

DSRL Responses to Interim Stage LoC Action Points for the DFR Raffinate Encapsulation Development Work and PFR Neutralisation with Limestone

Summary of Assessment Report

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Background

Dounreay Site Restoration Ltd (DSRL) and its predecessor organisations operating the Dounreay site have previously brought forward proposals for the packaging of raffinates from reprocessing Prototype Fast Reactor (PFR) fuel and reprocessing driver fuel from the Dounreay Fast Reactor (DFR).

PFR raffinate is a highly active waste stream with a specific activity towards the upper end of the range normally encountered for ILW. It represents the most active waste stream stored on the Dounreay site. The liquor contains a complex mixture of dissolved metals, fission and activation products and actinides. A small quantity of solid particles is also present. In addition, it was also proposed that an existing stock of plutonium nitrate solution should be processed as a mixture with PFR raffinate. The proposals for packaging PFR raffinate by neutralisation and cement encapsulation were endorsed in 2006 through provision of an Interim stage Letter of Compliance.

DSRL subsequently proposed to revise an aspect of the packaging processes for PFR raffinate, the method of neutralising the acidic liquor, prior to immobilisation using cements. The previously endorsed packaging process included a two-step neutralisation of the PFR raffinate, using calcium hydroxide and then sodium hydroxide. In 2010, DSRL submitted proposals to substitute limestone for calcium hydroxide in the first step of the PFR raffinate neutralisation process. The driver for this was an observation of the difficulty in delivering dry calcium hydroxide to a neutralisation tank in the development facility, due to the warm moist atmosphere in the equipment, which led to blockages of the delivery system. The assessment of the proposed change concluded that there was insufficient evidence to demonstrate the satisfactory performance of waste packages, arising from the proposed revised neutralisation process, to support endorsement. The subsequent advice to DSRL raised four Action Points for resolution. DSRL has now responded to these Action Points and has requested endorsement of the revised neutralisation process.

DFR raffinate represents one of the more active waste streams stored on the Dounreay site. 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 fission products and isotopes of plutonium. The proposals for packaging DFR raffinate were endorsed through a Conceptual stage Letter of Compliance, but were not endorsed at Interim stage due to uncertainties over the composition of the DFR raffinate in the storage tanks. A series of Action Points were raised to assist resolution of these uncertainties. DSRL has now responded to the DFR raffinate Interim stage Action Points, providing information for assessment by RWMD and requesting issue of the Interim stage Letter of Compliance.

DSRL has also now proposed that the neutralisation and packaging processes for PFR and DFR raffinates should be common, and that they should both be packaged in a new process line to be built within an existing facility.

RWMD has assessed the responses to the outstanding Action Points for DFR raffinate, the Action Points raised on the revised neutralisation process for PFR raffinate and the proposals to use the same neutralisation process for both PFR and DFR raffinates.

Packaging process

Raffinate from DFR or PFR would be homogenised and then retrieved in batches of approximately 1 m³ to a receipt and neutralisation tank. Each batch would be sampled and analysed to provide radionuclide and compositional data and to provide the basis for determining the necessary neutralisation conditions. A combination of limestone and sodium hydroxide would be used for neutralisation, as this prevents excessive heat generation during reaction and has been shown to provide wasteform stability. The neutralised raffinate would be dispensed to a stainless steel 500 litre drum consistent with RWMD standards and specifications. The raffinate would then be immobilised by an in-drum mixing process driven by a sacrificial paddle that subsequently would be retained within the wasteform. The immobilising material would be a 1:1 mixture of pulverised fuel ash and ordinary Portland cement (PFA/OPC) powders. Once cured, the wasteform would be capped with a standard 3:1 PFA/OPC grout.

Assessment outcome

It has been concluded that the existing Action Points relating to the revised neutralisation process for PFR Raffinate can be closed. The change to calcium carbonate, from calcium hydroxide, in the neutralisation process is accepted subject to a new Action Point. A new Action Point has had to be created, for closure at the Final stage Letter of Compliance, relating to the inadequate duration of the wasteform stability testing, since a period of only 3-months is reported. The new Action Point requests extension of the dimensional stability testing for a minimum period of 12 months to allow confirmation that the cementation process has produced a stable product.

It is also concluded that the same limestone and sodium hydroxide neutralisation process developed for PFR raffinate can also be applied to DFR raffinate. Dimensional stability testing of the cemented product to a minimum period of 12 months is also required for simulated DFR raffinate before a Final stage Letter of Compliance could be provided.

The assessment of the residual DFR Interim stage Letter of Compliance Action Points has concluded that the issues concerning the raffinate composition are not yet fully resolved. A further two Action Points have been created to move the project forward. Of these, one Action Point needs to be addressed before an Interim stage Letter of Compliance can be provided. This relates to the uncertainty over the contents of the DFR raffinate tanks, particularly for fissile materials content. It has not proved possible to improve the confidence in the composition of the raffinate, and DSRL is requested to define a process to manage the risk that waste retrieved from the DFR raffinate tanks has a different radionuclide inventory, especially of fissile materials, to that predicted and used for assessment purposes. This needs to be resolved before an Interim stage Letter of Compliance can be provided.

DSRL should consider how the settled solids in the neutralisation tank are managed. The routine suspension and processing of the settled solids to the 500 litre drum for encapsulation would be an acceptable solution.

DSRL has also given assurances that the packaging process previously defined for DFR raffinate would also be applied to any design of waste packaging plant. This includes the use of the previously endorsed 500 litre drum design with a dispersal cone fitted to the paddle.