

Hydrus hydrodynamic vessels at AWE (Conceptual stage)

Summary of Assessment Report

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Introduction

The Atomic Weapons Establishment (AWE) carries out hydrodynamic experiments to test the performance of materials under explosive force. These tests are performed inside highly robust steel pressure vessels which become contaminated with radioactive material as a result of test. Since it is not possible to re-use the vessels following active operations, each vessel is declared as Intermediate Level Waste (ILW) on completion of the test.

AWE has embarked on a project to develop a new hydrodynamic test facility to replace the existing (Phase I) facility. The Phase II facility is expected to replace the current hydrodynamics facility by around 2017. The new facility will use a larger design of test vessel, referred to as the 'Hydrus' vessel.

AWE has provided Conceptual stage proposals to RWMD to package the used Hydrus vessels for geological disposal. Owing to their large size, it is not feasible to package the Hydrus vessels directly into any of the existing designs of Unshielded ILW (UILW) package. AWE has therefore proposed to develop a framework (or "stillage"), into which the vessel would be secured, to form a skeletal package. The skeletal package would ensure compatibility with the requirements for handling, transport and disposal at a Geological Disposal Facility (GDF), as currently specified in the Generic Waste Package Specification (GWPS)¹. The stillage would provide all of the mechanical handling functions (lifting, stacking etc.) and hence compatibility with GDF infrastructure. The Hydrus vessel, being of highly robust construction, would provide the radionuclide containment function. AWE's proposals specifically exclude encapsulation of the vessel contents on the basis that it would actually be detrimental to evolution of the vessel contents to do so and, furthermore, that the vessel itself would safely contain the radionuclides.

The proposals would give rise to up to twenty-five off skeletal waste packages. This would represent less than 0.04% of the total volume of UILW being considered in the reference case inventory for a GDF.

This Assessment Report summarises the findings of the Conceptual stage disposability assessment by RWMD of the submission for Hydrus hydrodynamic vessels. The assessment has been carried out through the Letter of Compliance process². This involves a detailed examination of the potential disposability of AWE's proposed packages by assessment against ILW packaging standards and specifications for geological disposal. These standards and specifications are embodied in the GWPS. The proposals have also been considered for compatibility

¹ Nirex, *Generic Waste Package Specification, Volume 1 – Specification*, Nirex Report N/104, March 2007

² NDA, *Guide to the Letter of Compliance Process*, NDA Document WPS/650, March 2008

with the recently developed Waste Package Specification for robust, self-shielded containers³.

Scope of the Proposals

This assessment has considered the compatibility of the proposed packages with the requirements for safe long-term management, including storage, transport, emplacement and extended storage underground, and disposal. Where appropriate, the effects of prolonged storage of the waste on the site of arising and during care and maintenance of a GDF have also been assessed.

This report also provides an assessment of disposability of the proposed waste packages. This represents our advice as to the disposability of the skeletal waste packages based upon the standards and specifications developed from our disposal concept. This considers safety and environmental protection requirements for transport, handling and disposal of radioactive waste. The assessment of disposability would be expected to contribute to the Radioactive Waste Management Case to be produced by licensees as required by the regulators, and specifically to the reasoned judgement that the conditioned waste will meet the anticipated requirements for acceptance from the potential disposal site operator.

It is suggested that the proposals be considered as MEDIUM priority under the current regulatory prioritisation scheme⁴. The principal reasons for this judgement are the novel nature of the waste package and proposals for non-encapsulation of radioactive material. AWE is advised to seek the necessary interaction with regulators to confirm this position.

The proposals for packaging Hydrus vessels are novel in respect of the use of a skeletal package. For this reason, the findings from this Assessment Report have been referred to RWMD's Nuclear Safety and Environment Committee (NSEC) for consideration. The conclusions of this Assessment Report reflect the advice provided by the NSEC.

The proposals to package the Hydrus vessels without encapsulation of the contents, whilst unusual, do not represent a precedent for RWMD. RWMD has previously endorsed similar proposals from AWE for packaging its Phase I hydrodynamics vessels⁵.

Assessment of Disposability

The disposability of skeletal packages containing Hydrus hydrodynamic vessels has been assessed. The assessment of disposability has considered the risks associated with transport of these packages to the GDF, handling of the packages at the GDF, and finally, the period beyond backfilling and closure of the GDF.

The evaluation has shown that it would be feasible to safely transport and handle the Hydrus packages. This is based on an understanding of package performance as indicated by AWE. The construction of the Hydrus vessels is such that these should be capable of preventing any release of radioactivity under all normal and credible accident conditions. AWE will be required to provide evidence to fully substantiate this in future submission stages. AWE has also provided initial information to show

³ NDA, *Generic specification for robust shielded waste packages*, LL/10466229, August 2010

⁴ *The Management of Radioactive Waste on Nuclear Licensed Sites – Part 1: The Regulatory Process*, Guidance from the Health and Safety Executive, the Environment Agency and the Scottish Environment Protection Agency to nuclear licensees, December 2007.

⁵ NDA, *Conceptual Stage Letter of Compliance for the Packaging of Legacy Hydrodynamic Vessels from AWE Aldermaston*, LOC/12085510, July 2010

that that criticality safety can be assured for the Hydrus packages during the transport and GDF operational phases, even under accident conditions.

RWMD considers that the likelihood of a criticality event occurring during the post-closure period is low. Furthermore, in the event that a criticality event should occur, the consequences have also been assessed as being low since the geological environment would offer significant shielding, the fissile quantities involved would be limited and the chemical and geological barriers would continue to prevent radioactive material from reaching the surface.

The assessment of post-closure performance has also shown that the Hydrus packages would satisfy the safety requirements provided that the packages are distributed throughout the UILW disposal vaults, rather than being grouped together in stacks. This is a valid approach since the stillage would be designed to allow the Hydrus packages to be stacked with 3m³ boxes. Management controls would be implemented at a GDF to ensure that the Hydrus packages are suitably segregated from one another. Selective distribution of the Hydrus packages within the UILW vaults would therefore ensure consistency with the post-closure criticality safety case being developed for a GDF.

In summary, it is concluded that a disposability case could be made for the Hydrus packages.

Technical Issues

The RWMD assessment has included a detailed consideration of AWE's proposal for not encapsulating the contents of the Hydrus vessel. RWMD considers that the addition of an encapsulating medium would be undesirable. The main reasons behind this conclusion are that:

- The chemical environment within the vessels is expected to be in a passively safe condition, largely as a result of the very low water content of the waste. The addition of an encapsulating medium would alter the chemical environment in unpredictable ways, potentially leading to deleterious effects;
- The highly robust construction of the vessel means that containment would be provided on long timescales and releases of radionuclides under routine and accident conditions would not be possible. The benefits from adding an infilling medium are therefore questionable.

AWE cites a number of other reasons why it would be undesirable to infill the vessels, including unnecessary operator doses, creation of secondary waste streams and technical challenges. RWMD accepts the validity of AWE's arguments, especially given the small number of waste packages that are under consideration. These findings are consistent with the conclusions of the Conceptual stage assessment of packaging proposals for Phase I hydrodynamic vessels⁶.

The assessment has also considered whether the skeletal Hydrus packages would be compatible with the geological disposal concept for UILW packages as this is currently envisaged.

AWE has proposed to use the SWTC-150 transport container to transport the Hydrus packages between its Aldermaston site and a GDF. Whilst the SWTC-150 exists as a concept, this particular transport container may not be realised beyond the initial concept unless there is a wider industry need for its development. AWE has

⁶ NDA, *Conceptual Stage Assessment of Packaging Proposals for Legacy Hydrodynamic Vessels from AWE*, NXA/11793836, 11 March 2010

accepted this risk and has committed to the development and manufacture of such a package should such a situation occur.

On receipt at a GDF, the SWTC-150 would be taken into the inlet cell and the Hydrus package unloaded. The skeletal package would be designed to be compatible with the lifting and handling requirements for 3m³ boxes. Therefore, there should be no reason why it would not be feasible to handle the packages using standard infrastructure.

The skeletal packages would be stacked with 3m³ boxes. Mixed package stacking is feasible within the current GDF concept. Furthermore, selective emplacement, as required for criticality safety, is also permitted within the current concept.

In summary, it is concluded that although the Hydrus packages are novel, these do not present any new challenges to the existing GDF concept.

Future Development Work

In order to fully establish the disposability of skeletal packages containing Hydrus vessels, AWE will be required to develop the Hydrus waste package (Hydrus vessel plus stillage) to satisfy the following functional requirements:

- Compatibility with the lifting and stacking requirements for 3m³ boxes;
- Zero release of radioactivity following limiting mechanical and thermal design basis accidents;
- Inclusion of design features to prevent snagging on other waste packages during lifting operations;
- Elimination of design features that could act as aggressive features towards other waste packages in the UILW vault;
- Measures to prevent galvanic coupling between the carbon steel Hydrus vessel and stainless steel stillage; and
- General compliance with the relevant requirements of the RWMD Generic Waste Package Specification.

AWE will also be required to provide further evidence to show that the proposed packages would be consistent with the criticality safety case covering all phases of waste management for a GDF (transport, operations and post-closure).

As noted above, it is also possible that AWE would need to develop a suitable transport container conforming to the requirements for Type B transport of the Hydrus packages in the event that such a container is not developed by NDA or another waste management organisation.

Variant Package

The RWMD assessment has identified that there may be merit from adopting a package design that eliminates the open sections of the stillage. The addition of side panels to the stillage would eliminate open features that could potentially become snagged with other equipment or UILW packages during lifting operations.

The variant package also presents an opportunity to enhance the accident performance of the package. This is because the interspace between the stillage and vessel could be filled with a medium such as a lightweight cement grout or mineral fibre. In doing so, it may be possible to claim additional accident protection since the filled interspace would provide thermal insulation as well as some mechanical protection.

AWE may wish to take advantage of such a variant package if the future development of the skeletal package presents technical challenges, for example, in respect of potential snagging features or accident performance.

Conclusions

The Conceptual stage evaluation by RWMD has shown that it would be feasible to safely transport, handle and dispose of the Hydrus packages. The Hydrus packages would satisfy the requirements of the generic specification for robust shielded containers, based on an understanding of package performance as indicated by AWE. Furthermore, as a concept, the proposals have been shown to be entirely compatible with the geological disposal concept for UILW packages as this is currently envisaged. AWE will be required to provide more detailed evidence to fully establish this conclusion at future submission stages.

Finally, RWMD believes that the proposals are sufficient for endorsement at the Conceptual stage through the issue of a Conceptual stage Letter of Compliance.