

Packaging of Winfrith Dragon Reactor Decommissioning Wastes

(Conceptual stage)

Summary of Assessment Report

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Background

UKAEA has sought Conceptual stage endorsement for the packaging of waste arising from the decommissioning of the Winfrith Dragon reactor.

This document summarises the results of the assessment carried out by Nirex in response to the submitted proposals. The assessment has been carried-out as part of the Letter of Compliance process, whereby Nirex examines the disposability of the proposed waste packages by assessment against ILW packaging standards and specifications and the underpinning Phased Geological Repository Concept (PGRC). Further information on the Letter of Compliance process is available elsewhere¹.

A Conceptual stage disposability assessment has been conducted and this Assessment Report produced.

Scope of the proposals

Dragon was a block-type High-temperature Gas-cooled Reactor (HTGR). HTGRs are helium-cooled, graphite moderated reactors that utilise coated ceramic fuel particles dispersed in a graphite matrix.

The reactor first operated at power in July 1965, and reached its full capacity of 20MW (thermal) by April 1966. The reactor operated for long periods at full power, and ceased operation in September 1975. Since its final shutdown, it has been de-fuelled and is currently under care and maintenance.

The intention is to dismantle the plant and equipment within the Dragon reactor 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 waste is predominantly activated metals and graphite. The ILW stream would be sorted and further processed as required and then loaded into Nirex standard 2 metre Boxes lined with concrete shielding. The thickness of the concrete shielding will be determined on a case-by case basis.

The 2 metre Boxes of waste would be infilled with a cement grout 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.

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

The proposed packaging process is expected to result in the production of up to 17 off 2 metre Boxes containing activated metal wastes and up to 7 off 2 metre Boxes containing activated graphite wastes. When compared to a reference case conditioned volume of Shielded ILW (SILW) of 14,000 m³, the Dragon decommissioning wastes would constitute 0.7% of the volume of the SILW waste considered in the Phased Geological Repository Concept.

Assessment of Disposability

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.

When filled with waste, the 2 metre Box is designed to meet the requirements for an Industrial Package Type 2 (IP-2) Freight Container as specified in the IAEA Transport Regulations and the radioactivity content is restricted to that classified as solid Low Specific Activity (LSA) material or Surface Contaminated Objects (SCO) at the time of transport through the public domain. The assessments of transport safety show that although the material is considered likely to be compliant with the average specific activity limit for LSA-II material, there are doubts regarding the ability of the all the waste packages to comply with external IP-2 dose rate limits for transport under non-exclusive use in 2040 (the date assumed for transport to the repository). The current assessments indicate that the specified limits for external dose rates are exceeded, although it is expected that use of higher density concrete or more realistic dose rate modelling should be able to result in compliance with the relevant limits.

An additional requirement is that the activity is distributed throughout the wasteform. Although it does not have to be uniformly distributed to qualify as LSA-II material, the limit would fail to be meaningful if, in a large volume, the activity is clearly confined to a small percentage of that volume. Therefore the IAEA Transport Regulations guidance suggests an assessment method of dividing a volume greater than 1 m³ into ten portions and ensuring that the specific activity is roughly the same across those portions. It is not clear that all of the proposed Dragon decommissioning waste packages could be shown to demonstrate compliance with the IAEA Transport Regulations guidance, although it is clear that some of the wastes would be compliant (e.g. graphite). UKAEA will be required to demonstrate that the IAEA Transport Regulations requirements related to distribution of activity throughout the LSA package can be complied with and any endorsement will only be offered for waste that is compliant with the regulations.

The packages are assessed to be non-fissile, a requirement for IP-2 packages, in view of their low fissile content.

The risks calculated for the transport of the reference case inventory to a Nirex PGRC do not raise any issues which would preclude issuing a Conceptual Letter of Compliance for some of the Dragon decommissioning wastes. Wastes that cannot be shown to be compliant with the IAEA Transport Regulations will be excluded from endorsement at this stage.

The assessments of operational safety show that it should be possible for 2 metre Boxes containing Dragon decommissioning wastes to be handled and stored safely within a repository based on the PGRC.

The post-closure safety assessment has revealed no significant areas of concern that should prejudice disposal of packages containing Dragon decommissioning wastes. This is due to the relatively small number of packages containing the materials, and the relatively small inventory associated with them.

Requirements for further work

The following characteristics of the Dragon decommissioning waste packages are especially significant from the point of view of the repository design and safety cases:

- the segregation of Wastes Requiring Additional Treatment (WRATs);
- the successful development and application of separate small-scale processes to immobilise swarf, graphite dust and boron carbide grit before packaging, thereby minimising the source term of potentially mobile particulate activity;
- the development and application of the 2 metre Box;
- management of the loading of the wastes to ensure the external dose rates from the unshielded wasteform and the distribution of activity within the waste packages comply with the definitions of LSA-II materials.

The identification of these key characteristics provides a focus for development work. It is further noted that, where appropriate, such development would need to be based on a suitable simulant of the waste that took due account of any evolution that might occur during storage prior to final packaging.

Conclusions

A Conceptual stage assessment of UKAEA's proposals for packaging of Winfrith Dragon reactor decommissioning wastes has determined that the waste materials coming forward from decommissioning the Dragon reactor should be compatible with the Phased Geological Repository Concept. Consequently, Nirex is now able to endorse the proposed packaging of Dragon decommissioning wastes at the Conceptual stage through the issue of a Letter of Compliance, although endorsement is limited to those wastes which can be shown to comply with the IAEA Transport Regulations.

It is questioned whether the use of an Industrial Package (IP-2) is the optimum solution for all of the Dragon decommissioning wastes. A container that can be transported as part of an IAEA Type B package (i.e. a 3m³ Box) would avoid some of the issues raised by the current proposals for Dragon decommissioning wastes. This issue may be even more relevant if UKAEA wish to transport the packages earlier than assumed in the Nirex assessment, i.e. before 2040.