

Packaging of DFR Raffinate

(Interim stage)

Summary of Assessment Report

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Background

Dounreay has brought forward Interim stage proposals for the packaging of the stored raffinate from the reprocessing of driver fuel from the Dounreay Fast Reactor (DFR). These proposals build upon and supersede the Conceptual stage submission put forward, and endorsed, in 1999. It is now proposed that the raffinate should be packaged in the new Immobilisation and Encapsulation Plant, rather than in the Dounreay Cementation Plant.

The Radioactive Waste Management Directorate (RWMD) Letter of Compliance assessment process provides advice on the suitability of proposals for conditioning higher-activity waste in anticipation of geological disposal. Further information on the Letter of Compliance process is available elsewhere¹. The assessment is based on standards derived from the RWMD geological disposal concept, but is also compatible with a range of other possible long-term management options. The regulators' view is that packages conditioned in anticipation of geological disposal, and assessed under the Letter of Compliance process, will also be suitable for long-term storage in accordance with Government policy in Scotland.

In April 2008, Dounreay Site Restoration Limited (DSRL) was formed to become the operator of the Dounreay site. To avoid confusion between past and present operating arrangements, both UKAEA Dounreay and DSRL are referred to in this document as 'Dounreay'.

Scope of the Proposals

DFR raffinate represents one of the more active waste streams stored on the Dounreay site. The waste is currently stored in three tanks on site. A fourth tank contains a mixture DFR raffinate and MTR raffinate and is not included in this assessment.

The waste is in the form of an acidic aqueous solution of dissolved metals in nitric acid. Small quantities of suspended solids are also present, which are likely to contain radionuclides such as strontium-90, caesium-137 and isotopes of plutonium. The proposals also cover the retrieval and packaging of any residual tank heels.

The proposals potentially encompass over 900 packages of homogeneous immobilised waste. This would correspond to approximately 0.3% of the total volume of waste being considered for geological disposal in the UK.

¹ *Guide to the Nirex Letter of Compliance Process*, Nirex Document WPS/650, June 2006.

Packaging proposals

The waste would be packaged using the liquid waste line in the Immobilisation and Encapsulation Plant at Dounreay. The packaging process may be summarised as follows:

- vacuum transfer of raffinate to receipt tanks in batches of about 0.4 m³;
- sampling to establish inventory and neutralisation requirements and to confirm compliance with the Waste Product Specification (WPrS);
- transfer to a mixing vessel for neutralisation using NaOH. The liquor would be cooled during neutralisation;
- dispensing of neutralised liquor to 500 litre stainless steel drums for immobilisation using in-drum mixing with 1:1 PFA/OPC powder;
- capping, lidding and storage.

Assessment of Disposability

The acceptability of the proposed packages has been assessed against criteria established within the Geological Disposal concept and associated Generic Waste Package Specification (GWPS).

Inventory: The Assessment of Disposability is based upon the inventory data supplied by Dounreay for DFR raffinate. This data is based on a combination of sampling and analysis with FISPIN modelling of fuel activation in DFR. The waste is currently stored in three tanks, two of which have been sampled to provide the basis for the radionuclide and compositional data presented in the submission. Data for the third tank have been derived by conservative selection from the data pertaining to the other tanks. Sampling and analysis of the third tank is planned prior to the processing of the waste.

Assessment of the submitted information identified a number of unexplained discrepancies between the analytical results and the modelling of DFR fuel. Dounreay believes that around 300 litres of raffinate from the reprocessing of Prototype Fast Reactor fuel may have been transferred into each of the DFR tanks. Efforts are ongoing to ascertain if this hypothesis can be verified.

The presence of unidentified material means that the calculated quantity of plutonium and other radionuclides associated with precipitated solids may be under-estimated by the reported equilibrium calculations. Additionally, the validation of the reported equilibrium calculations through the similarity of the measured quantity of suspended solids and calculated solids loading could be undermined, thereby reducing confidence that the tanks contain little or no settled solids. This potentially undermines all the safety assessments and criticality safety arguments for these waste packages.

Wasteform: Extensive development work has been undertaken by Dounreay to establish the formulation for immobilising the waste, based on both simulants and samples of the actual waste. The process also has been demonstrated at full-scale using simulants of the raffinate liquor stored in the two tanks that have been sampled. This development work provides confidence that a good quality wasteform could be produced by the immobilisation of DFR raffinate in a cement matrix. The expected lower concentration of aluminium in the third tank (due to the absence of MTR raffinate) could result in different setting behaviour. It would not be appropriate to extrapolate from the behaviour of the current simulants to derive the expected behaviour for the third tank.

Sampling and development work on raffinate in the third tank will be undertaken and assessed before the Final stage submission. Active encapsulation trials are due to be undertaken in 2008-9.

Transport Safety: The assessment of transport safety shows that it would be possible for drums of DFR raffinate to comply with all relevant criteria if transported in 285 mm thick walled Type B transport containers such as the Standard Waste Transport Container (SWTC-285). In particular, the modelling of impact and fire behaviour for groups of four packages in an SWTC-285 shows that the criterion of activity released in a week following a transport accident would be met.

Operational Safety: The assessment of operational safety shows that it should be possible for 500 litre Drums containing DFR raffinate to be handled and stored safely within the Geological Disposal Facility.

Post Closure Safety: The potential long-term risk resulting from the disposal of the DFR raffinate has been assessed. Overall, the post-closure assessment revealed no significant issues that would prejudice disposal of packages containing DFR raffinate.

Proposals for the packaging of these wastes cannot be endorsed at the Interim stage until more evidence is provided on the nature and quantity of solids in the waste. During the course of the assessment, areas requiring additional work to progress the proposals to the Interim stage and beyond were identified. These are summarised below.

Requirements for further development work

Interim stage Requirements:

Dounreay should continue their efforts to confirm the provenance of the waste through the identification of all additions to DFR raffinate. The expected solids content of the waste and the fissile loading for each of the tanks should be established with more confidence.

It is noted that sampling and development work, including active encapsulation trials, on raffinate in the third tank are due to be undertaken before the Final stage submission.

The design of the store for wastes from the Immobilisation and Encapsulation Plant is likely to be undertaken prior to a Final stage submission for DFR raffinate. It is important that RWMD guidance for the control of environmental conditions and monitoring of the condition of packages are taken into account in the design process, to ensure package longevity. These issues should be resolved during the design of the store, and are also being tracked through the PFR Raffinate Letter of Compliance process.

Final stage Requirements:

At the Final stage, it is required that the necessary arrangements for the operation of the proposed packaging plant should be agreed and demonstrated through the following:

- demonstration of the satisfactory operation of the completed plant by providing the results of commissioning activities, including evidence that such activities have been, and will be, performed under a suitable Management System;
- development of the Management System for the operation of the packaging plant, in particular the plant for packaging liquid wastes;
- documentation of the endorsed packaging process through issue of an approved Waste Product Specification (WPrS) for the immobilisation of DFR raffinate;
- provision of approved Criticality Compliance Assurance Documentation (CCAD);
- provision of detailed proposals for producing waste package records, including the basis of the fingerprints and the recording methodology.

Conclusions

The Interim stage submission from Dounreay for the packaging of DFR raffinate has been assessed. The assessment of the proposals has concluded that further information is required before DFR raffinate waste packages can be shown to be consistent with disposal under the RWMD Geological Disposal concept.

It has not been possible to provide Interim stage endorsement of the proposed waste packages due to the uncertainty associated with the nature and quantity of solids in the waste. Action Points have been raised and will need to be addressed to allow further consideration for endorsement.

The proposals to package DFR Raffinate have been judged against the regulatory guidance² and the view of RWMD is that they be considered as HIGH priority for regulatory scrutiny. The principal reason for this judgement is the significant fissile inventory of the proposed packages and the requirement for a package-specific criticality assessment. Dounreay is advised to seek the necessary interaction with regulators to confirm this position.

² *The Management of Radioactive Waste on Nuclear Licensed Sites – Part 1: The Regulatory Process*, Guidance from the Health and Safety Executive, the Environment Agency and the Scottish Environment Protection Agency to nuclear licensees, December 2007.