

Ammonium Diuranate Floc waste (Interim stage)

Summary of Assessment Report

Issue date of Assessment Report: 31 March 2014

Introduction

Dounreay Site Restoration Ltd (DSRL) has sought Interim stage endorsement of proposals for the packaging of Ammonium Diuranate (ADU) floc wastes.

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 ADU floc waste. The assessment has been carried out through the Disposability Assessment process, whereby RWMD examines the compatibility of the proposed waste packages with the requirements for safe long-term management, including storage, transport, emplacement and extended storage underground, and disposal, as currently expressed for the Illustrative Geological Disposal Concepts for Intermediate Level Waste and Low Level Waste (ILW/LLW). The illustrative concepts have been developed as part of the programme to implement a Geological Disposal Facility (GDF) for the UK's higher activity wastes. Further information on the Letter of Compliance process is available elsewhere¹.

It is noted that since the ADU floc is a Scottish waste, subject to current Scottish Government Policy on radioactive waste disposal, the waste packages would be stored near to an existing facility with the intention of possible disposal to a near surface facility. The Regulators have concluded that assessment for disposal in a GDF is consistent with the requirements for disposal of Scottish waste.

Background

The Dounreay Lifetime Plan includes development of a stand-alone facility for cementation of ADU floc as part of the site plans for packaging remote-handled ILW. This Assessment Report is based on information submitted by DSRL in support of this work, contained in a proposal for conditioning ADU floc by cementation into 500 litre drums. DSRL developed the current Interim stage submission from a waste management option for conditioning the ADU floc by conversion to sodium diuranate followed by cementation, which gained Conceptual stage endorsement in 2007.

Waste packaging proposal and scope of assessment

ADU floc wastes originate from the treatment of medium and low activity, alpha contaminated, liquid waste streams arising from reprocessing of Dounreay Prototype Fast Reactor (PFR) reactor fuel and breeder material. The ADU floc, comprising the whole of UK Radioactive Waste Inventory (RWI) waste stream 5B22, is currently

¹ NDA, *Waste Package Specification and Guidance Documentation: WPS/650 Guide to the Letter of Compliance Assessment Process*, WPS/650/02, March 2008.

stored in settling tanks on the Dounreay site. Packaging of ADU floc and ADU settling tank washings is expected to result in 720 off 500 litre drum waste packages.

ADU floc would be re-suspended from settled floc held in settling tanks and transferred in large batches to a tank where the floc would be retained in suspension using the tank recirculation arrangement. The floc would be solubilised, using concentrated nitric acid, to produce a fully homogenised starting material which could be representatively sampled, accurately decanted and conditioned. At this point sampling and confirmatory analysis would be undertaken followed by any adjustments required to meet the waste envelope developed by DSRL through active and inactive trials. The ADU floc settling tanks at Dounreay are estimated to contain 164m³ of floc. Following ADU floc removal the tanks would be washed with nitric acid producing a further, smaller volume of nitric acid tank washings for conditioning by the same process.

A fixed volume of the acidified floc would be transferred to a reaction vessel and neutralised with sodium hydroxide, releasing ammonia gas and converting the uranium to insoluble sodium diuranate. The resultant slurry would then be transferred to a sentencing tank.

A fixed volume of the sodium diuranate slurry would be dispensed from the sentencing tank to a 500 litre D3900 MkII liquids design drum. Cement powders would be added and mixed using a lost paddle arrangement. The wasteforms would then be allowed to cure before lidding of the drum and interim storage in an as yet unspecified storage facility on the Dounreay site.

Outcome of assessment

Interim stage inventory development for the waste was supported with specific studies and supporting analysis and concluded to be acceptable.

Wasteform envelope development was based on suitably underpinned research work, including the use of both simulants and retrieved floc samples, and was considered robust for the ADU floc and settling tank washings.

Performance of the proposed ADU floc waste packages in fire and impact accident conditions was assessed as acceptable using modelling of the D3900 MkII liquids drum with no capping grout layer. In modelled impact accidents the inner and outer lid arrangement of the drum provided a safety function analogous to the capping grout layer, preventing release of particulates and providing RWMD with confidence that omission of a capping grout layer would be acceptable in this case.

It was concluded that evolution of the ADU floc waste packages would not be expected significantly to affect the package properties and performance, or their continued compliance with the waste package specifications (WPS) for 500 litre drum waste packages.

The Quality management system arrangements for the Interim stage development work were audited and considered satisfactory. The proposal included a draft waste package Data Recording Methodology (DRM), Waste Product Specification (WPrS) and Criticality Compliance Assurance Documentation (CCAD). These will need further development to support data acquisition and quality management arrangements for a future ADU floc packaging facility.

Compliance with concepts for a Geological Disposal Facility

The transport safety assessment was based on waste packages 4 to a stillage in an appropriately shielded Standard Waste Transport Container (SWTC). The average and maximum waste packages at 2040 meet the WPS dose rate criterion; 0.1mSv/h

at 1 metre from the surface of a SWTC-285, where the SWTC-285 is modelled as a 280mm steel shield with density of 7700kg/m^3 , in direct contact with a waste package. The waste packages are therefore consistent with IAEA Transport Regulation dose rate requirements for transport as a Type B package at 2040. Safety performance in normal and accident conditions of transport was predicted to meet regulatory requirements. RWMD concludes that the proposal to package ADU floc wastes is consistent with the current transport system design and with the basis of the transport safety case.

Design Basis Accident analysis (DBA) was used to estimate radiation doses to operatives and the public arising from fire and impact accident scenarios during the operational phase of the GDF. Most impact scenarios resulted in predicted doses to the public and to operators within the basic safety objectives (BSO), with all of them falling below the lowest basic safety levels (BSL). This represents an acceptable safety outcome at this stage of GDF development. Release of iodine-129 (I-129) in fire accident scenarios was predicted to result in public dose at a level above the lowest BSL. However, RWMD concluded that resolution of pessimistic assumptions including DBA fire duration and release fraction for I-129 were likely to result in public doses near or below BSO, which would therefore be acceptable. Estimates of doses to the public resulting from normal GDF operations also meet regulatory requirements. On this basis RWMD concludes that the overall GDF operational performance of the packages was acceptable and consistent with the Operational Safety Case.

The cementitious ADU floc wasteform has a high Ordinary Portland Cement content and therefore would be compatible with the high pH backfill and likely to contribute to the near-field performance. RWMD concludes that, in this respect, the ADU floc waste packages would be compatible with disposal in the current GDF concept. Risk from radioactive gases in the gas pathway is considered to be low. Organic content is low and RWMD concluded it unlikely to have significant consequences for radionuclide mobility in the groundwater pathway. Although an increase to the Interim stage I-129 inventory compared to the UK RWI and the Conceptual stage inventory represented an additional annual post-closure risk, it does not challenge the overall annual individual risk guidance level of $1\text{E-}06$ and is acceptable on this basis. The risk associated with I-129 would be likely to be much reduced for ILW disposal concepts in sedimentary and evaporate geologies, which exhibit lower groundwater flux and higher retention times. Overall, RWMD concludes that the ADU floc waste packaging proposal is consistent with the basis of the Environmental Safety Case.

DSRL provided a proposed safe fissile mass (SFM) for the ADU floc waste packages supported by a criticality argument based on calculations and values in the generic Criticality Safety Assessment (CSA) for Irradiated Natural Uranium (INU). Although ADU floc is not INU nor is it derived from INU, the isotopic proportions of fissile radionuclides in the ADU floc are within the range found in INU and so RWMD accepts that the generic CSA for INU can be used to justify the Safe Fissile Mass (SFM) for the ADU floc waste packages. Additionally, since the wasteform will be highly homogeneous, RWMD concludes that the upper screening limits would apply which means that the proposed ADU floc waste packages would meet criticality safety requirements for transport, operational and post-closure phases.

Overall the safety consequences of transport, storage and disposal of ADU floc waste packages in a GDF are concluded to be consistent with the requirements of the generic DSSC.

Compliance with the Waste Package Specification

The ADU floc waste packages were assessed for compliance against WPS/300, in the context of waste packaging requirements at Interim LoC stage. The packaging

proposals demonstrated a high level of compliance with WPS/300 requirements, with further development, associated with QMS and package data and information recording, required as the ADU project develops. This is discussed further in the following paragraphs.

The location, storage conditions and monitoring arrangements for interim storage of ADU floc waste packages were not available at Interim stage. However, because DSRL has significant experience in developing and running storage facilities for ILW waste products at Dounreay, RWMD has confidence that appropriate arrangements for ADU floc waste packages will be developed.

DSRL plans for ADU floc package data acquisition were presented in a draft Data Recording Methodology (DRM) document containing significant information concerning the parameters they intend to measure and monitor. Such parameters were selected to ensure that the wasteform produced will be compliant with the waste envelope and will form the basis of waste package records. The draft DRM addressed all of the required data classes and overall, RWMD concluded that the DSRL plans for data recording are well advanced and meet Interim stage requirements.

The draft WPrS included parameters the control of which would ensure product quality for ADU floc waste packages. It described the composition, properties and the performance characteristics of ADU floc waste packages, although some aspects need to be finalised. RWMD concludes that WPrS development was consistent with Interim stage requirements.

The draft CCAD included a justification of the SFM, a general discussion of the implication of sampling and analytical errors on compliance with the SFM, and analysis of potential faults. Needing to be finalised as the ADU project progresses further, the draft CCAD meets RWMD Interim stage requirements.

DSRL plans to use the Quality Plan (QP) and work instructions for the Dounreay Cementation Plant (DCP) as a template for the QP and control documents for a future ADU floc cementation plant. A RWMD audit, in January 2014, examined the quality management system documentation for the DCP, which RWMD concludes would provide an acceptable starting point for a QP for the ADU floc cementation plant.

Overall, RWMD concludes that DSRL plans for packaging ADU floc are consistent with WPS requirements at Interim LoC stage.

Statement of disposability

The assessment concluded that the proposed packaging process for ADU floc waste packages, and the data and quality management system plans currently envisaged for the proposed waste packages, are consistent with plans for a Geological Disposal Facility, and so can be endorsed.

Conclusions

The proposals from DSRL for packaging ADU floc wastes from Dounreay settling tanks have been assessed by RWMD. The assessment has concluded that proposals to incorporate treated ADU floc wastes into a cementitious wasteform using the proposed waste envelope are consistent with plans for a Geological Disposal Facility and for disposal under Scottish Government Policy. The shortfalls identified can be addressed through further development at Final Letter of Compliance stage, and so RWMD can endorse the proposals at the Interim stage.