

Packaging of Operational ILW from the Proposed EPRs at Hinkley Point C and Sizewell C (Conceptual stage)

Summary of Assessment Report

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Background

NNB GenCo has proposed that the operational ILW expected to arise at the planned UK-EPR (European Pressurized Reactor) reactors at Hinkley Point C and Sizewell C should be packaged using reinforced concrete casks denoted C1 and C4 casks. These proposals are based on current arrangements adopted for the management of equivalent wastes from the operation of PWRs (Pressurised Water Reactor) in France.

To progress these proposals, advice on the disposability of the proposed packages in a geological disposal facility has been sought from the NDA Radioactive Waste Management Directorate (hereafter RWMD). In particular, NNB GenCo has sought Conceptual stage endorsement for the proposed packages of EPR operational ILW based on the use of C1 and C4 casks.

These proposals follow engagement with RWMD on the disposability of these wastes under the regulators' Generic Design Assessment (GDA) process. In particular, it is noted that regulators require NNB GenCo to produce an approved Radioactive Waste Management Case covering operational ILW prior to commencement of reactor operations at Hinkley Point C.

The C1 and C4 casks are not yet recognised in the RWMD Disposal System Technical Specification (DSTS). Nevertheless, the feasibility of incorporating these casks into the disposal system design and compliance with the Generic Specification for Low Heat-generating Wastes has been assessed to allow consideration of Conceptual stage endorsement. Formal approval of a Disposal System Change would be required should the disposal of the proposed packages be progressed further in future.

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 geological disposal. The reference basis for this assessment of disposability is the conceptual designs for a Geological Disposal Facility (GDF) within the generic Disposal System Safety Case (DSSC) and the requirements placed on waste packages by the Generic Specification for Low Heat-generating Wastes¹. This is the relevant Level 2

¹ NDA, *Generic Specification for Waste Packages Containing Low Heat Generating Waste*, NDA Report NDA/RWMD/068, July 2012.

specification. Further information on the Letter of Compliance process is available elsewhere².

Scope of the Assessment

The assessment has considered the proposed packages containing EPR operational ILW, which are not included in the 2010 UK Radioactive Waste Inventory.

There have been no previous (LoC) Disposability Assessments for EPR Operational ILW. However, these packages were included as one option for the packaging of EPR operational ILW assessed previously by RWMD as a contribution to the regulatory GDA. The resulting GDA Disposability Assessment was not intended to provide endorsement, but instead provided advice on the main issues arising for consideration in a subsequent Conceptual stage assessment. The issues raised through that GDA Disposability Assessment have therefore been considered in the current assessment.

Packaging Proposals

Nature of the waste

The scope of the assessment is limited to the following operational ILW:

- ion exchange (IEX) resin;
- higher activity cartridge filters;
- lower activity cartridge filters;
- dry active waste (DAW);
- sludge;
- boric acid evaporator concentrate.

The baseline option for the management of both lower activity filters and boric acid evaporator concentrates is disposal as LLW in the LLW Repository (LLWR). Nevertheless, as a contingency measure, Disposability Assessment of these wastes also has been sought from RWMD by NNB GenCo.

Waste processing and packaging

The proposals are based on packaging in C1 and C4 concrete casks, the two types of cask differing in their dimensions and payloads. Further variations are available that also include internal steel shielding.

The C1 and C4 casks have been approved and operated as Industrial Package Type 2 (IP-2) transport packages for the transport of equivalent wastes arising from the operation of PWRs in France. It is proposed that the packages containing EPR operational ILW would be transported under the same arrangements in the UK.

The C1 cask is manufactured from reinforced concrete (super-plasticised structural concrete of French specification) and incorporates a steel inner liner. The cask is 1.4m in diameter and 1.3m in height, with a usable capacity of 0.91m³. The mass of the C1 cask is 2142kg and the total package mass is limited to 8000kg. The cask is closed using a cast lid and incorporates a lifting feature in the form of a steel-lined recess 188mm below the top of the cask. The C4 cask is similar to the C1 cask but is 1.1m in diameter and has a reduced usable capacity of 0.48m³. The mass of the cask is 1676kg and the total package mass is limited to 6000kg.

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

Both designs of cask can incorporate additional internal steel shielding. The use of additional shielding results in a reduction in capacity. Both types of cask also have the option of including a sacrificial paddle for in-drum mixing of mobile wastes, with at least two designs of paddle being available.

The proposals for the immobilisation of the wastes are based on existing processes used in France for similar wastes. Processing is based on the deployment of mobile plant to the power station where stored wastes would be packaged in batches on a campaign basis. The proposed packaging processes are based on infiltration of solid wastes with cementitious grout (filters and DAW) and the immobilisation of mobile wastes by in-drum mixing with polymer (IEX resins) or cement (sludge and boric acid evaporator concentrate). The detailed specifications, properties and performance of the encapsulating matrix materials have not been provided in the submission and RWMD would expect further information at the Interim assessment stage.

The waste packages would then be sealed and placed in an interim store until transport to a GDF, assumed by NNB GenCo to be 2080 at the earliest. NNB GenCo has indicated that the completed packages would be stored on-site to await transport to a GDF. The detailed storage arrangements have not been developed, but the submission recognises the need to manage the storage environment to maintain the integrity of the packages.

Parameters for Assessment of Disposability

Assessment Inventories and Number of Packages

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

The assessment inventories are based on the information supplied previously for the GDA Disposability Assessments. Average assessment inventories for packages based on the individual waste types were derived, based on the assumed content of packages for each waste type. In the absence of information on the variability of the packaged waste, bounding maximum inventories were derived by scaling the average inventories to give an external dose-rate equal to the transport limit of 0.1 mSv/hr at 1m. It will be required that controls are implemented during packaging to ensure compliance with this limit at the time of transport.

The estimated numbers of packages are based on the volumes of waste and package capacities as reported by NNB GenCo. Based on the current proposal for four reactor units (a two-unit system implemented at each proposed site), up to about 10,000 packages would be produced. This total comprises about 4000-off C1 packages and 6000-off C4 packages, although it is noted that the latter correspond to the lower activity wastes, some of which may be sentenced for disposal as LLW. Therefore not all the anticipated C4 packages may arise in practice requiring geological disposal.

Waste Package Properties and Performance

The submission provides sufficiently detailed design information to allow a suitably thorough consideration of the expected properties and performance of the casks at the Conceptual stage. Nevertheless, further details will be required at Interim stage to substantiate the initial conclusions.

It is noted that wasteforms based on suitably justified and demonstrated encapsulants would be expected to be largely benign and would not challenge the integrity of a package. Although some of the EPR operational ILW potentially could interact with an encapsulating matrix, the implementation of the proposed processes in France for equivalent wastes provides some confidence that suitable matrices

have been selected. It is also noted that cement and polymer based encapsulant matrices have been used in the UK for other ILW packaging, endorsed by RWMD. Nevertheless, explicit evidence of the behaviour of these specific wasteforms would be sought at Interim assessment stage.

In reviewing the proposed containers, the Conceptual stage assessment has assessed whether the concrete casks can be considered to represent good engineering practice. In particular, the use of a single layer of reinforcement, rather than the minimum of two layers commonly recommended for reinforced concrete structures, has been challenged. Further justification of the rationale for the designs will be required at the Interim assessment stage.

The submission states that the original French assessment of the containers concluded that integrity would be maintained for at least the 300 years required for near-surface disposal in France. It is recognised that the containers are currently in use and therefore it may be concluded that the French criteria have been fulfilled. Consistency with the French criteria provides some confidence in the general longevity of the containers. Notwithstanding the absence of explicit evidence, RWMD judges that there is potential for the casks to meet UK requirements. It is also recognised by NNB GenCo that 'UK-specific' designs of the casks could be developed, for example incorporating changes in design or materials specifications, nevertheless RWMD recognises the benefits of adopting existing proven and (transport) approved container designs. This position is considered sufficient at the Conceptual stage, but further evidence will be sought at Interim assessment stage.

The performance of the proposed packages in impact and fire accidents has been characterised through a limited programme of modelling. This indicates that the packages provide a high degree of protection of the wasteform in both impact and fire accidents. In the case of impacts, the casks themselves would be severely damaged, absorbing energy and minimising damage to the wasteform and thereby minimising predicted releases. This performance would be considered further at Interim stage, based on more extensive modelling and more detailed understanding of the package design.

Compatibility with Specifications

At the Conceptual stage it is necessary to demonstrate the compliance of the proposed packages with the relevant Generic Specification. This comparison indicates that the packages comply with the requirements of the Generic Specification for Low Heat-generating Wastes, although a more detailed, Level 3, Package Specification will need to be developed by RWMD and more detailed substantiation sought at the Interim stage.

Implementation within the GDF Concept

Currently, the C1 and C4 casks are not recognised in the DSTS and therefore the GDF design concepts do not include packages based on these containers. Consequently, in order to provide a basis for the current assessment and for a subsequent Disposal System Change request, it is necessary to define demonstrably feasible arrangements for the handling and emplacement of the proposed packages. These outline arrangements form the basis for the qualitative assessment of safety required at the Conceptual stage and will be confirmed through the Change Control process.

RWMD has determined that the packages should be assumed to be placed in a dedicated vault based on the existing design concepts for vaults containing shielded ILW (SILW) packages, but using crane emplacement where possible. In practice, crane emplacement would apply to higher strength and lower strength sedimentary

rock environments, but it is assumed a stacker truck would be used for an evaporite environment (due to vault size constraints imposed by the properties of the rock).

The wastes are not included in the current baseline inventory considered in the DSSC and therefore additional disposal costs above current estimates would be incurred irrespective of the means of emplacement. These additional costs would be borne by the power station operator. These costs are a necessary component of the overall costs of operating and decommissioning new power stations.

Assessment of Disposability

Transport Safety Assessment

As noted previously, the C1 and C4 casks have received approval as packages for transport under IP-2 arrangements and have been operated as such in France. Consequently, the acceptability of the proposed packages for transport ultimately would be determined through demonstrated compliance with the requirements of the existing approval, on an assumption that the UK-EPR wastes and casks were comparable. In the absence of a verified translation of such an approval, RWMD has reviewed the packages against its understanding of the relevant requirements, based on the IAEA Transport Regulations. This is considered an appropriate basis for assessment at the Conceptual stage. Further demonstration of compliance with the existing approval would be sought at later stages, including confirmation from the Design Authority, which is understood to be EdF.

The proposed packages are judged to be compliant with the IAEA Transport Regulations in terms of limits placed upon the radionuclide content, specific activity, homogeneity, dose rates, pressurisation under normal conditions of transport, fissile content, dangerous materials and surface contamination. The specified wastes are considered to comply with the definition of low specific activity (LSA-II) and therefore should be suitable for transport under IP-2 arrangements.

The changes in the estimated transport system operator dose, due to the addition of the proposed packages to the current inventory assumed by the DSSC, are small and do not have significant implications on the safety argument presented in the Transport System Safety Assessment.

These preliminary results, and the existing approval of the packages, provide confidence in the acceptability of the proposed waste packages in terms of transport safety.

Operational Safety Assessment

A preliminary assessment of operational safety has been performed, based on an initial review of the likely faults and hazards for the preferred disposal concept for these casks. Although it was accepted that the properties and performance of the proposed packages would influence the assessed risk, it was concluded that the use of concrete casks would not give rise to any significant additional faults or hazards.

The assessment indicates that protected doses from fault conditions will be within the most restrictive BSLs and typically are close to or less than the BSO for workers and public. The assessed doses for impact and fire accidents may be further optimised in the future through more detailed assessment and by challenging conservatism in the assessment methodology. This optimisation and challenge to assessment methodology has not yet been completed and the resulting reductions in assessed doses cannot yet be quantified. Nevertheless, it is believed that significant reductions in assessed dose could be achieved.

Finally, the assessment considered doses to workers in normal operations. Although RWMD has identified that such assessed doses will present a risk to workers for

SILW package types, it is anticipated that planned optimisation of relevant systems when GDF designs are fully developed would address any such challenges for individual waste streams. This position is considered also to apply to the shielded packages considered here.

Given the conservatism in the assessments, these preliminary results provide confidence in the acceptability at Conceptual stage of the packages in terms of operational safety. This position would be confirmed at this Interim stage, further to the necessary changes being made to the GDF designs and confirmation of the necessary handling and emplacement arrangements, and review of any resulting changes to the assumed faults and hazards.

Post-closure Safety Assessment

The potential significance of the proposed packages has been assessed by comparison with the baseline total inventory of waste to be disposed of as SILW, noting that the assessed wastes represent an addition to this total.

Within the overall GDF, the key radionuclides determining risk in the groundwater pathway due to ILW are ¹³⁵CS and ¹²⁹I for times between 1000 and 100,000 years post closure and ²³⁸U and ²³⁷Np and their decay products at later times. In all cases, the inventory of ¹³⁵CS in the proposed packages is significantly lower than that in an average SILW package. In some cases, the inventory of ¹²⁹I is higher than that in the previous average SILW package and hence the packages would make an above average contribution to risk at times between 1000 and 100,000 years. However, this conclusion is not considered significant since the total risk at these times is dominated by the contribution from other ILW in Unshielded ILW waste vaults.

The actinide inventories of the proposed packages are higher than for the average SILW packages. However, key species such as ²³⁸U and ²³⁷Np are solubility limited and the inventories and consequent risks would be dominated by U/ILW. On these grounds, the addition of the EPR operational ILW is not considered to significantly affect risk.

It is recognised that the construction of concrete casks requires the use of a super-plasticiser. Such materials may influence the solubility of key radionuclides and RWMD is undertaking work to identify an acceptable super-plasticiser for use in a GDF. It is required that the acceptability of any super-plasticiser used in the manufacture of the casks be agreed with RWMD before the packages were produced. This will form a caveat to Letters of Compliance endorsing concrete casks.

In addition to the above, organic IEX resins and epoxy resin ultimately may degrade to form soluble organic species. The significance of such species has been considered in previous generic work performed by RWMD on IEX and epoxy resins, for example the influence on the solubility and sorption of key radionuclides, and it has been concluded that the current proposals do not differ significantly from previously endorsed proposals.

The heat outputs of the proposed waste packages are well below the heat limits specified by RWMD. The anticipated gas generation rates are similarly low.

Overall, these preliminary results provide confidence in the acceptability of the proposed waste packages in terms of post-closure safety.

Review of Technical Issues and Action Points

The GDA Disposability Assessment identified 23 issues applying to the packaging of operational ILW from a UK-EPR. These issues have been reviewed in light of the conclusions of the current assessment. Of these 23 issues, two are not considered to be relevant to the assessment of the operational ILW as it currently defined, eight have been closed and 13 remain open. In all cases, the open issues have been translated into Interim stage Action Points.

Although no outstanding Conceptual stage issues have been identified, further substantiation of the initially supplied information will be sought at the Interim assessment stage. Consequently, the assessment has identified 25 Interim stage Action Points that need to be resolved to progress the endorsement of packages to the Interim assessment stage. A further three Final stage Action Points have been identified, which capture important matters to be resolved at that assessment stage.

Conclusions

A Conceptual stage assessment has been undertaken for the proposed packages containing EPR operational ILW, based on the use of C1 and C4 casks compliant with the requirements for transport under IP-2 arrangements. An Assessment of Disposability has been reported and the compliance of the proposed packages with all the requirements for transport, handling and disposal at a Geological Disposal Facility has been formally assessed.

The proposed packages are not currently considered in the existing Disposal System Technical Specification. In support of endorsement at the Conceptual stage, the necessary changes to the handling and emplacement of packages to accommodate the C1 and C4 casks have been assessed to be feasible. A formal change to the existing RWMD suite of documents will be required, supported by appropriate evidence, including the development of detailed (Level 3) Package Specifications, to support endorsement at the Interim assessment stage.

Based on the conclusions of the Assessment of Disposability and a consideration of the feasibility of the necessary change, it has been concluded that the proposed packages should be endorsed at the Conceptual stage through the issue of a Letter of Compliance.

The principal issues to be addressed at the Interim stage include further demonstrations of the effectiveness of the packaging processes and justification of the claimed performance of the casks. If appropriate, RWMD would seek the development of 'UK-specific' designs of cask to address particular challenges to their use in the UK. The Conceptual stage Letter of Compliance will be caveated regarding the need to demonstrate an appropriate superplasticiser for the cask concrete and to recognise the risk that the casks may require design modifications.