Radioactive Waste Management Directorate

Packaging of Berkeley MCI in Vault 3 and the Shielded Area using Type II and Type VI Ductile Cast Iron Containers

(Interim stage)

Summary of Assessment Report

Issue date of Assessment Report: 22 December 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-15 EI (MOSAIK) and Type VI-15 (GNS Yellow Box or MiniStore) containers for the packaging of Miscellaneous Contaminated Items (MCI) that is currently stored in the Active Waste Vaults and Shielded Area at the Berkeley Nuclear Licensed Site (BNLS); hereafter the Berkeley Vault 3 and SA MCI. The wastes are derived from operation of areas of the BNLS formerly known as Berkeley Power Station (BPS) and Berkeley Technology Centre (BTC). This proposal represents a change to the 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 containers, hereafter the Type II and Type VI container, are constructed from Ductile Cast Iron (DCI). They are 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 Berkeley Vault 3 and SA MCI using Type II (with and without shielding) and Type VI 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'.

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

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].

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 numerous Magnox Care and Maintenance Preparation (CMP) wastes based on Type II and Type VI containers have been endorsed against these requirements at the Conceptual stage[4]. The Conceptual stage assessment[5] 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 and Type VI 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 detailed Waste Package Specifications for packages based on the Type II and Type VI containers as part of this implementation.

A number of Interim stage submissions for the individual Magnox CMP ILW streams, including that for the Berkeley Vault 3 and SA MCI, 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 Berkeley Vault 3 and SA MCI.

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

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

4 Five of the waste streams in Berkeley Vault 3 MCI were excluded from the Conceptual stage endorsement since the information provided on the composition had >50% of the weight unspecified.

5 *Packaging of Magnox Care and Maintenance Preparation Wastes into Ductile Cast Iron Containers (Conceptual Stage)*, NDA Assessment Report NXA/14837157 (Issue 5 of the Assessment Report), July 2011.

Scope of the Assessment

The assessment has considered the proposed packages containing Berkeley Vault 3 and SA MCI, which corresponds to the following 14 waste streams:

- 9A36 to 9A38 BPS MCI;
- 9A57 to 9A59 Celite;
- 9A65 BTC FED;
- 9A68 to 9A70 BTC MCI;
- 9A82 Ion exchange (IEX) resin;
- 9R02 Miscellaneous ILW;
- 9R10 IEX materials;
- 9R101 Primary ILW.

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 Interim stage 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 Vault 3 and SA MCI packages. Finally, links to and overlaps with the 'common issues' discussed above are noted. As a result of the 'common issues' identified, a detailed Assessment of Disposability has not been completed or reported at this time.

Packaging Proposals

Nature of the waste

Operation of the Berkeley Nuclear Licensed Site (BNLS) has given rise to various radioactive waste streams. BNLS comprises areas formerly known as Berkeley Power Station (BPS) and Berkeley Technology Centre (BTC).

The wastes included in the current proposals, as currently stored in two separate locations: Berkeley Active Waste Vault 3 and the Shielded Area; these have arisen from a range of individual processes and operations and can be summarised as:

- BPS MCI arising from plant maintenance and replacement during the operation of BPS (11.3 m^3);
- BTC MCI arising mainly from PIE work in the BTC caves and cells (111.5 m^3);
- BTC FED arising from post-irradiation examination (PIE) of Magnox fuel elements (0.5 m^3);
- Ion exchange material used to infill containers of MCI (3 m^3);
- Celite (63.3 m^3);
- C35 ILW arising from AGR PIE activities (11 m^3);
- Ion exchange material (0.5 m^3); and
- E23 ILW arising from POCO and decommissioning of the Shielded Area (35.8 m^3).

Vault 3 is divided into sub-vaults (denoted as A, B and C) based upon the point of waste tipping, although there is no physical separation within the vault. The wastes in Vault 3 are co-stored with separate containers of AETP and PWTP sludge which may also contaminate the MCI wastes due to degradation of the cans during storage.

Waste processing and packaging

Magnox has proposed the separate retrieval and packaging of:

- Vault 3 MCI;
- Shielded Area wastes:
  - C35 ILW;
  - E23 ILW.

The Vault 3 waste and E23 ILW would be shredded and packaged using the Type VI DCI container; a sealed robust shielded container (RSC) suitable for Type IP-2 transport, which has a capacity similar to that of a 3 m³ Box. The C35 ILW would be shredded and packaged using either a Type VI DCIC, or the Type II DCI container, a robust, thick-walled container with a capacity similar to that of a 500 litre drum, either with or without shielding. To benefit from existing package approvals from the German transport regulator, the existing Type II and Type VI DCIC designs 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 C35 ILW. This configuration requires impact limiters and thermal protection to meet Transport Regulations. The proposed Type B(U) variant of the Type II container may be manufactured with internal lead shielding to provide additional shielding of more active wastes. It is currently planned that this option would be implemented for the more highly active waste from the C35 ILW stream.

The GNS KETRA heating jackets (or similar) would be deployed in order to vacuum dry the waste after retrieval and packing into the Type II and Type VI containers. Magnox states that the end point of the drying process would be deemed to have been met when the total water content of air measured less than 75% RH (equivalent to 15 g per m^3 of air), with no free water.

The packages would be stored to await transport to a geological disposal facility. Confirmation of compliance of the performance of the container sealing system (closure) with the requirements of the Qualification Certificate would be sought shortly before transport. It is assumed that remedial action would be taken should a container be noted to be non-compliant with the prescribed leak-tightness.

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 the 2007 UK RWI. These data have been enhanced using generic inventory data for Magnox fuel and AGR fuel, where appropriate, to provide a conservative assessment inventory. RWMD has judged that these data provide a suitable basis for assessment.

An average package inventory was determined for the Vault 3 MCI and E23 ILW waste packages, which included a contribution from contaminants; for Vault 3 MCI, the average was determined by dividing the total activity of the wastes in Vault 3 by the number of Type VI packages determined by the total volume in the Vault. Similarly, the average inventory for the E23 ILW waste package was determined by dividing the total activity of E23 ILW by the number of Type VI packages determined by the total volume in the waste stream.

The C35 ILW stream has been divided into three categories for each of the three package types: high (Type II with shielding), medium (Type II) and low (Type VI), based on activity measurements, in line with shielding calculations. Average radionuclide inventories have been derived for each waste package type based on these measured activities.

A total of five maximum assessment inventories were derived: one for each waste package type.

Based on the process description in the submission, the waste loadings of the Type II (with and without shielding) and Type VI DCICs are assumed to be 0.37 m^3, 0.49 m^3 and 2.5 m^3, respectively. On this basis, it is concluded that the following packages would be produced:

- 76 Type VI-15 waste packages containing Vault 3 MCI
- 15 Type VI-15 waste packages containing E23 ILW
- 2 Type VI-15 waste packages containing C35 ILW
- 9 Type II-15, without shielding, waste packages containing C35 ILW
- 11 Type II-15, with 30 mm lead shielding, waste packages containing C35 ILW.

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 DCIC.

The expected performance of the containers in the relevant design basis accidents has not yet been demonstrated to the satisfaction of RWMD. Consequently, it is assumed that activity would be released from a package in an accident, the potential releases being quantified by release fractions applied to package inventories. In the case of an impact accident, suspendible particles are assumed to be entrained in gases vented from the package as pressure is relieved. In the case of a fire accident, volatile and gaseous species are assumed to be released.

Although the release fractions have been found to be moderate, the potential releases, and any resulting doses, are subject to the need to demonstrate that an ALARP approach to safety has been adopted. In practice, this expectation should be informed by assessment of the expected releases using an appropriate RWMD operational safety assessment toolkit and, potentially, by considering the additional containment offered by the Type II and Type VI DCICs in an impact or fire accident. These expectations have not yet been fulfilled.

As the proposed DCIC packages are sealed and un-vented, the generation of gas within the package (e.g. by radiolysis of water and organic components of the wasteform) may be significant, with any resulting pressurisation potentially influencing the ability of the packages to contain radionuclides under both normal and accident conditions. Initial analyses demonstrate that the extent of pressurisation is, in effect, strongly dependent on the assumed but unsubstantiated permeability of the seal. It is therefore concluded that Magnox has not yet provided sufficient evidence to demonstrate that the necessary performance of the seal would be achieved in practice and therefore it is not yet proven that significant pressurisation would not occur.

A substantiated assessment of the potential for pressurisation should be based on a suitably detailed understanding of the container design and the performance of relevant elements of the container such as the sealing system (closure). This information has not yet been made available.

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 specifications are not yet available and therefore compliance cannot yet be established.

Review of Technical Issues and Action Points

The Conceptual stage assessment for Magnox CMP ILW in Type II and VI containers identified 20 Action Points to be addressed at the Interim stage, with a further four general Action Points being identified in the Interim stage assessments for Berkeley chute silo wastes and Bradwell Vault 6A sludge. The proposed packages have been reviewed against all relevant Action Points and it has been determined that one Action Point does not apply. The remaining 23 Action points have not been fully resolved for the packages considered here.

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, for the packages considered here, 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 Vault 3 and SA MCI identified in the current assessment are as follows:

- the Vault 3 MCI, E23 ILW and part of the C35 ILW is packaged using Type VI DCICs and ultimately would be transported under Type IP-2 arrangements;
- the remaining C35 ILW waste is packaged using Type II containers (with or without shielding) and ultimately would be transported under Type B arrangements;
- the waste comprises MCI with IEX and which may also be contaminated with Celite and sludge;
- the particulate material source term is not currently quantified and may evolve as the waste is packaged and stored;
- the radionuclide content of the packages is adequately represented by the current assessment inventories;
- the residual water content of the waste must be managed to ensure that all relevant criteria can be fulfilled. The appropriate limit has not yet been defined or substantiated. The current conclusions reflect this uncertainty.

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 otherwise would be (and have been) deemed to be resolved for the Berkeley Vault 3 and SA MCI in Type II and Type VI DCIC waste packages.

Conclusions

A curtailed Interim stage assessment has been undertaken for the proposed packages containing Berkeley Vault 3 and SA MCI waste, based on the use of both Type II and Type VI Ductile Cast Iron Containers compliant with the requirements for transport under Type B(U) and Type IP-2 arrangements. This curtailed assessment has focused on considering the outstanding Interim stage Action Points as they apply to these proposed packages. At this time a full Assessment of Disposability is not reported and the compliance of the proposed packages with all the requirements for transport, handling and disposal at a Geological Disposal Facility is not formally assessed. This reflects the current ongoing assessment of the proposed change to adopt packages based on Type II and Type VI containers into the GDF concept and the need to complete relevant elements of the implementation of this change to allow a formal Assessment of Disposability to be completed and reported.

The assessment has determined that a number of Interim stage Action Points remain to be resolved for these proposed waste packages. 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 Care and Maintenance Preparation wastes using the Type II and Type VI containers.

The conclusions of the current assessment have been based on a number of key features of the wastes, in particular the successful drying of the waste to a defined residual water content and the particulate content of the waste. Further evidence to demonstrate the validity of these assumed key features has been sought under the 'common issues'.

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