Radioactive Waste Management Directorate

Packaging of Dounreay PFR Decommissioning Waste in 2m or 4m Boxes

(Conceptual stage)

Summary of Assessment Report

Issue date of Assessment Report: 27 May 2011

Introduction

Dounreay Site Restoration Ltd (DSRL) is currently carrying out decommissioning of the Prototype Fast Reactor (PFR) facilities at Dounreay. All fuels and the bulk of the sodium coolant have already been removed from the reactor, and following future passivation of residual sodium, it is proposed to dismantle and remove all components from the reactor vessel and the associated mortuary holes. These wastes will be packed into containers for interim on-site storage.

Scottish Government policy (January 2011) allows waste producers to consider long-term management options for treatment of waste, or storage in near-surface facilities which are near to the site where waste is produced, or disposal in near-surface facilities near to the site where waste is produced. DSRL believes that this policy has the implication that wastes should be packaged in a non-encapsulated form, to allow wastes to be re-packed in the future if necessary. Regulators take the view 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.

DSRL has sought Conceptual stage endorsement of proposals for the packaging of PFR Decommissioning Wastes at Dounreay using 2m or 4m boxes, requesting assurance from RWMD that nothing in the plans would preclude disposal to the Geological Disposal Facility. The waste considered consists of items from within the PFR reactor vessel that have become activated during operations to levels whereby they will not be suitable for low level waste disposal. This Assessment Report provides the basis and findings of the Conceptual stage disposability assessment by NDA Radioactive Waste Management Directorate (hereafter RWMD) for these packages.

The assessment has been carried out through the Disposability Assessment process, whereby RWMD examines the disposability of proposed waste packages by assessment against the plans for geological disposal utilising the Geological Repository Concept for ILW disposal. It should be noted that RWMD has published the Disposal System Safety Case (DSSC), to account for a range of geological disposal environments and illustrative geological disposal concepts. Future waste packaging assessments, those commencing from late February 2011, will be against the basis of the DSSC and revised standards and specifications. 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 elsewhere[1].

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

Background

In 2007 a Conceptual stage Letter of Compliance (LoC) submission was made seeking advice on a number of options for packaging the PFR Decommissioning Waste. A Conceptual stage LoC was only issued for one option, packaging wastes in unshielded containers (500-litre drums or $3m^3$ boxes), based on the assumption of a transport date of 2040. The option to use 2m and 4m boxes, designs of Industrial Package Type 2 (IP2) containers under IAEA Transport regulations, was not supported. This was due to the expectation of excessively high external dose rates from the waste at 2040, and due to the potentially inhomogeneous distribution of activity challenging the IAEA requirements for transport of waste as Low Specific Activity material.

DSRL state that in the light of NDA funding constraints, they have reviewed their waste management strategy and have found that the construction of a highly-shielded packaging plant and stores required for unshielded containers represents a major capital investment that would challenge the annual site funding limit. In relation to this, it is also stated that the decommissioning requirements for PFR and Dounreay Fast Reactor can be met by having a single facility to package ILW from the two sources. DSRL is therefore investigating alternative strategies such as the use of shielded packages wherever practical to reduce the cost of storage facilities. DSRL has therefore reviewed the previous advice from RWMD concerning the unsuitability of 2m or 4m boxes for PFR Decommissioning Waste, and proposes consideration of their suitability for transport and disposal after a much longer period of on-site storage to allow greater radioactive decay.

Waste Packaging Proposal and Scope of Assessment

The submission provides details of plans to access waste items and for removal of LLW from peripheral structures. A key feature of these proposals is that LLW would be segregated from ILW as far as reasonably practicable, and packaged and consigned to its separate disposal route.

An ILW Head End facility would be constructed to allow ILW items to be size reduced in situ and then transferred to a Reactor Processing and Packaging Facility (RPPF) for cleaning and packaging. It is anticipated that the operations would include:

- buffer storage areas to allow optimum waste packing;
- facilities for steam cleaning/washing of items to remove residual sodium;
- facilities for the assay of items and/or collections of items for package data records, using a gamma technique;
- provision for the receipt of empty containers, their filling with waste, contamination monitoring and decontamination if required.

Items of waste would be loaded into waiting boxes according to a packing plan. It is proposed that consideration would be given to the need for and design of in-box furniture to prevent shifting of loads during box movements, although no details are presented at this stage. The loaded packages would then be moved into long-term storage on the Dounreay site. The location of the store is currently undetermined. The submission does refer to a storage period of up to 100 years from the date of packaging, to 2120, although also makes reference to transport by 2090 on the basis of the earliest date of geological repository closure for ILW.

The submission recognises that packages would require remote handling on site due to high dose rates during and after packing operations (e.g. 100s of mSv/hr in the 2020s, based on >1 Sv/hr at 2010), and that it is necessary to carry out more detailed evaluations than those presented in the submission. This is necessary to ensure that dose rates during both operational and storage phases can be appropriately controlled in addition to ensuring that

the packages are transportable. The submission refers to a number of options for managing high dose items, including:

- packaging items into smaller containers for transport in Type B overpacks;
- placing items in small shielded containers in the 2m/4m boxes;
- increasing the density of the box shielding to meet the dose at 1m limit;
- redesigning the box shielding to include additional internal shielding.

It is also proposed to retain an option to encapsulate wastes or void fill packages prior to the time of transport, should that be required.

Outcome of Assessment

Radionuclide Inventory

At the proposed dates for decommissioning the dominant gamma dose contributor is Co-60, but by 2090 is superseded by Nb-94 as the shorter-lived radionuclide decays. Due to the long half-life of Nb-94 (20,000 years), relatively little reduction in gamma dose rates will occur over realistic waste management timescales beyond the end of the century. Compliance with the 3m dose rate limit for unshielded waste transported in an IP2 will depend on not grossly underestimating the radionuclide inventory of this waste for the proposed waste package waste loading. On the assumption that heavy package shielding is used for DSRL operational purposes, this should ensure that other transport dose rate limits, which take credit for shielding, can easily be met. The submitted and assessed radionuclide inventory is based on core flux and materials activation modelling. RWMD understands that DSRL are in the process of undertaking a programme of dose measurements, sampling and analysis for the core materials. It is recommended that the results of these measurements are used to improve confidence in the modelled inventories.

Compliance with Waste Package Specification

Shielding within the 2m or 4m box will need to be increased beyond a typical 200mm of standard density concrete to ensure that the 0.1mSv/hr at 1m dose rate limit is complied with at the time of transport (assumed for assessment purposes to be ~2090). The assessment currently predicts that this limit will just be exceeded with typical shielding, although as noted above the use of heavily package shielding may be required for DSRL operations. The limit for 3m unshielded dose rate is expected to be complied with by 2090.

It is not clear to RWMD how much box shielding will be needed by DSRL for interim storage at Dounreay. The submission may contain a degree of contradiction, since it refers to a strategy for avoiding development of highly shielded facilities, but then also recognises a need for remote handling on-site. If it is intended to use a store with low shielding then very heavy shielding in the boxes may be required to reduce dose rates to an acceptable level. Such a consideration affects the viability of this packaging Concept. Increases in box integral shielding will increase package mass, although this might be partially off-set by a reduced waste loading capacity (and thus an increase in the total number of waste packages). Package mass may be a significant factor affecting the transportability of the proposed packages from Dounreay. It is estimated that packages containing typical levels of shielding and waste in a non-encapsulated form may only just comply with current RWMD Waste Package Specification mass limits.

For handling packages at the dose rate limit set by transport (dose rate of 0.1mSv/hr at 1m), considering the relatively low total exposure time for handling the relatively few packages involved, the repository worker is estimated to receive a dose equivalent to the typical worker annual dose. This is unacceptable. A reduced dose could be achieved by application of increased box shielding and/or perhaps by changing the design of the box handling system through a process of change control for the GDF design. The PFR decommissioning waste package does present a case of very high dose rate compared to most wastes which are

expected to be packaged in 2m or 4m boxes, nevertheless the significance of dose rates for packages just meeting transport limits does suggest lack of optimisation in GDF design and/or package specification.

It is also necessary to show that doses to transport system and repository workers are shown to be as low as reasonably practicable (ALARP), which may also require an increase in box shielding and/or a change to the design of the GDF to reduce doses to workers handling 2m and 4m boxes.

As a minimum, DSRL and RWMD need to determine how much shielding is required and the impact of the necessary shielding on compliance with mass limits. Such a study also needs to consider how dose to workers is demonstrated to be ALARP throughout the lifecycle of the waste packages. DSRL also needs consider the implications of an increase in the mass limit of a 2m box from 30t to 40t.

The potentially high mass of a 4m box suggests changes to the GDF design and transport system would be required. In addition the 4m box design would need to be modified and testing would be required. Use of 4m box cannot be endorsed at this stage. If this concept is pursued, DSRL and RWMD would need to consider whether use of a 2m box is preferable to the additional work required to justify use of a 4m box.

Policy

A key feature of the proposals is the likely requirement for decay storage until ~2090 or later. RWMD does not specify a required transport or receipt date, but assessments are typically based on the earliest transport date of 2040, rather than ~2090. This does represent a change in assessment philosophy and it may present an increased risk of future non-compliance since the waste package is a transport package and transport regulations may not evolve favourably over such a long timescale. Considering that the proposed packages are borderline acceptable against current regulations for a ~2090 date this suggests an increased sensitivity to any adverse changes in regulations. Upon completion of the development work described above, assuming a favourable outcome for DSRL and RWMD, RWMD will need to seek advice from its Nuclear Safety and Environment Committee (NSEC) concerning the policy of endorsing a proposal for which transport would not be feasible until ~2090 based on existing regulations.

Conclusions

Before endorsement of this concept for packaging wastes in a 2m box can be provided by RWMD, DSRL need to show what level of box shielding is required to meet dose rate limits for interim storage at Dounreay and transport at 2090, and work with RWMD to show that doses to workers across the lifecycle of the waste package will be acceptable and ALARP. This work needs to consider how shielding requirements and void filling or encapsulation affect package mass and number of packages required. RWMD will also need to seek advice from its NSEC concerning the policy of endorsing a proposal for which transport would not be feasible until ~2090 based on existing regulations.

It is also recommended that the results of core measurements and sampling are used to improve confidence in the radionuclide inventory of the core materials to ensure predictions are not overly optimistic or conservative.

Use of 4m box cannot be endorsed at this stage. If this concept is pursued, DSRL and RWMD would need to consider whether use of a 2m box is preferable to the additional work required to justify use of a 4m box.