Radioactive Waste Management Directorate

Packaging of Chute Silo Wastes at Berkeley using Type II Ductile Cast Iron Containers

(Interim stage)

Summary of Assessment Report

Issue date of Assessment Report: 26 August 2011

Background

EnergySolutions, acting as the Parent Body Organisation for the Magnox decommissioning station sites and in concert with the relevant Site Licence Company continues to seek innovative solutions for the management of radioactive wastes arising from preparations for care and maintenance of those sites. To this end, EnergySolutions has proposed adopting the German-designed and operated thick-walled Type II-15EI (MOSAIK flask) container for the packaging of the wastes currently stored in the Chute Silo at the Berkeley Decommissioning Site (hereafter the Berkeley chute silo wastes). This proposal represents a change to the current baseline for these wastes, which is currently based on cementation into thin-walled stainless steel containers of the types currently adopted for most ILW in the United Kingdom[1].

The proposed container, hereafter the Type II container, is constructed from Ductile Cast Iron (DCI). It is designed to be sufficiently robust to provide all safety functions required for transport and disposal in Germany without the need for the encapsulation of the waste or for additional external shielding. These properties offer the potential to package wastes for disposal without encapsulation and to avoid the need for a shielded store for interim storage. It is understood that the realisation of this opportunity would offer significant reductions in the cost and timescale for preparing the Berkeley site for care and maintenance.

To progress these proposals, advice on the disposability of the proposed packages has been sought from the NDA Radioactive Waste Management Directorate (hereafter RWMD). In particular, EnergySolutions, on behalf of Magnox, has sought Interim stage endorsement for the storage, transport and disposal of chute silo wastes from Berkeley decommissioning sites, using Type II containers. For convenience, and to avoid ambiguity when roles are unclear, throughout this summary the organisation responsible for the submission is referred to as 'Magnox'.

RWMD Reference Basis for Assessment and Endorsement

This assessment has considered the compatibility of the proposed packages with the requirements for safe long-term management, including storage, transport, emplacement and potentially extended storage underground, and disposal. The current reference basis for this assessment of disposability is a conceptual design for a Geological Disposal Facility (GDF) derived from the Nirex Phased Geological Repository Concept (PGRC). This is shortly to be updated to the recently-published generic Disposal System Safety Case (DSSC). Further information on the Letter of Compliance process is available elsewhere[2].

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1 *Magnox Optimised Decommissioning Programme, SR10 and Beyond*, Magnox Report TI-MS-07-MEL-2687 (Issue 6), September 2010.

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

The general requirements placed on ILW packages for disposal in a GDF are embodied in the Generic Waste Package Specification (GWPS). The GWPS has been supplemented, following a change control process, by an 'addendum' that reflects the 'robust shielded container' approach and the associated requirements for disposal[3]. The proposed packages for Magnox Care and Maintenance Preparation (CMP) wastes based on Type II and Type VI containers, including the Berkeley chute silo wastes packages, have been endorsed against these requirements at the Conceptual stage. The Conceptual stage assessment also identified detailed technical issues to be resolved at the current Interim stage.

In order to address the varied issues raised by the Conceptual stage assessment, subsequent Interim stage submissions have been based on individual waste streams, or particular waste types.

Assessment at the Interim stage is based on consideration of specific requirements that directly reflect the detail of the current conceptual design(s) for a GDF. These specific requirements are expressed as a detailed Waste Package Specification for a particular package design. In the case of novel proposals that may require significant modifications to the conceptual design(s) for a GDF, as is the case for packages based on Type II containers, the development of detailed Waste Package Specifications is preceded by a formal process of concept change. RWMD is currently implementing the necessary change and will develop a detailed Waste Package Specification for packages based on the Type II container.

A number of Interim stage submissions for the individual Magnox CMP wastes, including that for the Berkeley chute silo wastes, were made in anticipation of both the outcome of the Conceptual stage assessment and the approval and implementation of the necessary concept change. The initial stages of the assessment of these submissions have identified several common shortcomings and issues (common issues). Consequently, it has been agreed with Magnox that the 'common issues' should be managed and resolved separately to the continuing assessments for individual wastes such as the chute silo wastes.

Scope of the Assessment

The assessment has considered the proposed packages containing Berkeley chute silo wastes, which correspond to waste stream 9A44.

The continuing requirements to resolve the 'common issues' and to implement the necessary concept change, including developing a detailed Waste Package Specification, mean that RWMD is not be able to endorse the proposed packages at this time. Consequently, the Interim stage assessment has reviewed the proposed packages against the specific Interim stage Action Points raised by the Conceptual stage Assessment Report as they apply to the Berkeley chute silo waste packages. In addition, links to and overlaps with the 'common issues' discussed above are noted. A detailed Assessment of Disposability has not been reported at this time.

Packaging Proposals

Nature of the waste

The chute silo wastes comprise Miscellaneous Activated Components (MAC) from the operation of Berkeley Power Station, comprising fuel charge chutes, a thermocouple chute and control rods. These items are predominantly steel (stainless steel, boron steel, mild steel) with small quantities of iron shot concrete, high alloy steels and sealant materials (further information on the last of these will be required). The items were consigned to the Chute Silo between 1962 and 1978, where they have been stored in nominally dry conditions. Historical camera surveys indicate that the wastes have not visibly deteriorated.

[3] NDA, *Generic Specification for Robust Shielded Waste Packages*, Technical Note 13403461, November 2010.

The waste consists of 118 control rods, five fuel charge chutes and one trailing lead thermocouple chute, with a total mass of about 19,000 kg and an as-stored volume of about 38 m^3. The activity in the wastes derives primarily from the neutron activation of the constituent materials through use in the reactor cores. The degree of activation of the wastes is variable, dependent on the position and duration of use in the reactor cores. It is anticipated that the items also may have been contaminated during use. It is assumed that this contamination would take the form of fixed deposits, rather than as significant quantities of potentially mobile particles.

Waste processing and packaging

Magnox has proposed that the chute silo wastes would be packaged using the Type II DCI container, a robust, thick-walled container with a capacity similar to that of a 500 litre drum. To benefit from existing package approvals from the German transport regulator, the existing Type II container design would be used without modification.

The Type II containers are approved as both IP-2 and Type B transport containers. Magnox has proposed that the Type B configuration should be used for the packaging of the Berkeley chute silo wastes. This configuration requires impact limiters and thermal protection to meet Transport Regulations. The Type B variant of the Type II container may be manufactured with internal lead shielding to provide additional shielding of more active wastes. This option would be exercised for the more active fraction of the chute silo waste.

The waste items would be size-reduced and monitored prior to loading into the containers using one of two designs of insert to ensure suitable positioning.

Although the waste is nominally dry, it will be subject to a drying process after packing to guarantee the conditions within the packages. Proposals for dewatering or drying of the waste remain to be fully developed and proven, although it is understood that existing methods applied in Germany are likely to be adopted. In the absence of the necessary evidence of the effectiveness of a drying process, the assessment has assumed that the residual water would be suitably low. This assumption simplifies the assessment as corrosion and gas generation from radiolysis would be minimal. The sensitivity of the conclusions of the assessment to this assumption has been examined.

The packages would be stored to await transport to a disposal facility. The performance of the container seal would be confirmed to be compliant with the requirements of the Transport Certification immediately before transport. Furthermore, it is assumed that, should a container be noted to be non-compliant with the prescribed leak-tightness, remedial action will be taken.

Parameters for Assessment of Disposability

As noted above, the scope of the assessment has been limited to reviewing the proposed packages against existing Action Points and an Assessment of Disposability has not been reported. Nevertheless, the principal input parameters for an Assessment of Disposability have been deduced as a means of understanding the sufficiency of the submission.

Assessment Inventories and Number of Packages

To assess the disposability of the proposed packages, it is necessary to define suitably conservative waste package inventories that capture the range and variability of the package contents.

The submission presents inventory data derived from modelling of the activation of the control rods and chutes, taking into account variations in the neutron flux, the irradiation time and subsequent cooling time. In addition, an illustrative contribution for fixed contamination was estimated, based on the expected activity in reactor circuit and a pond sludge inventory (the latter being used as an approximation to possible contamination, rather than represent the actual source of the contamination). These data have been tested against generic data available to RWMD and have been judged to be a suitable basis for assessment.

The average package inventory for each packaging option was determined by dividing the total activity by the number of waste packages. The maximum package inventory was determined by considering the highest activity control rod sections for each packaging option.

The submission presents two options for the distribution of the waste between packages, which result in different numbers of packages, as follows:

- Concept Option (Option 1) – eight packages with 20mm lead shielding (each containing 69 control rod sections) and 28 packages with no lead shielding (each containing three chute silo sections and 24 control rod sections) – a total of 36 packages;
- Alternative Option (Option 2) – four packages with 40mm lead shielding (each containing 55 higher activity control rod sections); four packages with no lead shielding (each containing 73 lower activity control rod sections) and 22 packages with no lead shielding (each containing three charge chute sections and 22 lower activity control rod sections) – a total of 30 packages.

It is recognised that these options represent a provisional assignment of items between packages and this may need to be modified to accommodate the waste as it is retrieved and sentenced. Furthermore, it is known that some control rods are bent and therefore would be size reduced to a shorter length to allow loading. This will increase the number of a packages compared with the estimates above and as a result it is assumed that up to 40 packages could be produced.

For those waste items that do not require additional lead shielding, we understand that Magnox is considering whether such items should be packaged using the IP-2 variant of the Type II container. This alternative is not considered in this assessment. It should be noted that the lead shielding is an integral part of the container variant and cannot be removed or added once the container has been manufactured.

Waste Package Properties and Performance

In the absence of conditioning material, the containment of mobile activity associated with the waste under both normal and fault conditions depends significantly on the performance of the Type II container. However, in the case of larger steel components such as the chute silo waste, it is assumed that the waste itself offers a high degree of retention of radionuclides.

Based on the above, it is assessed that the proposed packages would provide the necessary containment of activity under both normal and accident conditions for the transport and operational phases. This assumed behaviour takes credit for the currently established understanding and demonstration of the performance of the container. Further evidence of container performance is not sought for these proposed packages. This conclusion is specific to the Berkeley chute silo wastes and does not remove the need to address such Action Points for other proposed packages.

The simplified treatment of the performance of the packages depends on the absence of a significant source term of mobile particles. Although this requirement is consistent with the description of the chute silo wastes, it is important to note that the current conclusions of this assessment depend on the assumed absence of such particles, including the development of dispersible corrosion product. This in turn requires that the dryness of the waste be demonstrated. In the event that these expectations cannot be fulfilled, the arguments used herein would need to be re-visited.

Compatibility with Specifications

At the Interim stage it is necessary to demonstrate the compliance of the proposed packages with an appropriate detailed Waste Package Specification. As discussed above, the necessary specification is not yet available and therefore compliance cannot yet be established.

Review of Technical Issues and Action Points

The Conceptual stage assessment for Magnox CMP wastes identified 20 Action Points to be addressed at the Interim stage. The proposed packages containing Berkeley chute silo wastes have been reviewed against these Action Points and it has been determined that nine Action Points have been addressed satisfactorily for these packages, or do not apply. The remaining 11 Action Points remain to be fully resolved. These continuing Action Points are set out in Section 5 of the Assessment Report.

It is noted that several of the remaining Action Points correspond to general shortcomings in submitted information and are covered by the 'common issues'. Examples include the fulfilment of expectations regarding Data Recording and the demonstration of the application of a suitable Quality Management System.

The current assessment has taken credit for specific features of the proposed waste packages (as listed below) in resolving the Interim stage Action Points (and in determining that other Action Points remain to be resolved). It is essential that such features are maintained to ensure the validity of the arguments that would ultimately support the Assessment of Disposability.

The key features of the proposed waste packages for Berkeley chute silo wastes identified in the current assessment are as follows:

- the waste is packaged using Type II containers and ultimately would be transported under Type B arrangements;
- the waste comprises intact solid items with no significant particulate material present;
- contamination levels are suitably represented by the current illustrative inventories;
- should significant particulate material be present, it would be diverted from the waste for separate processing;
- fines generated from size reduction also would be diverted for separate processing;
- the waste would be dried to a residual water content consistent with preventing the generation of a significant quantity of particulate material derived from corrosion products (this position is an assumption and has not yet been demonstrated to the satisfaction of RWMD);
- the waste would be dried to a residual water content consistent with preventing gas pressure through corrosion or radiolysis (this position is an assumption and has not yet been demonstrated to the satisfaction of RWMD).

Should these key features not be maintained, consideration would need to be given to the construction of alternative arguments. It should be noted that such arguments might depend on information that would have been generated under Interim stage Action Points that have been determined to be resolved for the Berkeley chute silo wastes.

Conclusions

A curtailed Interim stage assessment has been undertaken for the proposed packages containing Berkeley chute silo wastes, based on the use of Type II Ductile Cast Iron Containers. This curtailed assessment has focused on considering the outstanding Interim stage Action Points as they apply to these proposed packages.

The assessment has determined that a number of Interim stage Action Points remain to be resolved at this time. Further interactions with Magnox will be sought to resolve these outstanding issues. Some of the identified issues correspond to facets of the 'Common Issues' regarding the suite of submissions for the packaging of Magnox CMP wastes.

The conclusions of the current assessment have been based on a number of key features of the wastes, in particular the assumed absence of significant quantities of particulate material and the successful drying of the waste to a suitable residual water content. Further evidence to demonstrate the validity of these key features is sought.

The continuing need to resolve 'common issues' with the submissions for these and other Magnox CMP wastes, and to implement the concept change necessary to accommodate the proposed DCI containers, mean that RWMD is not be able to endorse the proposed packages at this time. Consequently an Assessment of Disposability is not reported at this time.