

RIPPLE I - X and Large Sources (Final stage)

Summary of Assessment Report

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Introduction

Research Sites Restoration Ltd (RSRL) has requested a Final stage Letter of Compliance for the grout encapsulation of 18 discrete sealed sources (including RIPPLE^[1] generator X) into four 3m³ boxes. A further nine 500-litre drums would be produced from the grout encapsulation of RIPPLE generators I – IX. This Assessment Report provides the basis and findings of the Final stage disposability assessment performed by NDA Radioactive Waste Management Directorate (RWMD). The assessment has been carried out through the Disposability Assessment process, whereby RWMD examines the compatibility of the proposed packages with the requirements for safe long-term management, including storage, transport, emplacement and extended storage underground, and disposal, as currently expressed for the reference ILW Concept. This concept has been developed as part of the programme to implement geological disposal for the UK's higher activity wastes. Further information on the Letter of Compliance process is available elsewhere ^[2].

Scope

Harwell stores a number of sealed sources (including the RIPPLE generators as well as teletherapy and other radiotherapy units) which contain high activity levels of Cs-137, Sr-90 or Co-60. The waste to be packaged comprises 27 discrete sealed sources (10 RIPPLE generators and 17 Large Sources), contained within the original shielded transport packages.

¹ RIPPLE is understood to be an acronym of Radioactive Isotope Powered Prolonged Life Equipment.

² NDA, *Guide to the Letter of Compliance Process*, NDA Document WPS/650, March 2008

The following wastes are encompassed by this assessment:



Various Ripple Generators of Type I to IX

RIPPLE I - IX

The RIPPLE (Radio-Isotope Powered Prolonged Life Equipment) project was established in 1963 by the Applied Physics Division of the UKAEA Atomic Energy Research Establishment at Harwell to produce thermoelectric generators suitable for uses such as powering navigation buoy lights and radio-direction equipment. A total of 10 RIPPLE generators (I – X) were built to seven basic designs. RIPPLE generators I – IX are small enough to fit into 500 litre drums. The power sources for the RIPPLE generators consist of sealed sources of Sr90 (in the form of strontium titanate pellets) encapsulated within two high-integrity, hermitically sealed containers. Over 99% of the total waste mass comprises radiation shielding

components. The shielding for generators I – III comprised steel and brass. Depleted uranium shielding is only present in RIPPLEs IV – IX, and is encased in steel of thickness from 8 mm – 60 mm.

RIPPLE X

The RIPPLE X generator, which is slightly too large to fit in a 500 litre drum, is part of the 5C33 wastestream (Harwell Contact Handled ILW, 2010 UK Radioactive Waste Inventory).

RIPPLE X is of a completely unique design and represented the first of a second-generation of generators, which never progressed beyond the one unit. The generator has a mass of 1500kg and consists of twelve individual sealed sources of Sr90, in the form of strontium titanate pellets, encapsulated within high integrity, hermetically sealed containers.



Ripple X Generator

Large Sources

The National Disposal Service (NDS) collected unwanted sources from UK minor waste producers for transfer to Harwell for management. Seventeen of these sources are included in the current packaging proposal, and are understood to be part of the 6C31 wastestream (NDS Contact Handled ILW, 2010 UK Radioactive Waste Inventory). The radioactive nature of the sources is believed to be Co60, Cs137 and Sr90, but the chemical nature of the source material itself is not known. The shielding around the sources may be steel,

lead or depleted uranium (DU). For some sources, the shielding material is not recorded.

The sources themselves are stored within their transport packaging, although their certification is now lapsed. Each source transport container is different in design. Due to the origin of these sources, detailed design drawings of the source containers are not available. Examples of some of the sources are shown below.



Examples of Large Sources

Available information is often limited to the source activity, and measurable physical quantities such as mass and dimensions.

Waste packaging proposal

Two package designs are proposed.

RIPPLE I - IX

RIPPLE generators I – IX would be grouted into nine 500 litre drums (one generator per drum) using a mobile grouting plant. Furniture would be placed in the bottom of each drum to ensure centralised placement of the generator. The proposed grout is 3:1PFA/OPC, with a water to solids ratio of 0.42. The completed packages would be monitored and decontaminated as required before transfer to the vault store.

RIPPLE X and Large Sources

RSRL has obtained four side-lifting 3m³ boxes that were originally manufactured in 2004 for Berkeley power station. RSRL intends to package the RIPPLE X generator and the Large Sources into these boxes without the removal of shielding, by wrapping the sources in sacrificial harnesses and lifting them into a 3m³ box. The 3m³ box would then be filled with 3:1 Pulverised Fuel Ash/Ordinary Portland Cement (with a water to solids ratio of 0.42) using a mobile grouting plant. The completed package would be monitored and decontaminated if required and would be protected using non-chloride plastic tents designed to minimise surface contamination with chloride. They would be stored in a controlled area awaiting transport for disposal in a GDF.

Parameters for Assessment of Disposability

Assessment Inventories

Previous assessment inventories for the proposed packages have been checked for suitability based on the information provided in the submission and additional information provided by RSRL. Previous assessment inventories are judged to be sufficiently bounding.

Waste Package Properties and Performance

The completed 500 litre drums and 3m³ boxes are expected to meet RWMD requirements as defined in the appropriate Waste Packaging Specifications³.

Assessment of Disposability

RIPPLE I - IX

The packing of RIPPLE generators I – IX has previously been endorsed at Final stage by comparison with the safety assessments performed for Harwell RHILW⁴. The current packaging proposals do not affect the previously endorsed inventory or accident release fractions, which were found to be acceptable in 2010⁵. No further Assessment of Disposability calculations were required for this waste.

Transport Safety Assessment- RIPPLE X and Large Sources

The assessments of Transport Safety show that it should be possible for packages containing RIPPLE generator X and Large Sources to comply with all relevant criteria if transported in the SWTC-70, subject to meeting the requirements for external dose rates from the transport package.

Operational Safety Assessment - RIPPLE X and Large Sources

Numerical targets representing the boundary between the intolerable and tolerable regions for doses are defined as Basic Safety Levels (BSLs) by the Health and Safety Executive. The impact, fire and contamination re-suspension accident performance of this waste/container combination is acceptable, with the worst case doses (for fire accidents) being well below the most stringent BSLs. Radioactive gas generation is insignificant and there are no chemotoxicity issues associated with the waste.

Doses to operators during normal operations appear to be acceptable when considered in isolation, but will need to be considered in conjunction with other wastes and operations that may be required during the period of their emplacement in a GDF. Additional dose reduction measures (e.g. use of SWTC-285) could be considered for the waste package vault emplacement operations to demonstrate that routine worker doses would be ALARP.

Post-closure Safety Assessment - RIPPLE X and Large Sources

The potential significance of the proposed packages has been assessed by comparison with the baseline total inventory of waste to be disposed of as UILW. The assessment of GDF Post-closure Safety shows that packages containing RIPPLE generators and Large Sources would have a negligible effect on the Environmental Safety Cases for the GDF.

³ NDA RWMD, *Waste Package Specification for 500 litre drum waste packages*, WPS/300, 2013 and NDA RWMD, *Waste Package Specification for side lifting variant of 3 cubic metre Box waste packages*, WPS/310, 2013

⁴ RWMD, *Extension of Final stage Letter of Compliance for the Packing of Harwell RHILW to include RIPPLE generators I – IX*, LOC/11881354, 9 March 2010

⁵ RWMD, *Packaging of Remote Handled ILW in Harwell Waste Encapsulation Plant (progress towards Final Stage)*, September 2010, LL12710362

Storage Conditions

The environmental conditions of the proposed storage areas for boxes and drums are controlled to achieve a temperature of 16-18°C. The relative humidity is normally 60-80%. RSRL will protect the boxes containing RIPPLE X and Large Sources waste with low-chloride plastic tenting to minimise surface contamination with chloride during storage.

Every year, two drums will be randomly selected for inspection. One 3m³ box will be inspected every ten years. Package inspection will cover radiological contamination, chloride contamination, dents, damage, protrusions and pitting that could indicate corrosion. The results of the inspection will be included in the package records. Abnormal results will be reported to the Waste Product Manager for investigation.

Package Records

RSRL has provided a suitable list of the documents that will form the package record, including information that would be generated during the encapsulation and storage of the waste. RWMD aims to audit the package records for RIPPLE I – X and Large Sources in 2014.

The long-term plans for package record retention are not well developed. RSRL plan to review the format and location of the package records within the next five years.

Statement of Disposability

The assessment of the submission has not identified any issues that would preclude issue of a Final LoC for waste packages containing RIPPLE I – X and Large Sources. As such, there are no Action Points identified.

However, the following compliance gap has been identified:

- Compliance Gap 1: The long-term plans for package record retention are not well developed.

RWMD considers it appropriate to manage the requirements related to this compliance gap as a Qualification to the Final stage LoC, and this is recorded in the formal endorsement.

Conclusions

The conclusion of the assessment is that the packaging of RIPPLE generators and Large Sources is compatible with the requirements we see as necessary for transport, handling and disposal.

RWMD has therefore provided Final stage endorsement of the waste packages, via LOC/20458763 Issue 1, with one Qualification expressed as a condition - 'RSRL should develop the plans for long term management and storage of Package Records, aiming to store the package records as consolidated, co-located sets. RWMD anticipates removal of the LoC Condition via re-issue of the LoC following technical audit.'