

## **Packaging of Dounreay Materials Test Reactor (DMTR) Decommissioning ILW in 6m<sup>3</sup> Concrete Boxes (Interim stage)**

### **Summary of Assessment Report**

**Issue date of Assessment Report: 19<sup>th</sup> March 2018**

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## **EXECUTIVE SUMMARY**

### **Background**

Radioactive Waste Management Limited (hereafter RWM) has undertaken an interim stage Disposability Assessment for the proposals by Dounreay Site Restoration Ltd (DSRL) for the packaging of Dounreay Materials Test Reactor (DMTR) Decommissioning ILW in 6m<sup>3</sup> concrete boxes at the Dounreay site.

The objectives of this interim stage assessment of proposals for packages of DMTR decommissioning ILW in 6m<sup>3</sup> concrete boxes are to provide DSRL with:

- An assessment of disposability in accordance with the Joint Regulators' Guidance to Industry
- Supporting advice on disposability of DMTR decommissioning ILW in 6m<sup>3</sup> concrete boxes in the form of an Assessment Report
- Where appropriate, endorsement of the proposals via issue of a Letter of Compliance (LoC).

Further information on the Disposability Assessment process is available elsewhere<sup>1</sup>.

DSRL has not made any previous submissions related to the packaging of decommissioning ILW from DMTR; however, Research Sites Restoration Ltd (RSRL), now part of Magnox Ltd, made a successful Conceptual stage submission for the same type of reactor, named PLUTO, on the Harwell site in 2014. DSRL has cited this submission and attempted to address the relevant interim stage action points in its submission.

### **Reference Basis for Assessment and Endorsement**

The Disposability Assessment process considers the compatibility of the proposed packages with the requirements for safe long-term management, including interim storage at the site of arising, transport, emplacement and potentially extended storage underground, and disposal. The current reference basis for such an assessment is the documented disposal system concept and safety case for a Geological Disposal Facility (GDF) derived from the generic Disposal System Safety Case (DSSC). It should be noted that this assessment is completed against the 2010 DSSC but that a revised

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<sup>1</sup> *An Overview of the RWM Disposability Assessment Process, WPS/650/03, April 2014.*

DSSC was completed in 2016 and this is shortly to be implemented by RWM in Disposability Assessments.

Scottish Government policy specifies long-term near surface, near site storage and disposal facilities, so that the waste can be monitored and is retrievable, however the regulators' view is that packages conditioned in anticipation of geological disposal, and assessed under the Disposability Assessment process, will also be suitable for long-term storage in accordance with Government policy in Scotland. Therefore the Disposability assessment process can be applied to Scottish wastes. It should also be noted that reference to geological disposal in this report refers to the assessment basis, not the planned outcome.

The general requirements placed on waste packages for disposal in a GDF are embodied in the Generic Waste Package Specification (GWPS)<sup>2</sup>. Further requirements for particular types of waste package are embodied in the relevant Waste Package Specification (WPS). In the case of the DMTR decommissioning ILW waste packages, the relevant WPS is that for packages based on the 6m<sup>3</sup> concrete box (WPS/360/03).

### **Scope of the Assessment**

The Dounreay Materials Test Reactor (DMTR) was an experimental reactor at Dounreay, Scotland, that was mainly used for fuel testing and sample activation experiments. Final decommissioning of DMTR is expected to start around 2018, with all the Intermediate Level Waste (ILW) to be removed and packaged into normal density 6m<sup>3</sup> Concrete Boxes. These wastes, which are the subject of the submission, constitute stream 5B310 in the 2016 UK Radioactive Waste Inventory (UKRWI).

### **Packaging Process**

#### **Nature of the Waste**

The ILW arising from decommissioning of the DMTR reactor is all solid waste consisting of irradiated graphite, carbon and stainless steels, aluminium, cadmium and lead. There is expected to be negligible fissile material within the waste. The DSRL submission states that the DMTR decommissioning ILW waste occupies 7.6m<sup>3</sup>.

#### **Waste Processing and Packaging**

DSRL proposes to carry out the decommissioning of DMTR by systematic dismantling from the top of the reactor. Any heavy or large components will be size-reduced for removal and packaging but there is currently no process identified for the packaging of the particulate material (fines) produced by these size-reduction activities.

Waste removed from DMTR would be loaded into 6m<sup>3</sup> concrete boxes located on the ground floor of the reactor building. Large items would be located in position with box furniture with smaller items including graphite, contained within baskets.

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<sup>2</sup> NDA, *Generic Waste Package Specification*, NDA Report NDA/RWMD/067, March 2012.

The loaded 6m<sup>3</sup> concrete box would be filled with grout and allowed to cure in the reactor building. The grout formulation to be used for encapsulation of the DMTR decommissioning ILW would be a standard grout formulation of 3:1 Pulverised Fuel Ash /Ordinary Portland Cement, w/s 0.42). Following this a reinforcement mat would be added and a concrete lid cast onto the box.

DSRL is proposing to transfer the completed packages into a new 100 year design life unshielded waste store on the Dounreay site.

### **Assessment Inventory and Number of Packages**

Assessment inventories for the proposed packages have been generated by DSRL based on estimating the mass of components from dimensions on engineering drawings and radionuclide analysis campaigns conducted in 2006 and 2008, based on samples obtained by coring into the reactor in 2004. The results from this sampling have been compared with activation modelling, carried out in 1993 and updated in 1998. The modelling was based on the neutron fluxes estimated from the known irradiation history of the reactor components over its 11 years of operation from May 1958 to May 1969, and associated radioactive decay calculations.

Each component type would have its own associated fingerprint in Bq/g, derived from the sampling measurements, which would be applied to the waste item. This fingerprint would be combined with the mass of the component, estimated from the engineering drawings, to derive an activity in Bq. The inventories of individual waste items will be summed to provide a total radionuclide inventory for each of the packages.

The DMTR decommissioning ILW is expected to be accommodated in four 6m<sup>3</sup> concrete boxes.

### **Assessment of Disposability**

#### **Waste Package Properties and Performance**

The 6m<sup>3</sup> concrete box design is based on the original WAGR box design, as modified by DSRL and subsequently by Magnox, the latter now being the Design Authority for the box. The boxes to be used for packaging DMTR decommissioning ILWs are to be manufactured to the Magnox specification and this specification has been assumed. Aspects of the design are currently subject to re-design, so a full evaluation of the developed package has not been undertaken at this time.

DSRL provided an assessment in the submission indicating that the long term performance of the wasteform and waste package is not expected to be affected by expansive corrosion of the metal waste. Impact release fractions in potential accident scenarios have been generated based on that expectation. The DSRL assessment assumes that the aluminium component of the waste will be distributed across the four boxes to manage potential expansive aluminium corrosion. RWM further supports DSRL pursuing the possible option of separating the aluminium and decay storing for management as LLW.

### **Compatibility with Specifications**

At the Interim assessment stage it is necessary to demonstrate the compliance of the proposed packages with the appropriate Waste Package Specification. This assessment indicates that the packages comply with the requirements of the Generic Specification for Low Heat-generating Wastes, and are expected to meet the Waste Package Specification for the 6m<sup>3</sup> concrete box (WPS/360/03). However, further information will be required prior to Interim stage endorsement on a number of requirements.

### **Compliance with the Transport System Design and Safety Case**

RWM has confidence that the proposed packages would be compliant with the IAEA Transport Regulations, in particular the limits placed upon the radionuclide content, specific activity, homogeneity, dose rates, pressurisation under normal conditions of transport, fissile content, dangerous materials and surface contamination. The Low Specific Activity (LSA) of the wastes should allow their transport as Industrial Packages Type 2.

This level of confidence is sufficient for Conceptual stage endorsement. However, further information would be required prior to endorsement at Interim stage.

### **Compliance with Engineering Design and the Operational Safety Case**

A preliminary assessment of operational safety has been performed, based on an initial review of the likely faults and hazards for the preferred disposal concept for these packages.

The impact performance of the waste packages is in general considered to be acceptable, although recent finite element modelling undertaken for Magnox has indicated that there could be significant lid detachment in a severe lid edge drop. Magnox and RWM are considering design mitigations against this possibility at the current time.

### **Compliance with the Environmental Safety Case**

It is expected that the use of the 6m<sup>3</sup> concrete box for DMTR decommissioning ILW would be consistent with meeting the GDF Environmental Safety requirements as currently foreseen by RWM. There are no radionuclides identified in the DMTR decommissioning ILW that challenge the inventory assumptions used in the generic Post-Closure Safety Assessment for the groundwater or gas pathways.

In addition, the waste contains relatively large quantities of the chemo-toxic materials cadmium and lead. However, the amounts of these materials in the waste are small percentages of that considered in the overall inventory for disposal. Nevertheless, DSRL should note that RWM is currently undertaking ongoing work on chemo-toxics, which may influence future assessments; this is reflected in the presence of lead and cadmium being identified as a potentially significant risk to the disposability of these waste packages.

### **Status of Management System and Data Recording**

The submission contains a draft Waste Product Specification (WPrS), a draft Package Record Specification (PRS) and a draft Data Recording Methodology (DRM). DSRL has not supplied draft Criticality Compliance Assurance

Documentation (CCAD). The submitted documents are considered to be largely consistent with endorsement at Interim stage, although advice on further development has been provided.

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

The assessment has identified a number of issues that would currently preclude endorsement of the proposed packages at the Interim stage, as was requested by DSRL. These primarily result from the need to complete the development of the container design and to fully establish its expected performance.

### **Requirements for Further Work**

The key technical areas where further development work is required are:

- Demonstration of the ability to manufacture a 6m<sup>3</sup> concrete box.
- Resolution of the issues around the impact performance of the box and lid.
- Demonstration that the waste encapsulation grout will successfully infill the waste in the 6m<sup>3</sup> concrete box, including any fines generated by the size reduction process.
- Demonstration of the ability to manufacture a 6m<sup>3</sup> concrete box lid at DMTR.

The first two of these are the responsibility of Magnox, however they will require resolution before the current proposals can be endorsed at interim stage and therefore represents a significant risk to DSRL.

### ***Conclusions***

Based on the conclusions of the Assessment of Disposability, it has been determined that the proposed packages should not be endorsed at the Interim stage, as there are significant compliance gaps in meeting RWM requirements. However, RWM is able to provide endorsement of the proposals at the Conceptual stage through a letter of compliance.

Related to the nine Compliance Gaps identified by the assessment, 15 Interim stage Action Points have been raised for resolution by DSRL, to allow endorsement of packages at Interim assessment stage by RWM. In addition, four Final Stage Actions Points are identified.

RWM also recommends that DSRL continue to investigate the option of separating the aluminium from the waste stream with the aim of decay storing it to LLW at the Dounreay site as this would remove the risk to the package integrity from hydrogen gas and, more importantly, the potential expansive aluminium corrosion product.

In summary, the greatest risk to the disposability case for DMTR decommissioning ILW waste packages is that the design and manufacture by Magnox of the 6m<sup>3</sup> concrete box does not meet RWM requirements. RWM would re-iterate that DSRL needs to ensure it maintains an on-going dialogue with Magnox to ensure it is fully appraised of progress with the issues around the box as summarised in the report.

Finally, a significant risk is recorded against the Conceptual LoC in respect of lead and cadmium. These two metals are listed as hazardous materials within the EU groundwater directive. Their acceptability for disposal in the GDF ultimately will be subject to the successful completion of ongoing work by RWM.