

# Packaging of Ion Exchange Materials at Bradwell using Type II Ductile Cast Iron Containers (Interim stage)

## Summary of Assessment Report

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### **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 (MOSAİK flask) container for the packaging of the Ion Exchange (IEX) materials currently stored in vessel 56V at Bradwell Decommissioning Site (hereafter the Bradwell IEX materials). 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<sup>1</sup>.

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 of appropriate waste 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 Bradwell 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 transport and disposal of Bradwell IEX materials 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<sup>2</sup>.

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

<sup>2</sup> 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<sup>3</sup>. The proposed packages for Magnox Care and Maintenance Preparation (CMP) wastes based on Type II and Type VI containers, including the Bradwell IEX materials 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 Bradwell IEX materials, 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 Bradwell IEX materials.

### ***Scope of the Assessment***

The assessment has considered the proposed packages containing Bradwell IEX materials, which correspond to waste stream 9B02 in the 2010 Radioactive Waste Inventory.

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 Bradwell IEX materials packages. Links to and overlaps with the 'common issues' are noted.

The Bradwell IEX materials were the subject of a previous, Conceptual stage assessment based on cementation of the materials. Although these proposals are now superseded, the Action Points raised at that time have been reviewed to establish whether any outstanding issues continue to apply to the current proposals.

A detailed Assessment of Disposability has not been reported at this time.

### ***Packaging Proposals***

#### ***Nature of the waste***

From 1968 to the present day, a variety of organic (Lewatit DN and Duolite C3) and inorganic (Duocil, Decalso Y, Attapulugus clay and AW-500) IEX materials have been used by Bradwell power station for abatement of caesium from the Fuel Cooling Pond. The spent IEX materials are stored in a single closed mild steel storage vessel (56V). Storage vessel 56V

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

contains an estimated 21m<sup>3</sup> of flooded IEX materials. Individual charges (approximately 0.34m<sup>3</sup>) of each IEX material were added to vessel 56V. It is therefore expected that the waste IEX materials may be present as broadly stratified layers.

### ***Waste processing and packaging***

Magnox has proposed that the Bradwell IEX materials 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 Bradwell IEX materials. This configuration requires impact limiters and thermal protection to meet the requirements of the 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. It is not currently planned that this option would be implemented for the IEX materials.

The stored IEX materials would be retrieved from the vessel by fluidisation and pumping, and transferred into a 2.5m<sup>3</sup> shielded batch tank located in a processing area. The retrieved materials subsequently would be transferred from the shielded batch tank to a Type II container using a FAFNIR-V unit (a purpose-designed unit supplied by GNS), which would also remove the bulk of over-standing liquid from the IEX materials.

Once a container is filled to the appropriate level (approximately 95% of the available volume), the package would be left to stand for one week, allowing further settling and draining of the waste. Following the drain down period, the IEX material would be dewatered using the NEWA system (a purpose-designed unit supplied by GNS) which would draw liquid from a 5mm deep sump located at the base of the Type II container. It is planned that the dewatering process would be repeated at hourly intervals until a target residual free water content of 1% (4.9 litres) is achieved.

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 would 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 sampling of the stored IEX material undertaken in 1989, together with records of the individual batches of material consigned to the storage vessel. These data have been enhanced using generic inventory data for Magnox fuel to provide a conservative assessment inventory. RWMD has judged that these data provide a suitable basis for assessment.

The average package inventory was determined by dividing the total activity by the number of waste packages. The conservative waste package radionuclide inventory has been derived by basing the assessment inventory on the batch of material with the highest reported dose rate.

Based on the process description, the waste loading is assumed to be 95% of the capacity of the container. Hence, for assessment purposes a full Type II container is assumed to contain 466 litres of drained IEX material with a free water content of up to 4.9 litres. On this basis, it is concluded that 47 packages of Bradwell IEX materials would be produced.

### ***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. The expected performance of the containers in the relevant design basis accidents has not yet been demonstrated adequately. Magnox continues to investigate the expected performance of the containers.

In the absence of satisfactory evidence of the performance of the container in an accident, RWMD has developed simple, conservative models of the potential releases of activity from packages in accidents, based on the properties of the waste itself and taking no credit for the container. This conservative approach ultimately may be superseded, or additional mitigations identified, once the expected performance of the container in accidents has been better demonstrated.

The potential releases have been quantified as release fractions. In the case of an impact accident, suspendible particles are assumed to be entrained in gases vented from the package as pressure is relieved through a suitable opening caused by the impact. In the case of a fire accident, volatile and gases species are assumed to be released after degradation of the container seals.

Although the estimated release fractions are 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 fulfilled by assessing the expected releases using an appropriate RWMD operational safety assessment toolkit and, potentially, by considering the additional containment offered by the Type II container in impact and fire accidents. These expectations have not yet been fulfilled.

As the proposed DCIC package is sealed and un-vented, the generation of gas within the package 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 gas loss rate, which is currently represented in models as an assumed permeability of the seal. Magnox has not yet provided sufficient evidence to demonstrate that the necessary performance of the seal would be achieved and maintained in practice and therefore it is not yet proven that significant pressurisation would not occur.

Prior pressurisation of a package also might influence the response of the container to an accident. 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 closure. This information has not yet been made available and this matter represents a potentially significant uncertainty.

### ***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 in Type II and VI containers identified 20 Action Points to be addressed at the Interim stage, with a further general Action Point being identified in the Interim stage assessment for Berkeley chute silo wastes. A further 23 Action Points were identified in the previous assessment of the baseline packaging proposals for Bradwell IEX materials based on grouting. The proposed packages containing Bradwell IEX materials have been reviewed against all relevant Action Points and it has been determined that 27 Action Points have been addressed satisfactorily for these packages, or do not apply. The remaining 17 Action Points are therefore continued and are listed in detail in 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 assumed 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. Where credit has been taken for these features in resolving Action Points, 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 Bradwell IEX materials 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 organic and inorganic materials with significant particulate material present;
- the particulate material source term may evolve as the waste is packaged and stored, any such evolution should not undermine existing arguments;
- the radionuclide content of the packages are likely to be represented by the current assessment inventories;
- the rate of loss of gas through the container closure should be consistent with maintaining tolerable peak pressures in the packages;
- the residual water content of the waste will be managed to ensure that all relevant criteria can be fulfilled. The appropriate limit has not yet been substantiated or shown to be achievable in practice. 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 have been determined to be resolved for the Bradwell IEX materials.

## ***Conclusions***

A curtailed Interim stage assessment has been undertaken for the proposed packages containing Bradwell IEX materials, 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. 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 able to endorse the proposed packages at this time. Consequently an Assessment of Disposability is not reported at this time.