# SGHWR decommissioning ILW in $6m^3$ concrete boxes
# (Interim stage)

## Summary of Assessment Report

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### *Introduction*

Research Sites Restoration Limited (RSRL) has sought interim stage endorsement of proposals for the packaging of Intermediate Level Wastes (ILW) produced from the decommissioning of the Steam Generating Heavy Water Reactor (SGHWR) into 6 cubic metre concrete boxes at Winfrith.

This Assessment Report provides the basis and findings of the interim stage disposability assessment by NDA Radioactive Waste Management Directorate (hereafter RWMD) for packages of SGHWR decommissioning ILW. The assessment has been carried out through the Disposability Assessment process, whereby RWMD examines the disposability of proposed waste packages by assessment against relevant waste package standards and specifications and the illustrative geological disposal concepts for LLW/ILW. The illustrative geological disposal concepts for LLW/ILW have been developed as part of the programme to implement geological disposal for the UK's higher activity wastes. Further information on the Disposability Assessment process is available elsewhere[1].

### *Background*

The Winfrith SGHWR was a prototype uranium dioxide fuelled, heavy water moderated, light water cooled reactor. It began operations in 1967 and was shutdown in 1990. After the reactor shutdown, all fuel and heavy water was removed and transported off-site, and the cooling towers, cooling ponds and some ancillary facilities were decommissioned. A conceptual LoC submission for the packaging of the ILW from the decommissioning of SGHWR into 2 metre boxes was written in 2005.

The current submission encompasses most of the ILW that will be generated from the decommissioning of the SGHWR Primary Circuit and Reactor Core, including:

[1] NDA, Guide to the Letter of Compliance Process, NDA Document WPS/650, March 2008

- In-situ SGHWR components, and
- Miscellaneous ILW (referred to as "Stored ILW" in the submission), consisting of waste items produced during plant operations, maintenance and repair work, and other obsolete items. These items are stored within reactor Fuel Channels and Mortuary Holes. The nimonic springs in this stream were excluded from the current submission by RSRL due to the high dose rate expected.

### *Waste packaging proposal and scope of assessment*

The wastes included in the submission constitute streams 5G302 and 5G01 (excluding nimonic springs) in the 2010 UK Radioactive Waste Inventory (UKRWI). The total volume of raw waste material is given as $43m^3$, with an anticipated conditioned volume of $302m^3$ (93 off $6m^3$ concrete boxes, with a total packaged volume of 1102 $m^3$). The wastes consist of metallic items, most of which would be size-reduced for removal and packaging. In summary:

- the radial shield tank would be cut up in situ by two Brokk machines
- other large items would be moved into one of two 'segmentation cells' and cut into pieces small enough to fit into the packages

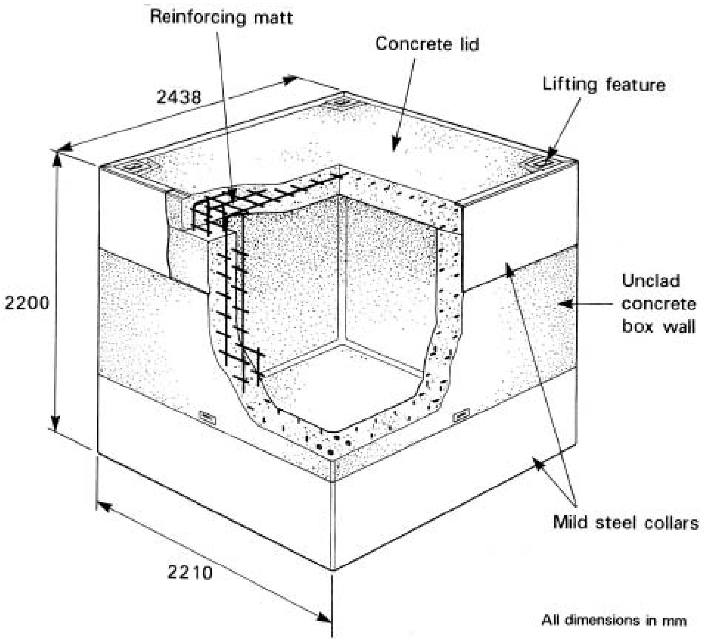
The fine material produced by the cutting process would be immobilised by polymer encapsulation of the fines in 10 litre cans. These cans would be placed into the $6m^3$ concrete boxes and grouted. Following waste retrieval and size reduction processes, other waste packaging steps can be outlined below:

- The size-reduced SGHWR ILW arisings from each campaign would be loaded into perforated waste baskets using appropriate furniture. Higher-activity components would be placed within an inner basket.
- The waste baskets would contain furniture designed to ensure good grout infiltration: 'milk crates' to keep pipework upright and 'toast racks' for planar or nearly planar items.
- The filled waste baskets would be transferred to the grouting facility and would be subject to dose rate assaying before being loaded into the 6 cubic metre concrete boxes.
- The loaded 6 cubic metre concrete box would be filled with grout and allowed to cure.
- Once the grouted box has been allowed to cure, a concrete lid would be cast onto the box.
- The resulting waste package would be radiologically surveyed prior to transfer off-site

RSRL proposes to carry out the packaging of ILW arisings from SGHWR core and the primary containment in seven campaigns, based on source and material type of the wastes. It is not intended to mix ILW arisings from different campaigns, although some higher activity materials may be distributed amongst boxes from several campaigns. Waste shown by assay not to fit within the radionuclide inventory envelope allowed by the Waste Product Specification for SGHWR decommissioning waste in $6m^3$ concrete boxes would be diverted for disposal via an alternative route.

The grout formulation and envelope to be used for encapsulation of the SGHWR decommissioning ILW is yet to be defined, but RWMD expects that a suitable grout can be developed.

The design of the $6m^3$ concrete box was intended for use in packaging activated metals and transport of Low Specific Activity wastes as Industrial Packages. The $6m^3$ concrete box has dimensions 2438 by 2210mm on plan by 2200mm height. It comprises a reinforced concrete box with 8mm thick mild steel collars top and bottom. The collars provide additional protection to the corners and incorporate the twistlock lifting features. The lid is cast after grouting the contents in place so as to present a monolithic structure.




The package has 240mm thick walls for shielding, a mass limit of 50t and a payload volume of $5.76m^3$. Two variant options are available: standard or high density, where the option applies to both the type of concrete container and the waste encapsulating grout. The high density option is proposed for packaging these solid wastes, although RSRL may opt to use standard density boxes if the dose rate from the waste is low enough.

## *Parameters for Assessment of Disposability*

*Assessment Inventories*

Assessment inventories for the proposed packages have been generated based on the information provided in the submission. There is some uncertainty regarding the nature and quantity of the “stored ILW”. This can only be resolved during the packaging process, leading to requirements on the assay system and quality management system to identify wastes to be diverted for disposal via an alternative route.

*Waste Package Properties and Performance*

The $6m^3$ concrete box design is considered likely to meet RWMD requirements, but there is some uncertainty regarding the details of the design and manufacture.

The long term performance of the wasteform could be affected by expansive corrosion of the metal waste. This could cause the package to degrade and could affect the performance in impact accident scenarios. Impact release fractions have been generated on the assumption that the packing of metal waste would be controlled to avoid the effects of expansive corrosion.

*Compatibility with Specifications*

The current packaging proposal meets or could be shown to be compatible with many areas of the RWMD specifications. Further information is needed on external dose rate, surface contamination, lifting feature, package integrity, criticality safety, stackability, quality management, waste package data and information recording.

All of these areas are discussed further in the key issues section below.

### ***Assessment of Disposability***

*Transport Safety Assessment*

There is insufficient information to state that use of the $6m^3$ concrete box for SGHWR decommissioning ILW is consistent with meeting the transport system design and safety requirements as currently foreseen by RWMD. Six issues have been noted:

- Some individual waste items could exceed LSA-II specific activity limits.
- A collection of individual waste items could exceed the bare dose rate at 3m limit.
- The 6 $m^3$ concrete box has not been shown to comply with transport stacking requirements.
- Some packages may exceed surface contamination limits.
- The proposed package has not yet been shown to be fissile excepted.
- There is currently no Design Authority for the $6m^3$ concrete box.

*Operational Safety Assessment*

The impact, fire and contamination accident performance of this waste/container combination is acceptable. Although the Basic Safety Levels (BSL) were exceeded for certain fire and impact faults, the dose consequences are below the equivalent doses calculated for the bounding waste streams in the DSS. It is expected that addressing the conservatisms in the current calculation methodology would bring all of these doses to below the BSL. Doses calculated under normal conditions are expected to be below the Geological Disposal Facility (GDF) design target. Radioactive gas generation is insignificant and there are no chemotoxicity issues associated with the waste.

*Post-closure Safety Assessment*

The potential significance of the proposed packages has been assessed by comparison with the baseline total inventory of waste to be disposed of as Shielded ILW. It is concluded that the use of the $6m^3$ concrete box for SGHWR decommissioning ILW would be consistent with meeting the GDF post-closure requirements as currently foreseen by RWMD. One issue has been noted:

- Due to their potential to affect radionuclide migration, RSRL needs to confirm the type and quantity of superplasticisers to be used in the manufacture of concrete boxes

## ***Key issues***

*Expansive corrosion of waste*

RSRL proposes to limit the volume of waste within a package to ensure less than 1% volume expansion in 500 years. RWMD currently understands that modelling shows there is a limit of 0.08% on wasteform expansion before the rebar in the concrete box would start to deform. This is anticipated to be followed by spallation of concrete from the walls of the $6m^3$ concrete box, and should be avoided.

*Transport requirements*

Based on a conservative interpretation of the IAEA transport regulations, the transport assessment has made the following assumptions:

- Each solid item needs to be LSA II (or LSA-III, if it meets leach test requirements) based on its individual $A_2$ /g value. RWMD notes that there is an opportunity for RSRL to challenge this assumption.
- An appropriate collection of unshielded solid items must have a total dose rate of less than 10 mSv/h at 3 m. RWMD notes that there may be scope to interpret this requirement in different ways (e.g. dose rate at 3m from the edge of the collection of objects, rather than at 3m from each individual item.)

Further information is required to show that individual waste items would not exceed LSA specific activity and bare dose rate limits at 2040. RWMD recommends that RSRL should discuss the interpretation of average specific activity and bare dose rate with the ONR Radioactive Materials Transport team.

Transport Regulations require that the waste package must be capable of being stacked six high. This leads to a requirement that the waste package must be capable of withstanding a compressive load of 2.0MN applied along the vertical axis of the waste package. Further evidence is required to show that the proposed packages can be stacked 6 high.

The non-fixed surface contamination of a waste package is limited by the transport regulations. Tritium from the calandria material could cause the radiological surface contamination limits to be breached. RSRL has suggested a plastic overpack as a potential solution to surface contamination issues. Water vapour (and hence tritium) can pass through many types of plastic. RSRL needs to show that packages can meet limits on non-fixed surface contamination during the transport period, and that any overpack would be suitably robust.

*Number of packages*

Meeting the required dose rate at 3m from the bare waste in order to allow transport from Winfrith to the store at Harwell in ~2020 could significantly increase the number of packages required. This may not be consistent with RWMD's Disposability Principle 3, which states that proposed waste packages should not unnecessarily or disproportionately consume the resources for geological disposal or disposal system capacity. RSRL should confirm the number of packages that would be manufactured, consistent with meeting RWMD's principles.

*Box design and manufacture*

RSRL has created a specification for the manufacture of a prototype 6 cubic metre concrete box. RWMD supports the need to show that a $6m^3$ concrete box with suitable characteristics can be manufactured and emphasizes that RSRL should evaluate the performance of the prototype (for example, uniform shielding requirements, no stress-induced cracking, concrete strength).

The following issues have been identified for specific development:

- The type of plasticiser to be used in prototype manufacture has been specified as SikaPlast 12RM. No further information is available regarding the chemical composition of SikaPlast 12RM. There is a possibility that superplasticisers may degrade to form chelating agents which could lead to the increased solubility and unacceptable mobility of radionuclides at a GDF in the post-closure phase. RSRL is recommended to liaise with RWMD on the issue of superplasticisers, to confirm that the performance of the superplasticiser used in the prototype box manufacture (SikaPlast 12RM) is consistent with current plans.
- Revised box drawings have not yet been prepared. RSRL should provide detailed design drawings and full manufacturing specifications of the $6m^3$ concrete box, defining the concrete formulation to be used for the standard

density and high density concrete box. The precise concrete formulation to be used for the standard density and high density concrete will also need to be defined. In addition, the surface finish for the cold joint between the box and the lid should be specified.

- Higher strength twistlocks may be required for the $6m^3$ concrete box, as standard twistlock equipment only lifts around 32.5 tonnes. RSRL will need to confirm that a suitable number of twistlocks will hold under a suitable snatch factor and performance of the base twistlocks should also be confirmed. RSRL should consider using interspacers between boxes in store – this gives the option to forklift the packages if needed. RWMD believes that that the original design of twistlock on the WAGR box did not allow for drainage – this could lead to potential issues with ice formation during transport in cold weather. Arrangements should be made during transport to ensure that the twistlocks do not fill up with water, or a drain hole could be added to the twistlock design.

*Quality Management System*

The quality management system being applied to research and development activities is not clearly defined. Once RSRL have confirmed the system under which the SGHWR decommissioning project is being managed, RWMD will make arrangements to perform an audit of how these arrangements are being implemented.

*Package Records*

RSRL needs to ensure realistic and justifiable package inventories are produced, particularly for “Stored ILW”, which is expected to have a contamination related waste inventory as well as the activation product inventory. This is particularly important in showing waste components will comply with LSA-II and fissile material limits. The retention of information relating to these methods and their justification is best ensured through a methodology statement. The methodology should provide information on assay methods, uncertainties and their justification.

## Conclusions

The proposed encapsulation of SGHWR decommissioning ILW within $6m^3$ concrete boxes has been assessed. This assessment report has concluded that packages containing SGHWR decommissioning ILW within $6m^3$ concrete boxes are currently not consistent with disposal under the geological disposal concept. Further evidence is required to support an Interim stage LoC, particularly with respect to wasteform stability, transport system compliance and box manufacture.

This assessment report has been prepared by RWMD to highlight the additional information required in a future submission from RSRL for the packaging of SGHWR decommissioning ILW. Eight Action Points are outstanding from the previous conceptual stage assessment for the use of 2m boxes, and 13 have been raised, to be resolved at the interim assessment stage. A further seven Action Points have been raised for resolution at the final assessment stage.