

Bradwell Miscellaneous ILW in Type II DCICs(Final Stage)

Summary of Assessment Report

Issue date of Assessment Report: 02 August 2016

Background

Radioactive Waste Management Limited (hereafter RWM) (formerly NDA Radioactive Waste Management Directorate) has undertaken a Final stage Disposability Assessment of the proposals by Magnox Limited for the packaging of certain miscellaneous intermediate level wastes (MILW) at the Bradwell Site.

The proposals are for packaging dried MILW, packaged within inner drums or baskets in vented Type II (GNS MOSAIK® II-15 T ISAR) 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 objectives of this Final stage assessment are to provide Magnox 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 the proposed Bradwell MILW in Type II DCIC waste packages 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.

The packaging of Bradwell MILW has been the subject of various previous interactions. Notably, Conceptual stage LoC endorsement was provided in 2011 for packaging of Magnox Care and Maintenance Preparation (CMP) Intermediate Level Waste (ILW) in DCICs, of which Bradwell MILW is a component. Subsequent interactions culminated in 2015 with RWM providing a positive view of the controlling documents for packaging Bradwell MILW, in advance of the current Final stage assessment.

Future tense is used when referring to the packaging process in this document, although RWM recognises that packaging of the wastes has commenced.

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

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

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 requirements for particular types of waste package are embodied in the relevant Waste Package Specification (WPS). In the case of the Bradwell Type II MILW 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 Bradwell Site.

Scope of the Assessment

Bradwell Power Station was operational from 1962 to 2002, was defueled over the period 2003 to 2006, and is currently in an ongoing period of Care and Maintenance Preparation.

Operation of the two Magnox reactors, and the associated vaults, ponds and effluent treatment plants at Bradwell has generated various waste streams that are considered as MILW. The MILW to be packaged in Type II DCICs comprises parts of the following 2013 UK Radioactive Waste Inventory (RWI) streams:

- 9B55 (Ponds Decontamination Sludge)
- 9B59 (FED Magnox)
- 9B63 (Contaminated Gravel)
- 9B65 (Sand and Gravel in Sand Pressure Filters)
- 9B77 (FED Magnox Dust/Sludge)
- 9B83 (Graphite Filter Dust Pots).

Packaging Process

Nature of the waste

The MILW to be packaged in Type II DCICs comprises:

- Centre Bay wastes; shielded drums containing residual mixed solid items retrieved from the station cooling pond Centre Bay, including Fuel Element Debris (FED) Magnox and non-Magnox fuel components, and sludge including concrete scabblings from pond wall pressure washing. Part of 2013 UK RWI stream 9B55.
- Vault 8B sludge/dust; drummed mixed wastes retrieved from FED Vault 8B comprising of FED corrosion product, gravel and sludge from pond clean-up operations tipped into Vault 8B. Part of 2013 UK RWI streams 9B59, 9B63 and 9B77.
- Higher dose rate By-pass Filter Room (BPFR) filter pots; filter pots containing activated graphite dust and crud (steel corrosion product) from the reactor circuits together with water and oil. Part of 2013 UK RWI stream 9B83.
- Contaminated sand; bulk Sand Pressure Filter (SPF) beds from operation of active effluent and pond water clean-up systems (likely to be LLW). Part of 2013 UK RWI stream 9B65.

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

The radionuclide source term of MILW to be packaged in Type II DCICs is principally irradiated natural uranium-derived contamination dominated by the skin-effect fraction of fuel, with an additional contribution from corroded activated Magnox cladding material. MILW also contains irradiated fuel pieces, activated non-Magnox fuel components, activated graphite/crud, contaminated sand, and potentially small sealed sources. The radionuclide source term is dominated by Cs-137 and Co-60 in varying proportions.

Waste processing and packaging

The packaging proposals are based upon the use of “*robust shielded waste containers*” for the containment of solid wastes, aiming to make them passively safe whilst avoiding the need for future repackaging. This is provided by containment, principally by the function of the waste container, taking little credit for any contribution toward containment from the wasteform (non-encapsulated dried waste). The process also includes the option of adding sand as a void filler.

The waste packaging process, initially based upon experience gained in packaging of wastes in Germany, would deploy the Magnox-developed Advanced Vacuum Drying System (AVDS) together with a vented design of Type II (MOSAIC II-15 T ISAR) DCICs.

Centre Bay wastes and BPFR filter pots have now been packed into Type II DCICs; fifty containing Centre Bay wastes (some with sand) and seven containing higher dose rate BPFR filter pots (all with sand). Vault 8B sludge will be consolidated into a single waste package.

The proposed wasteform envelope for Bradwell MILW in Type II DCICs is defined by a Magnox WPrS on the basis of the following parameters: wasteform mass; waste physical/chemical composition; waste radionuclide composition; and waste drying end point. RWM has a high degree of confidence that the necessary operational controls are in place to ensure that wasteforms would conform to the relevant aspects of the WPrS.

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 a nominally sealed building. 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 total inventory used in the assessment for Bradwell MILW in Type II DCIC waste packages has been based upon a combination of pond surveys, operator knowledge and waste characterisation data. The waste package assessment inventory has been established, taking account of uncertainty in characterisation data and waste feed composition to define a bounding maximum case.

The estimated total conditioned waste volume for Bradwell MILW to be packaged in Type II DCICs is 28.5 m³ (based upon an estimated 58 waste packages, each with an internal volume of approximately 0.49 m³), with no anticipated future arisings.

Assessment of Disposability

Waste package properties and performance

The proposed dried Bradwell MILW in Type II DCIC wasteform essentially comprises unimmobilised particulates including some solid inclusions. The proposed packaging process is designed to ensure no free water in the waste packages.

RWM considers that the 'as manufactured' wasteforms for Bradwell MILW in Type II DCIC are likely to perform adequately in the context of the overall mechanical and physical properties of the waste package. In addition, evolution of the Bradwell MILW wasteform is unlikely to have any significant detrimental effect on waste package mechanical and physical properties.

The vented Type II (MOSAIIK II-15 T ISAR) 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, including stacking and handling features.

The proposed Bradwell MILW in Type II DCIC waste packages would generate gas, principally hydrogen from radiolysis of organic materials. The magnitude of bulk gas generation has been estimated by RWM and the performance of the engineered vent assembly is considered to represent a suitable pressure mitigation strategy.

Magnox has defined a Safe Fissile Mass (SFM) for Bradwell MILW 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. Criticality compliance is assured by the preparation of verified Loading Plans that consider the fissile content of waste drums or pots derived from In-situ Object Counting System (ISOCS) measurements. RWM is content that no additional operational controls are required.

Magnox has provided an impact accident performance justification, based upon modelling, designed to describe 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).

Magnox has defined 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 RFs taking account of loss of containment at the main lid/body interface or vent assembly, and assuming a bounding internal pressure within the waste package.

Magnox has defined a methodology to define fire accident RFs which takes account of temperatures experienced by the waste package during a fire, structural response of the waste package to a fire and release of radionuclides. RWM has defined RFs for the waste packages in the event of fire accidents, based upon: results of Magnox-commissioned thermal modelling of Type II DCIC waste packages containing a variety of relevant materials with differing thermal properties; and, radionuclide release data for a variety of relevant unimmobilised materials at temperatures up to 1000°C. RWM has defined these RFs on the basis that 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 Bradwell MILW 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 Bradwell MILW 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 Bradwell MILW 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 Bradwell MILW 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 the waste packages, if required, is to be retained.

Status of Management System

Magnox has supplied approved versions of Management System documents, including Quality Plans, operating instructions, evidence of internal assurance activities and a Company Standard for management of non-conforming waste packages. These provide RWM with confidence that the Bradwell MILW in Type II DCIC waste packages would be manufactured and stored in compliance with the approved WPrS and Criticality Compliance Assurance Documentation.

Status of waste package records and information

Waste package data recording proposals for Bradwell MILW Type II DCIC waste packages, including a Package Record Specification (PRS) are compatible with RWM requirements and provide confidence that adequate waste package records would be produced. Magnox plans for the long term management of information and records are sufficiently developed to provide confidence that they would meet RWM requirements.

Magnox plans for waste package records and information provide RWM with confidence that the necessary records would be generated and managed appropriately, supporting Final stage endorsement. RWM will continue to interact with Magnox to address minor details to finalise the waste package-specific PRS and associated documentation.

Conclusions of Assessment of Disposability

The proposed Bradwell MILW 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 Bradwell MILW in Type II DCIC waste packages are disposable and all outstanding Action Points have been closed.

Conclusions

The Final stage Disposability Assessment undertaken for the proposed Type II DCIC waste packages containing MILW from Bradwell 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 three time-limited Conditions, a Caveat and an Exclusion.