

Packaging of Winfrith SGHWR Decommissioning Wastes (Conceptual stage)

Summary of Assessment Report

Issue date of Assessment Report: 8 February 2006

Introduction

This is a summary of an assessment carried out by Nirex in response to a Conceptual stage proposal from UKAEA for the packaging of waste arising from the decommissioning of the Winfrith Steam Generating Heavy Water Reactor (SGHWR).

A Conceptual stage disposability assessment has been conducted and an Assessment Report produced. Issues have been identified through the disposability assessment and until these issues are resolved Nirex would not be able to endorse the packaging proposal through issue of a Conceptual stage Letter of Compliance.

Background

The Nirex mission is, in support of Government policy, to develop and advise on safe, environmentally sound and publicly acceptable options for the long-term management of radioactive materials in the UK. This includes all intermediate-level radioactive waste and some low-level radioactive waste (ILW and LLW).

As part of this role, Nirex sets standards and specifications for the packaging of ILW and LLW, based on its Phased Geological Repository Concept (PGRC). Nirex issues Letters of Compliance (LoC) when proposed packaging methods are assessed to be capable of producing waste packages that would be consistent with Nirex requirements for long-term management and protection of the environment. This process is intended to minimise the risk of inappropriate treatment, the need for future repackaging or the creation of a new legacy of wastes to be dealt with by future generations, with all the attendant safety, environmental and cost implications. The process of obtaining a Letter of Compliance is embedded in the regulators' arrangements for the conditioning and packaging of ILW, as described in guidance issued by the regulatory bodies.

Nirex has performed an independent assessment of the specific waste packaging proposal for the SGHWR decommissioning wastes, against the requirements for future storage, transport and disposal as embodied in the Nirex PGRC to confirm disposability of the proposed waste packages.

UKAEA's proposals for packaging waste from the Winfrith SGHWR

The Winfrith Steam Generating Heavy Water Reactor (SGHWR) was a single-cycle pressure tube reactor that used light water as coolant and heavy water as the neutron moderator. It was commissioned in 1968, providing 100MW(e) to the National Grid with 60-65% utilisation, until it was closed in 1990.

Since its final shutdown, it has been de-fuelled and is currently under care and maintenance. Some of the ancillary facilities have already been decommissioned, including the fuel ponds, and plant has been constructed to process historic sludge wastes.

The intention is to dismantle the plant and equipment in the SGHWR primary containment in a step-wise fashion, using a combination of manual and remote techniques. A sequence of

campaigns would be undertaken and baskets of size-reduced wastes would be transferred into the waste processing plant where the waste would be segregated into LLW and ILW streams. The ILW stream would be sorted and further processed as required and then loaded into 2 metre boxes lined with 240mm of concrete shielding.

The 2 metre boxes of waste would be infilled with a 3:1 PFA/OPC grout with a water/solids ratio of 0.42, and then capped with grout of a similar formulation. The 2 metre boxes would then be lidded, monitored, decontaminated if necessary and transferred to an on-site store.

UKAEA's current reference strategy is that packaged ILW from the Winfrith site would be transferred off-site in the year 2015 in line with plans for remediation and delicensing the site.

The proposed packaging process yields a prediction of up to 55 off 2 metre boxes with an average package inventory at 2040 of 3 A₂ multiples¹ and a maximum package inventory of 92 A₂ multiples. When compared to a reference case conditioned volume of Shielded ILW (SILW) for the 2001 National Inventory of 14,000 m³, the SGHWR decommissioning wastes would constitute 1.2% of the volume of the SILW waste inventory considered in the 2003 Generic Post-Closure Performance Assessment.

Disposability assessment

The disposability assessment conducted by Nirex considers the proposed waste packages for compliance with the Phased Geological Repository Concept (PGRC). This is achieved by assessing the proposed waste packages against published generic safety assessments that address transport of waste packages to the facility and safety of operations at the facility. The wastes and packages are also assessed against the generic post-closure performance assessment.

Transport safety

The assessments of transport safety show that although the material is considered likely to be compliant with the specific activity limit for Low Specific Activity (LSA-II) material, it is evident from the information provided in the submission that the additional requirement for the external radiation level not to exceed 10 mSv h⁻¹ at 3 m from the unshielded material may not be met.

There are also doubts regarding the ability of the waste packages to comply with Industrial Package (IP-2) external dose rate limits, even after decay to 2040. The assessments indicate that the specified limits for IP-2 external dose rates are significantly exceeded. Although UKAEA claim that appropriate furniture and careful waste loading could reduce dose rates, it is possible that these measures could increase the waste package mass to an unacceptable level. Already, the maximum mass of a waste package currently exceeds the 30 t limit proposed in the existing Waste Product Specification for the 2 metre box and the average expected package mass of 29 t is also close to the limit.

The packages can be confirmed as non-fissile, a requirement for IP-2 packages, in view of their low fissile content. Also, the expected maximum heat output at from the packages is suitably low at 2040, although the Nirex specified heat generation limit of 60W is exceeded at 2015, which requires further consideration by UKAEA.

With regards to the risks calculated for the transport of the reference case inventory to a Nirex PGRC, the calculated risks do not raise any particular issues and are generally consistent with the generic Nirex transport risk assessment. It should be noted that it has not been possible to calculate the doses to workers from routine transport operations at this stage.

¹ A₂ multiples provide a measure of the activity content of transport packages, where each radionuclide is weighted according to its damage potential.

Operational safety

The proposed cemented SGHWR decommissioning waste packages present issues for the Generic Operational Safety Assessment in several areas, as summarised below.

Under normal conditions of operation at the repository, workers would be exposed to the waste packages considered in this proposal at the receipt facilities and in the Shielded ILW vaults and there is an expectation that these shielded 2 metre boxes will involve some amount of manual handling. The doses to workers under normal conditions of operation at the repository are significant and provide an unacceptable contribution to annual worker dose, and potentially exceed the basic safety objective (BSO) (2mSv per year).

The probabilistic risk to workers associated with accidents would increase significantly although the target worker risk per annum (1.6×10^{-6}) is not breached.

Although the design target for the dose band 0.1 to 1mSv to members of the public of 10^{-2} occurrences per annum would be exceeded, the design limit of 1 per annum is not breached.

Post-closure safety

The post-closure safety assessment has revealed only one area of concern that could prejudice disposal of SGHWR decommissioning waste packages, relating to the potential for formation of carbon-14 labelled methane from corrosion of aluminium, steels and Zircaloy. This issue is not unique to SGHWR decommissioning waste, is likely to be a significant issue for many other ILW products and is being investigated within the Nirex generic technical programme.

Potential package design improvements

At this Conceptual LoC stage, development work by UKAEA is by necessity at an early stage and a number of action points identifying additional information and/or research needs have been identified. It is envisaged that when completed, the action points will provide the necessary information to enable completion of the disposability assessment.

In summary, the key areas requiring further development are:

- demonstration of the ability to transport the waste as IP-2 packages;
- demonstration that the external dose rates from the packages during transport and the operational phase are acceptable;
- the rate of release of gases containing carbon-14 under routine transport and storage conditions and its release fraction in fire accidents;
- the rate of hydrogen evolution following grouting and associated detrimental effects on wasteform;
- the impact performance of the box and wasteform, and the extent of corrosion of the metallic items of waste. The levels of contamination of the waste will provide an input to the assessment of the impact performance;
- the extent of expansive corrosion for packages containing large quantities of steel shot;
- the ability of the encapsulant to infiltrate the spaces in a package of steel shot and to immobilise the shot and associated corrosion products.

At future LoC stages of submission, UKAEA will also need to comply with various mandatory requirements. These will include:

- to conduct all phases of the SGHWR decommissioning project under an appropriate quality management system (QMS);
- to provide a suitable data recording methodology for the waste packages;

- to consider international safeguards and physical protection issues;
- to provide a Waste Product Specification and Criticality Compliance Assurance Documentation.

Summary and conclusions

A Conceptual stage assessment of UKAEA's proposals for packaging of Winfrith SGHWR decommissioning wastes has determined that the waste materials coming forward from decommissioning the SGHWR should be compatible with the disposal concept embodied within the Phased Geological Repository Concept. However, it is clear that the form and characteristics of the packaged waste will be a significant factor in determining overall disposability. At this Conceptual stage demonstration that the proposed waste packages are likely to be compliant with IAEA Transport Regulations is required.

A Conceptual stage disposability assessment has been conducted and an Assessment Report produced. Due to the external dose rates from the package and uncertainty as to whether the packages can be transported as IP-2 packages, it is not currently possible to demonstrate that limits will be met. Until these issues are resolved Nirex would not be able to endorse the packaging proposal through issue of a Conceptual stage Letter of Compliance.

It must be questioned whether the use of an Industrial Package (IP-2) is the optimum solution for the SGHWR decommissioning wastes. A container that can be transported as part of an IAEA Type B package (i.e. a 3m³ box) would avoid many of the issues raised by the current proposals for SGHWR decommissioning wastes.