

Piles Fuel Storage Pond (PFSP) Sludge at the Wastes Encapsulation Plant (WEP), Sellafield

Summary of Assessment Report

Issue date of Assessment Report: 28 October 2013

Introduction

Sellafield Ltd (SL) has sought advice on the proposals for the packaging of Piles Fuel Storage Pond (PFSP) sludge at the Wastes Encapsulation Plant (WEP) prior to submission of Interim and Final stage proposals.

This report provides the basis and findings of the assessment by NDA Radioactive Waste Management Directorate (RWMD) for the proposals to package PFSP sludge. The assessment has been carried out in order to identify expectations for the Interim and Final stage submissions prior to completion of a Disposability Assessment, where RWMD will examine the compatibility of the proposed packages with the requirements for safe long-term management, including transport, emplacement and extended storage underground, and disposal. In commissioning this work, SL had no intention to seek endorsement of the proposals. Further information on the RWMD disposability assessment (Letter of Compliance) process is available elsewhere¹.

Background and Scope of Assessment

A Conceptual stage Letter of Compliance (LoC) was provided in 2004, supported by a formal assessment identifying 16 Interim stage Action Points. This LoC does not capture the most recent processing route now proposed. SL worked over the years to address the 16 Action Points and in 2008, RWMD assessed the work against the Action Points and issued advice that nine of the actions could be closed.

SL has now sought advice on the November 2012 submission which proposes a revised sludge treatment and packaging approach. The main objective was to consider the consistency of the November 2012 submission with RWMD expectations for Interim and Final stage. This was done by reviewing the current submission in addition to providing a update on the status of the outstanding Interim and Final stage Action Points. It has been agreed that a formal Assessment of Disposability for the PFSP sludge packages will not be produced at this time.

The assessment has been performed in accordance with the terms and conditions of the Transport and Packaging Contract between NDA and Sellafield Ltd, dated April 2005 (Purchase Order 9030/4510346578).

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

Waste Packaging Proposal

The majority of the sludge is located on the floor of the pond. It would be cleared using suction via a sludge retrieval hood. Sludge at the pond edges would be mobilised and cleared using a water lance. The pump would draw in sludge and a filter would remove debris larger than 3mm. It would then be deposited via a hose into a corral previously installed on the floor of the PFSP. A Remotely Operated Vehicle would be used to gather sludge in areas where the crane and water lance cannot reach. A combination of water flow and water lance would be used to clear the bays of sludge. Skips in the pond also contain sludge and would be cleaned using a skip wash, with the sludge removed via a pump and filter into the corral. The corral would act as a settling area to allow a deep bed of concentrated sludge to be discharged to the Local Sludge Treatment Plant (LSTP) via an overland pipe bridge.

At the LSTP, the sludge would be routed into a thickening plant to increase the sludge concentration. It would then be pumped into the concentrated sludge buffer storage tank where it would be homogenised. It is estimated that an average sludge solids concentration of 10wt% would be present in the thickening tank. The sludge would then pass into a sentencing vessel from which sludge samples would be retrieved for analysis of the chemical and radiological composition and solids content, while the sentencing vessel contents are continuously agitated to ensure a representative sample is taken.

Thickened sludge would be transported from LSTP to the WEP via a new Drum Filling Plant (DFP). At the DFP, sludge would be transferred from LSTP storage into the product drum and sealed in to a flask. Following monitoring for export and decontamination as required, the flask would then be returned to WEP by road.

Following import to WEP, the drum would be moved to the In-Drum Mixing Station, blended Blast Furnace Slag/Ordinary Portland Cement powder would be added to the drum while the drum's internal paddle is rotated to encapsulate the sludge. The grout would then be allowed to cure prior to the capping grout being added and the drum lidded. Following cap curing, the drum would be decontaminated and monitored prior to export for interim storage, to await the availability of a Geological Disposal Facility (GDF). It is estimated that approximately 1,073 product drums would be produced from this process.

The drums would be stored in the Encapsulated Product Store 3. This store is designated to accept 500 Litre drums in 4-drum stillages and 3m³ boxes.

Outcome of Assessment

Nature and quantity of waste

Although no open Action Points exist in relation to the radionuclide inventory, it is a key part of records requirements to have a clearly defined and justified inventory. SL should consider the following inadequacies identified in the submission inventory to provide improved inventory data:

- It is not apparent how the 2012 inventory values reported in the submission have been calculated.
- The submission inventory does not provide an adequate representation of all 112 potentially relevant radionuclides, but only those reported from the samples taken. SL should provide an explanation for excluding some

radionuclides based on extrapolating the basic data to ensure that any exclusion is not significant.

- SL should consider how the presence of fuel fragments in the sludge may impact the inventory and lead to uncertainty over the radionuclide content.
- Small quantities of graphite are likely to be present in the sludge. If the General Criticality Safety Assessment is used, SL would need to show that there is less than 1kg graphite in each waste package which could be measured through appropriate means.

Wasteform and Gas Generation

There were six Interim stage Action Points from the 2004 Conceptual stage LoC relating to development of a suitable wasteform and understanding the effects of gas generation.

Although the development work for sludge simulants and the formulation envelope is not complete, SL is progressing in a manner that should ultimately confirm that the envelope is robust to expected variations in the feed, and that the proposed formulation would give a stable wasteform. No details have been provided for active trials work to underpin the acceptance test so it is not possible to assess if progress is being made against the Action Point related to this development work.

The proposed long-term waste immobilisation studies programme would investigate irradiation testing, dimensional stability, and gas monitoring. This output should gather the necessary information to support the case for disposability. The Action Point related to these investigations should remain open. In regards to dimensional stability studies, early results will be of interest to RWMD at Interim stage (i.e. 90 or 180-day test results). Later results would also be valuable at the Final stage (i.e. 360-day test results).

The evidence provided by SL has enabled two of these six Action Points to be closed out. Although the Action Point related to determining whether pre-treatment is required to ensure the waste is compatible with the cementation process is considered closed, it is now to be considered as part of the Action Point related to determining the formulation envelope. The Action Point related to providing more realistic information on likely gas production rates has been resolved.

Container materials, design and manufacture

The 500 litre WEP drum is a standard design, previously used extensively for immobilising sludges arising from operation of the Thermal Oxide Reprocessing Plant. SL should provide a Manufacturing Specification at Interim stage in order to confirm that the performance of the waste container and waste package will comply with requirements.

Criticality safety

To demonstrate criticality safety requires that a Safe Fissile Mass (SFM) is established, that the proposed packages can be shown to comply with this mass, and to identify how compliance would be achieved. If the fissile levels breach 50g (Pu-239 equivalent level) in the General Criticality Safety Assessment then SL would need to make a case based on a Generic Criticality Safety Assessment (irradiated natural uranium).

To ensure compliance with the SFM, a draft Criticality Compliance Assurance Document (CCAD) has been produced. It focuses on how the packaging process will be controlled, such that if all the worst case uncertainties are added together, the SFM cannot be exceeded. The draft CCAD has been reviewed and shown to provide reasonable clarity to ensure criticality safety including the description of possible

faults and control methodology, although currently it is not clear whether the stated fissile contents (as specified in the CCAD) include the uncertainties defined in the CCAD, as the range between the average and maximum case is so large.

Production and management of waste package records and information

A key part of records requirements is the development of a disposal inventory with a clearly defined and justified scope. The data recording proposals include a list of significant radionuclides. As stated previously, an adequate representation of all 112 potentially relevant radionuclides is not provided. It is possible that the data recording analysis will miss some radionuclides that should be analysed.

Fingerprints should be developed on the basis of sampling data to produce accurate records. The nature of the pond sludge will be uncertain until retrieval, but it will be important to have adequate estimates of a bounding inventory to make sensible conclusions for fingerprints which produce an accurate record of the waste products. This is important to RWMD because waste packages or waste streams contribute to the overall GDF disposal inventory, and consideration has to be given to how these may affect compliance with the overall generic post-closure safety assessment. SL should provide an explanation for excluding some radionuclides based on extrapolating the basic data to ensure that any exclusion is not significant. The lack of clarity in the proposals has prevented the related Action Point from being closed.

Furthermore, SL need to keep in mind the overarching record set which would include key package records, experimental evidence, and other supporting documentation representing campaigns of waste.

Quality Management System (QMS)

SL has stated that the design, manufacture, installation, commissioning and operation of the LSTP will be undertaken in accordance with the already established QMS and that a formal QMS will provide information from various plant operating phases associated with the waste packaging process. Although complete and comprehensive QMS documentation is not necessary until Final stage, it is important at Interim stage for a proposed QMS structure to be established identifying where new documentation is needed and where existing arrangements will be used. An Action Point to provide this information has been assigned.

The draft Waste Product Specification provided by SL is broadly consistent with expectations at Interim stage, although the parameters defined in the document will remain speculative until the research and development work is completed. The document should be underpinned by reference to research and development, finalised and submitted for assessment and agreement with RWMD as part of a Final stage submission.

At the final stage, it will be important that SL can provide evidence of relevant QMS documentation. It is good practice to coordinate an audit prior to plant commissioning to ensure appropriate QMS arrangements are in order so RWMD may request that an audit is completed at this time.

Nuclear Materials Accountancy and Safeguards

SL's proposal for Nuclear Materials Accountancy and Safeguards was assessed in 2008. The proposal was considered to be sufficient but that SL would need to provide confirmation that the approach to safeguards was acceptable to the safeguards authorities as part of the future Interim stage submission. This still remains the case, so a Final stage Action Point has been assigned for SL to provide confirmation that the proposed approach is acceptable to the safeguards authorities.

Conclusions

SL has sought advice on revised proposals (submitted in November 2012) to package PFSP sludge at WEP. The assessment has considered the consistency of the proposal with RWMD expectations for Interim and Final stages of endorsement and has reviewed the outstanding Action Points. A formal Assessment of Disposability has not been produced.

Two of the six Interim stage Action Points relating to development of a suitable wasteform and gas generation have been closed. The remaining four Interim stage Action Points and Interim stage Action Point related to Data Recording proposals remain open. One additional Interim stage Action Point has been raised, related to developing an overarching QMS structure for PFSP sludge waste products. One additional Final stage Action Point has been raised, related to confirming the safeguards approach is acceptable to the safeguards authorities.

The assessment has also identified a number of shortcomings and opportunities for improvement in the proposal related to underpinning a justified inventory, providing evidence of a manufacturing specification to confirm compliance of the waste container, make a criticality case based on a Generic Criticality Safety Assessment (irradiated natural uranium) if the fissile levels breach 50g (Pu-239 equivalent level), and to consider CCAD uncertainties/errors within the fissile limits.