Nuclear Decommissioning Authority

Radioactive Waste Management Directorate

Packaging Options for Hydrus vessels at Atomic Weapons Establishment

(Pre-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 using highly robust steel pressure vessels which become contaminated with radioactive material. Since it is not possible to re-use the vessels following active operations, these become process wastes.

AWE has embarked on a project to develop a new hydrodynamic test facility to replace the existing (Phase I) facility. This 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 Phase II, or 'Hydrus', vessel. AWE has previously received separate Conceptual stage advice from RWMD on options for managing the Phase I hydrodynamic vessels[1]. This assessment considers the disposability of a number of alternative management options for the larger replacement Phase II vessels. For clarity, the Phase II vessels are referred to as 'Hydrus' vessels throughout this document.

AWE has undertaken a number of optioneering studies to identify a shortlist of potential solutions for the disposition of the Hydrus vessels. As an input to this work, AWE has sought pre-conceptual stage advice from RWMD on its shortlist of potential disposal options for the Hydrus vessels.

This Assessment Report summarises the findings of the pre-conceptual stage disposability assessment by RWMD of the submission for Hydrus hydrodynamic vessels through the Letter of Compliance process. This involves an examination of the potential disposability of AWE's proposals by assessment against ILW packaging standards and specifications for geological disposal. These standards and specifications are embodied in the Generic Waste Package Specification (GWPS). Further information on the Letter of Compliance process is available elsewhere[2].

The purpose of this assessment is to enable AWE to narrow down its shortlist of options for the packaging and disposal of Hydrus hydrodynamic vessels, thus preventing further nugatory work in developing unfeasible options. Ultimately, AWE is seeking to obtain a Conceptual stage Letter of Compliance for one or more packaging options by November 2010, since this is a critical component of the sanctioning process in the development of the replacement hydrodynamic test facility.

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

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

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 Geological Disposal Facility (GDF) also have been assessed.

This report does not provide a detailed assessment of disposability for the packaging options since this is not appropriate at the pre-conceptual assessment stage.

AWE predicts that no more than fourteen Hydrus vessels would be used during the lifetime of the Phase II hydrodynamic test facility. Packaging of these vessels is expected to give rise to no more than 28 off waste packages, though this is dependent upon which waste packaging solution is adopted by AWE. Clearly options involving the packaging of a complete vessel would give rise to a maximum of fourteen waste packages.

Due to restrictions on security of information, it has been necessary to use certain code words in this report when referring to sensitive information.

It is suggested that the proposals be considered as LOW priority under the current regulatory prioritisation scheme[3]. The reason behind this judgement is that the proposals are for initial screening only. Furthermore, the proposals raise similar issues to those previously identified for the Phase I hydrodynamic vessels, which the regulators have been made aware of through the provision of the Conceptual stage Assessment Report issued in February 2010[4]. AWE is advised to seek the necessary interaction with regulators to confirm this position.

Hydrus Vessel Packaging Options

AWE has indicated that there may be operational benefits to packaging Hydrus vessels without having to break their containment, as might be the case if the contents of the vessels are to be encapsulated, such as by cement grout or polymer. For this reason, AWE has requested feedback from RWMD on the requirement to infiltrate the internals of each vessel with an encapsulation matrix prior to disposal.

In terms of different packaging and disposal options, AWE has requested formal feedback on the following five potential options:

1. Package each vessel inside a 2m box. Infill interspace between vessel and container walls with cement grout. Transport the 2m Box to the GDF as an Industrial Package (IP-2). Dispose of the 2m Box in Shielded Intermediate Level Waste (SILW) vault at GDF with other contact-handled 2m and 4m Boxes.
2. Package each vessel in a new variant package known as the $5m^3$ Drum[5]. Infill annulus between vessel and container walls with cement grout. Transport $5m^3$ Drum in a 2m Box as IP-2 package. Remove Drum from 2m Box at GDF and dispose of Drum in Unshielded Intermediate Level Waste (UILW) vault.
3. Package each vessel in a $5m^3$ Drum. Transport to GDF using a transport flask that satisfies the requirements for a Type-B package, such as the Transactive-20 transport flask. Remove from transport flask at GDF and grout annulus between vessel and $5m^3$ Drum walls at GDF. Dispose of package in UILW vaults.

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[3] *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, February 2010

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

[5] The $5m^3$ Drum would be based on a modified $3m^3$ Drum.

4. Fit Hydrus vessel within a bespoke transport/handling stillage. Transport stillage within a Type B such as the Transactive-20 transport flask. At GDF, grout stillage/vessel in 2m Box and place in SILW vaults.
5. Infiltrate the vessel contents with a cement grout or polymer encapsulating matrix. Following curing, cut the vessel into sections into suitably sized pieces for packaging in a standard $3m^3$ Box. Infill annulus in Box with cement grout. Transport to GDF as Type-B package and dispose of in UILW vaults.

AWE has proposed Options 1 to 4 on the basis that the Hydrus vessel is too large to fit inside any of the standard UILW packages. Option 5 would offer a solution to use an existing design of UILW package but may not be preferred due to the challenges associated with breaking the containment offered by the vessels.

Feedback on the above options forms the basis of this assessment. In addition, RWMD has provided identified other possible alternative or variant options that could also be exploited at later assessment stages. In particular, since the main challenge to disposability for the Hydrus vessels relates to the transport of these large vessels, further potential opportunities for transporting the vessels to the GDF have been considered, including:

- Qualification of the bare Hydrus vessel as a Type B transport package in its own right. To qualify as a Type B package, it is necessary to demonstrate that the package can satisfy a number of stringent criteria, including impacts and fire. Type B qualification may be feasible due to the expected high integrity of the vessels.
- A concrete box known as the WAGR Box that has been developed by UKAEA. This container satisfies the requirements for IP-2 packages and has previously been endorsed by RWMD for packaging wastes from the decommissioning of the Windscale Advanced Gas Reactor (WAGR).
- An overpack that has been designed to accommodate non-standard $3m^3$ Boxes. This has been developed by Magnox North. The overpack would be transported to the GDF within an SWTC-150 transport container.
- For Hydrus vessels within a bespoke stillage, transport within an SWTC-150 transport container. This is a variant of Option 4 identified above in which the Transactive-20 is replaced with the SWTC-150.
- A larger Type B Reusable Transport Container (RTC). RWMD is currently considering the feasibility of such a transport container as an alternative to the current SWTC to respond to the demands of the industry for a larger capacity flask.

Technical Assessment

The assessment has identified that it should be feasible to dispose of 2m Boxes containing Hydrus vessels in the contact-handled (SILW) vaults (as proposed for Options 1 and 4). Due to the fissile content of the Hydrus vessels, it may be necessary to emplace the packages towards the rear of the SILW vaults to satisfy security requirements. In this arrangement, the packages would be physically protected by the location of adjacent (low fissile content) packages.

Disposal of a $5m^3$ Drum (as per Options 2 and 3) would be more problematic as neither the UILW nor SILW vault handling systems are compatible with such a package. Therefore, to use the $5m^3$ Drum would require significant modification to the design of handling and transfer systems as these are currently envisaged. Such change control could be accommodated but this could incur a long and costly exercise. Furthermore, development of a bespoke container such as the $5m^3$ Drum would incur significant cost

and programme issues for AWE. Given that only fourteen Hydrus vessels are expected to be generated during the lifetime of the test facility, the economics of this option may be difficult to justify.

Whilst it should be feasible to dispose of a 2m Box containing a Hydrus vessel at the GDF, it would not be feasible to transport this package under the current IAEA Transport Regulations. This is predominantly due to the limit on fissile content for IP-2 packages being exceeded by each Hydrus vessel. To make Options 1 and 2 viable, AWE would need to seek approval in principle from the Department for Transport (DfT) to transport 2m Boxes containing Hydrus vessels. For example, it may be possible to apply for a Special Arrangement or alternatively seek to designate the 2m Box as a fissile package. RWMD would not be in a position to offer endorsement for this proposal without evidence of such an approval from the DfT.

It may be possible to transport the Hydrus vessels as a Type B transport package. This would require a suitable handling stillage to be developed to enable safe handling of the vessel at the GDF, for example, to facilitate loading of the vessel into a 2m Box for transfer to the SILW vaults. The Transactive-20 transport flask could be suitable for this purpose, although this is an existing design that has previously only been used to transport small drums of waste. Since the vessels exceed the current mass payload of the Transactive-20, this flask would need re-licensing to allow for the transport of Hydrus vessels.

Of the additional transport solutions identified by RWMD, the following two Type-B packages are considered to be the most feasible:

- The SWTC-150 transport container - initial indications suggest that the Hydrus vessel and stillage may fit inside the cavity of this transport container. This transport container was originally identified as a solution for the transport of waste packages from Sellafield, though there is a risk that this may never be developed by Sellafield Ltd or other UK waste producers.
- An optimised Re-usable Transport Container (RTC) – whilst this is an un-developed concept at the current time, RWMD could well develop such a flask to meet the demands of industry for the transport of packages that are larger than the current fleet of UILW containers.

AWE could propose to use any of the above transport containers to provide a transport solution for Option 4. However, any endorsement based on the use of such transport containers would be conditional on their future development. It is possible that NDA or other waste producers could develop these alternative transport containers, in which case, AWE would be in a position to adopt these for their own needs. However, if no such development is forthcoming, then the impetus to do so would rest entirely with AWE.

For the options involving intact vessels (Options 1 to 4), consideration has been given to the requirement to encapsulate the internals and contents of the vessels, or otherwise leave the waste unencapsulated within the vessels. RWMD considers that it may be feasible to engineer safe working solutions that do not require breach of containment of the vessels. Such solutions take credit for immobilisation of the radionuclides within the vessels. Nonetheless, the assessment has also identified a number of reasons why it might not be desirable to encapsulate the vessel contents. These reasons include the potential to adversely affect the expected passive nature of the waste within the vessels. Furthermore, it may be possible that any encapsulant would not offer any safety enhancement to the package on the basis that the vessel itself could prevent releases under routine and accident conditions. However, this case would need to be presented by AWE in future submissions.

The assessment indicates that the package comprising a sectioned Hydrus vessel grouted into a $3m^3$ Box (Option 5) should be compatible with RWMD requirements.

Subject to provision of further information, it is likely that this option could be endorsed at the Conceptual stage, based on previous experience with similar waste packages. RWMD recognises that sectioning the Hydrus vessels could create some significant operational challenges for AWE. Nevertheless, this option would provide a contingency in the event of other options not being suitable.

Future Development Work

In order to progress the proposed options towards Conceptual stage endorsement, AWE would need to address some or all of the following key issues:

- Since there are pros and cons associated with filling the vessels, AWE will need to present the case for infiltration of the vessels with encapsulant or otherwise leaving the vessels empty in any Conceptual stage submission. This will be important since the BPM case for not infilling the vessels must be capable of standing up to future challenge.
- Discuss proposals for transport of Hydrus vessels as IP-2 packages with the DfT. In order to obtain a Conceptual stage Letter of Compliance, AWE would need to obtain approval in principle for such transports with the DfT and provide evidence of this as part of any future submission.
- The feasibility of using the Transactive-20 needs to be better understood. This needs to address the re-licensing of this transport container for greater payloads, as well as exploring the compatibility with handling systems at the GDF.
- The outline design of a transport/handling stillage needs to be considered. This should seek to demonstrate compatibility with GDF handling and stacking requirements, and also confirm envelope dimensions to establish fitment inside an appropriate transport container.
- The provision of further information on the outline packages that would be generated from Option 5, including the size and mass of the vessel sections in each package.

Future development of the RTC/SWTC-150 would also be required should AWE wish to pursue the future use of such Type B containers.