews with Magnox sites and SEPA to be performed.

## **References**

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- <sup>1</sup> Review of Options for Employing Wastes in Grout Formulations, NNL (09) 10076 Issue 1, Butcher EJ.