

Packaging of Site-Wide ILW at VULCAN Nuclear Reactor Test Establishment (Conceptual stage)

Summary of Assessment Report

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Introduction

Babcock Ltd, on behalf of the Ministry of Defence (MoD) has sought Conceptual stage endorsement of proposals for the packaging of site-wide Intermediate Level Waste (ILW) at the VULCAN Nuclear Reactor Test Establishment (NRTE) site. The wastes are identified in the 2010 UK Radioactive Waste Inventory by the waste streams 7V24 (metallic ILW from VULCAN) and 7V25 (resin from decontamination operations).

This Assessment Report provides the basis and findings of the Conceptual stage disposability assessment by NDA Radioactive Waste Management Directorate (hereafter RWMD) for packages of site-wide ILW. The assessment has been carried out through the Disposability Assessment process, whereby RWMD examines the disposability of proposed waste packages by assessment against the most appropriate standards and specifications, in this assessment: WPS/350/02 (the 2 metre box waste package) and WPS/300/02 (the 500l drum waste package, representing the TRU-Shield® drum for which no specification currently exists), and the reference ILW disposal 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 elsewhere¹.

Nature of Waste

The VULCAN site houses two facilities: the Dounreay Submarine Prototype 1 and the Shore Test Facility. These were used for testing next generation nuclear plants and reactor cores for the Royal Navy. The bulk solid reactor wastes that cannot be sentenced as Low Level Waste are included in this proposal. Each of the facilities has an associated pond for interim storage of used fuel (subsequently transferred to Sellafield Ltd) and associated waste items; the latter only are included in this submission as discrete solid pond waste. Both of these wastes are described in the UK Radioactive Waste Inventory by the waste stream 7V24. The submission also includes ion exchange resin, as described by the waste stream 7V25. Ion exchange material was used for maintaining coolant contamination at minimum levels in the reactor primary circuits, during decontamination of the reactor primary circuit and reactor internals and for maintaining the water quality in the ponds.

Waste packaging proposal and scope of assessment

It is proposed that bulk solid reactor wastes would be size-reduced and packaged by encapsulation in cement grout in 2 metre boxes fitted with internal shielding. The discrete solid pond wastes would be size-reduced as required, drained and packaged in TRU-Shield drums, incorporating integral lead shielding. These wastes would be encapsulated in polymer resin. The ion exchange resins are proposed to be retrieved from their current storage container as pumpable water slurry and mixed with a cement powder to form a homogenous

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

wasteform in 200 litre steel drums. These drums would be packed, ungrouted, in a single 2 metre box with no internal shielding.

Outcome of assessment

Compliance with Waste Package Specification

Bulk solid reactor wastes

The disposability assessment identified a compliance gap for the packaging proposal of bulk solid reactor wastes. The external dose rates at 2040 were shown to exceed the transport limit, as defined by the IAEA Transport Regulations, of 0.1 mSv/h at 1 metre from the transport package. The external dose rates at 3 metres from the bare waste at 2040 were also shown to exceed the limit required to meet the conditions for transporting wastes as Low Specific Activity (10 mSv/h) for the maximum inventory package.

Both decay storage and increased shielding in the waste package could be adopted to reduce the external dose rates. Increased shielding from 200mm to 300mm of high density concrete would reduce the available volume for packaging waste to the extent that alternative waste packaging options may be required. The conditions for transporting these wastes as Low Specific Activity would also not be met for the maximum inventory package. Decay storage to 2064 would allow these wastes to be transported to a Geological Disposal Facility with no other changes to the packaging proposal. RWMD considers this to be acceptable for endorsement at the Conceptual stage, with decay storage to meet the IAEA external dose rate regulations for transport. The waste packager should consider whether appropriate safety cases can be made for interim transport if applicable and interim storage.

Discrete solid pond wastes

The packaging proposal for discrete solid pond wastes includes the use of TRU-Shield drums. These drums are not currently part of the Geological Disposal Concept and therefore compliance with the Waste Package Specification was assessed against the closest analogy available, namely the 500 litre drum. The disposability assessment identified several compliance gaps. The assessment was not able to quantify the accident performance of the waste package during the operational period of a Geological Disposal based on the submission data. The assessment was also not able to assess the stacking load against requirements, from the submission data. The TRU-Shield drum is handled using an integral pallet mounted at the base. As such the TRU-Shield design is also non-complaint with the current drum grab arrangement via the underside of the lid. Progress is being made by the TRU-Shield drum manufacturer in each of these areas, but compliance has yet to be demonstrated.

The Waste Package Specification also places demands on the properties of the wasteform to maximise containment of radioactivity. The physical nature of the pond wastes leads to some possibly significant uncertainties in terms of voidage and immobilisation of particulate. In particular, the particulate in the waste bags of the underwater suction cleaners are proposed not to be immobilised and hence would not comply with RWMD's requirements. The waste packager would also need to demonstrate that the Zircaloy swarf would not introduce a pyrophoric hazard to a Geological Disposal Facility.

Ion exchange resin wastes

The disposability assessment identified compliance gaps for the packaging proposal of ion exchange resin wastes. The external dose rates were shown to exceed the transport limit of 0.1 mSv/h at 1 metre from the transport package. This limit is also used as an external dose rate limit for routine operational handling of transport packages at a Geological Disposal Facility. The assessment also calculated high dose consequences from potential accident fault scenarios involving fires at a Geological Disposal Facility.

Each of the issues may be potentially resolved by the inclusion of concrete internal shielding within the 2 metre box. The required thickness and density of shielding would be subject to adequate demonstration that external dose rates would be reduced to ALARP levels both for interim storage and subsequent transport to a Geological Disposal Facility. Scoping calculations suggest that the IAEA transport limits could be met at 2040 through the use of 100mm of normal or high density shielding. Alternatively, a similar approach to that used for bulk solid reactor wastes, namely decay storage, could be adopted. RWMD prefers the use of additional shielding because of the reduction in routine dose rates and the potential for significantly improved fire accident performance. With the addition of internal shielding, the packaging proposal for ion exchange resin wastes is considered to be compliant with RWMD requirements and suitable for endorsement at the Conceptual stage.

The wasteform in this proposal comprises of unimmobilised drums of cemented waste in a 2 metre box. The use of internal furniture or even grouting of these drums is recommended to fully immobilise waste and to ensure movement of the drums does not contribute negatively to the impact performance or handling, through shifting loads, of the waste package at a Geological Disposal Facility.

Compliance with concepts for a Geological Disposal Facility

The TRU-Shield drum is not currently included within the RWMD concept for the disposal of higher activity waste. RWMD has initiated the concept change control process to consider whether these drums can and should be included in the Geological Disposal Concept. As part of this process, characterisation of the operational handling and accident performance of the TRU-Shield drum is needed, under the conditions defined by the concept. Despite this, it should be noted that inclusion of the TRU-Shield drum to the concept this does not guarantee acceptance of the waste packaging proposal, taking advice from our Nuclear Safety and Environment Committee into account regarding the number of TRU-Shield drums being proposed. The waste packager is advised to consider whether the TRU-Shield drum represents the Best Available Technique and demonstrate this to RWMD.

Statement of disposability

RWMD is able to endorse the proposal to package bulk solid reactor wastes at Conceptual stage, subject to decay storage until the criteria of LSA II wastes, including the external dose rates limits of the IAEA Transport Regulations, are met. This is calculated to be 2064. The waste packager should consider whether appropriate safety cases can be made for interim transport if applicable and interim storage.

RWMD is able to endorse the proposal to package ion exchange resin at Conceptual stage, subject to the inclusion of concrete internal shielding to the 2 metre box waste package (the thickness and density of the shielding to be justified by the waste packager at the Interim stage).

Conclusions

With the use of appropriate internal shielding on the 2 metre boxes, the assessment concludes that the ion exchange resin wastes raise no major disposability issues. With appropriate decay storage, the assessment concludes that the bulk solid reactor wastes also raises no major disposability issues. Further work is required to develop the packaging processes for both of these wastes at the Interim stage, as outlined in the disposability assessment report. The packaging proposals for the discrete solid pond wastes are not endorsed at the Conceptual stage. The TRU-Shield drum is not currently included in the concept for disposal of higher activity waste and was assessed against the Waste Package Specification of the closest analogy: the 500 litre drum. Compliance gaps were identified with the physical nature of the drum, namely the mass limits, lifting features, stackability and identification. These may be resolved through development of a specific Waste Package Specification if the TRU-Shield drum is included in the concept. Further work would be needed to demonstrate the accident performance of the package to fault conditions at a

Geological Disposal Facility. Further work would also be needed to demonstrate the immobilisation of the wasteform and safety against pyrophoric hazards.