

Packaging of Sizewell B ILW Ion Exchange Resin (Lower Activity Envelope) in Vented DCICs (Final Stage)

Summary of Assessment Report

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Background

Radioactive Waste Management Limited (hereafter RWM) has undertaken a Final stage Disposability Assessment of the proposals by EDF Energy Nuclear Generation Ltd (hereafter NGL) for the packaging of current stocks and future arisings of spent Lower Activity Envelope (LAE) ILW ion exchange (IEX) resins at Sizewell B power station.

The proposals are for packaging dewatered IEX resin in vented Type II (MOSAİK® II-15 EI Variant 2) Ductile Cast Iron Containers (DCICs) for storage and future transport in a Standard Waste Transport Container (SWTC) as Type B packages. A Type II DCIC is an example of a 500 litre robust shielded drum waste container.

The Type II DCIC was originally 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.

The objectives of this Final stage assessment of proposals for packages of Sizewell B LAE resin are to provide NGL with:

- An assessment of disposability in accordance with the Joint Regulators' Guidance on the management of higher activity radioactive waste on nuclear licensed sites
- Supporting advice on disposability of packages of Sizewell B LAE IEX resin in Type II DCICs in the form of an Assessment Report
- Where appropriate, endorsement of the proposals via issue of a Letter of Compliance (LoC).

Further information on the Disposability Assessment process is available elsewhere¹.

RWM Reference Basis for Assessment and Endorsement

The Disposability Assessment process considers the compatibility of the proposed packages with the requirements for safe long-term management, including interim storage at the site of arising, transport, emplacement and potentially extended storage underground, and geological disposal. The current reference basis for such an assessment is the documented disposal system concept and safety case for a Geological Disposal Facility (GDF), the latter derived from the published generic Disposal System Safety Case (DSSC).

The general requirements placed on waste packages for disposal in a GDF are embodied in the Generic Waste Package Specification (GWPS)². Further

¹ NDA, *Geological Disposal: An Overview of the RWM Disposability Assessment Process*, WPS/650/03, April 2014.

requirements for particular types of waste package are embodied in the relevant Waste Package Specification (WPS). In the case of the Sizewell B LAE IEX resin waste packages, the relevant specific requirements are those developed in the WPS for 500 litre robust shielded drum waste packages to be transported in a Standard Waste Transport Container (WPS/380/01). An essential component of these requirements includes consideration of the effects of interim on-site storage of the conditioned waste at the Sizewell B site.

Scope of the Assessment

ILW resins have arisen as a result of station operations at the Sizewell B Pressurised Water Reactor power station. The station began operations in 1995 and is currently expected to be shut down in 2035; resins are expected to arise until 2038, to accommodate decommissioning activities.

The scope of the current assessment covers stocks and arisings until 2026 only, representing the LAE. Arisings post-2026 (up to 2038), which are expected to be within the Higher Activity Envelope (HAE), will be covered by separate packaging proposals and are excluded from this assessment.

The LAE IEX resins represents part of 2013 UK RWI waste stream 3S12; *CVCS Resins and Spent Resins (ILW)*.

An incomplete Assessment of Disposability for the Campaign 1 and 2 proposals has been reported previously. The objective of this Final stage assessment is to provide a finalised Assessment of Disposability in order to support the disposal of packages of Sizewell B LAE IEX resin in Type II DCICs.

Packaging Process

Nature of the waste

NGL has prepared Final stage proposals for the packaging of ILW IEX resins at Sizewell B in two campaigns (Campaigns 1 and 2), covering both stocks currently packaged and in interim storage and approximately half of the total future arisings to the current planned end of station life. The currently packaged resins consist of a variety of spent organic IEX resin products comprising mixed anion and cation bead resins. All resins are based on styrene divinylbenzene (DVB) co-polymer. It is anticipated that future arisings of resins (to be packaged in Campaign 2) would not be significantly different to those in storage. The total volume of waste packaged in Campaign 1 was 25 m³, with a further 25 m³ of arisings to be packaged in 2026 (Campaign 2).

Waste processing and packaging

The resin would be retrieved from the current storage tanks using existing site infrastructure and transferred into Type II DCICs using the GNS FAFNIR V processing plant. Subsequently, the resins would be bulk-dewatered using the FAFNIR V plant and further dewatered using the GNS NEWA plant. FAFNIR V and NEWA are standard plant items used in Germany. This process would reduce the 'free water' content to a target of less than 1% by volume, or about 5 litres per package. The currently proposed process would not seek to remove 'bound water' directly associated with the resin beads. 'Bound water' would represent around half of the mass of the dewatered IEX resin.

² NDA, Geological Disposal: Generic Waste Package Specification, NDA/RWMD/067, March 2012.

The waste package would then be sealed and placed in an interim store until the currently assumed earliest date of transport to a GDF, namely 2040. A vented closure lid would be fitted as part of preparations for transport.

NGL development work has shown that process requirements are defined by the following elements: requirements for the dewatering of the waste and the dewatering end point; waste package mass; and the waste radionuclide composition. RWM considers that NGL has placed appropriate operational controls in place via the Waste Product Specification to meet the process requirements.

The proposed interim storage arrangements include control of environmental conditions in order to: maintain the DCIC waste package seals in a temperature range of 0 to 40°C; minimise the likelihood of condensation forming on the waste packages by the operation of dehumidifiers; and, minimise contamination of the waste packages by pollutants (e.g. marine salts) through use of filtered air inlets. An inspection and monitoring regime is in place to ensure that the required waste package performance can be maintained through any necessary intervention.

Assessment inventory and number of packages

The assessment inventory defined for Campaign 1 IEX resins is principally based upon characterisation data for arisings to 2008, with three additional years arisings based upon best estimate Station Safety Report data. The resulting Campaign 1 inventory has been augmented using extrapolations from generic fuel data for relatively high burn-up fuel. The separate contributions to the total have been individually decayed to 2040. The assessment inventory defined for Campaign 2 IEX resins is based upon that for Campaign 1, but with lower decay time to reflect the later date of arisings. This approach to the derivation of the total inventory of the resins for each campaign is judged to be based on well-provenanced sources, with a proportionate approach to the augmentation of the data being adopted.

The number of waste packages produced in Campaign 1 is 55; this was constrained by the number of containers purchased for this campaign. It is envisaged that Campaign 2 will also produce 55 waste packages in 2026, thereby giving a total of 110 waste packages, which have been considered within this assessment.

Assessment of Disposability

Waste package properties and performance

RWM considers that the 'as manufactured' Sizewell B LAE IEX resin wasteforms are likely to perform adequately in the context of mechanical and physical properties and that evolution of the wasteform is unlikely to have any significant detrimental effect on wasteform mechanical and physical properties or performance of the waste package.

The vented Type II (MOSAIK II-15 EI) DCIC is considered by RWM to represent 'sound engineering' practice and was modified to meet the requirements of the transport and GDF systems as expressed in the relevant WPS. RWM has confidence in the durability of the integrity of the waste container for a period of 500 years during on-site storage and at a GDF, including stacking and handling features.

The proposed Sizewell B LAE IEX resin in Type II DCIC waste packages would generate gas, principally hydrogen from radiolysis of water and organic materials. Gas generation rates and container pressurisation have been considered particularly in regard to a potential scenario in which a vent were to become blocked. RWM has confidence that Campaign 1 waste packages would not pressurise significantly, thereby supporting Final stage endorsement. There is uncertainty as to whether Campaign 2 waste packages would meet gas pressurisation limits and therefore NGL has committed to redesigning the vent prior to it being fitted if this is required.

NGL has defined a Safe Fissile Mass (SFM) for Sizewell B LAE IEX resin in Type II DCIC waste packages which is consistent with fissile exception under paragraph 417(e) of the IAEA Transport Regulations (2012 Edition) as implemented in UK law. RWM is content that no operational controls are required to ensure criticality safety of the proposed waste packages.

The impact performance justification for DCIC waste packages describes the response of DCICs to a range of relevant impact accident conditions up to 500 years from waste package manufacture. On the basis of this, RWM has confidence that Type II DCICs would retain structural integrity under bounding GDF impact accident conditions for an illustrative three-high stack vault design (five-high stacking is retained by RWM as an opportunity for optimisation).

The impact performance justification for DCIC waste packages also defines airborne release fractions (ARFs) for the waste in the event of impact accidents, based upon experimental data describing the behaviour of powders under impact conditions. RWM has used these ARFs to define waste package impact accident RFs taking account of loss of containment at the main lid/body interface, and assuming a bounding internal pressure within the waste package.

The performance of Sizewell B LAE resin in Type II DCIC waste packages under fire accident scenarios has been considered particularly in regard to the anticipated temperatures experienced in a fire, the structural response of the containers to fires and associated pressurisation, and the potential release of radionuclides as a result of a fire. RWM considers that the waste packages will retain structural integrity in a fire. RWM has conservatively defined fire RFs on the basis that the IEX resin degrades and no containment is offered by the DCIC.

Compliance with the transport system design and Transport Safety Case

The proposed waste packages have been assessed against the transport safety aspects of the WPS for 500 litre robust shielded drum waste packages to be transported in a Standard Waste Transport Container, and directly against the requirements of the IAEA Transport Regulations as established in the generic DSSC.

On the basis of quantified estimates of package performance, RWM has confidence that the Sizewell B LAE IEX resin in Type II DCIC waste packages would be compliant with the transport system design and safety case as currently foreseen.

Compliance with engineering design and the Operational Safety Case

The proposed waste packages have been assessed against the operational safety aspects of the WPS for 500 litre robust shielded drum waste packages and directly against the requirements of the deterministic operational safety case established in the generic DSSC.

On the basis of quantified estimates of package performance, RWM has confidence that Sizewell B LAE IEX resin in Type II DCIC waste packages would be compliant with the disposal system engineering design and Operational Safety Case as currently foreseen.

Compliance with the Environmental Safety Case

The proposed waste packages have been assessed against the environmental safety aspects of the WPS for 500 litre robust shielded drum waste packages and directly against the requirements of the environmental safety case established in the generic DSSC.

On the basis of quantified estimates of package performance, RWM has confidence that the Sizewell B LAE IEX resin in Type II DCIC waste packages would be consistent with the published generic Operational Environmental Safety Assessment.

Consideration of the properties of the proposed waste packages, including evolution of such properties, also provides confidence that they would be consistent with the published generic Post-closure Safety Assessment.

Overall, RWM has confidence that Sizewell B LAE IEX resin in Type II DCIC waste packages would be compliant with the disposal system Environmental Safety Case as currently foreseen.

The potential for, and significance of, voidage within packages to alter the performance of the engineered barrier system as containers corrode is being considered as part of ongoing work by RWM and the option to void-fill a sub-set waste packages, if required, is to be retained.

Status of Management System

NGL has supplied approved versions of Management System documents, including Quality Plans, operating instructions, evidence of internal assurance activities, and a Company Specification for management of non-conforming waste packages. These provide RWM with confidence that the Sizewell B LAE IEX resin in Type II DCIC waste packages would be manufactured and stored in compliance with the approved Waste Product Specification and Criticality Compliance Assurance Documentation.

Status of waste package records and information

RWM considers that the proposed waste package data and information recording system is compatible with the requirements specified in the Generic Waste Package Specification and the Data and Information Recording Specification. This provides adequate reassurance that relevant data will be recorded. NGL plans for the long term management of information and records are sufficiently developed to provide confidence that they would meet RWM requirements.

Conclusions of Assessment of Disposability

The proposed Sizewell B LAE IEX resin in Type II DCIC waste packages have been found to be consistent with RWM requirements as currently foreseen and therefore are considered disposable. The arrangements for controlling the production of waste packages and the associated waste package records are satisfactory.

Requirements for further work

The Assessment of Disposability has concluded that the proposed Sizewell B LAE IEX resin in Type II DCIC waste packages are disposable and all outstanding Action Points have been closed.

RWM requires that NGL keeps the suitability of the proposed replacement vented closure lid design under review, taking into account the results of ongoing waste package pressure monitoring, the and Campaign 2 waste package inventories, and modifies the design if necessary. RWM interactions with other waste packagers have confirmed the feasibility of a vent assembly design with sufficient gas pathway over an extended period. Given that NGL does not intend to fit the replacement vented closure lids to the waste packages until the time of transport, the residual uncertainty will be managed by a Qualification to Final stage LoC endorsement, expressed as a Condition.

Conclusions

The Final stage Disposability Assessment undertaken for the proposed Type II DCIC waste packages containing LAE IEX resin from the Sizewell B site has considered the consistency of the proposed packages with RWM requirements for safe long-term management, including interim storage at the site of arising, transport, emplacement and extended storage underground, and geological disposal. It is concluded that the

proposed waste packages are consistent with RWM requirements as currently foreseen and therefore the packages may be endorsed at the Final stage through the issue of a Final stage Letter of Compliance.

RWM has judged that a small number of remaining requirements that do not preclude endorsement are most appropriately addressed as Qualifications to the endorsement. These Qualifications have been captured as six Conditions and one Caveat.