Geological Disposal
Specification for Miscellaneous Beta Gamma Waste Store box waste packages

July 2014
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Bibliography

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Executive Summary

This document forms part of the Waste Package Specification and Guidance Documentation (WPSGD), a suite of documents prepared and issued by the Radioactive Waste Management Limited (RWM), a wholly owned subsidiary of the Nuclear Decommissioning Authority (NDA). The WPSGD are intended to provide a 'user-level' interpretation of the RWMD packaging specifications, and other aspects of geological disposal, to assist UK waste producers in the development of plans for the packaging of higher activity waste in a manner suitable for geological disposal.

Key documents in the WPSGD are the Waste Package Specifications which define the requirements for the transport and geological disposal of waste packages manufactured using standardised designs of waste container. The WPS are based on the high level requirements for all waste packages as defined by the Generic Waste Package Specification and are derived from the bounding requirements for waste packages containing a specific category of waste, as defined by the relevant Generic Specification.

This document provides a specification for waste packages containing low heat generating waste that are to be manufactured using the Miscellaneous Beta Gamma Waste Store box, a standardised design of waste container that could be used for the packaging of such wastes for transport and geological disposal.

The documents that make up the WPSGD will be subject to periodic revision which may lead to significant changes in packaging requirements. Users are therefore advised to contact RWM, or refer to http://www.nda.gov.uk/rwm/waste-producers/detail/#packaging-specifications-for-higher-activity-waste, to confirm that they are in possession of the latest version of any documentation used.
1 Introduction

Radioactive Waste Management Ltd (RWM) produces packaging specifications as a means of providing a baseline against which the suitability of plans to package higher activity waste for geological disposal can be assessed. In this way we assist the holders of radioactive waste in the development and implementation of such plans, by defining the requirements for waste packages which would be compatible with the anticipated needs for transport to and disposal in a geological disposal facility (GDF).

The packaging specifications form a hierarchy which comprises three levels:

- The **Generic Waste Package Specification** (GWPS) [1]; which defines the requirements for all waste packages which are destined for geological disposal;
- **Generic Specifications**; which apply the high-level packaging requirements defined by the GWPS to waste packages containing a specific type of waste; and
- **Waste Package Specifications** (WPS); which apply the general requirements defined by a Generic Specification to waste packages manufactured using standardised designs of waste container.

As a means of making the full range of RWM packaging specifications available to waste producers and other stakeholders, a suite of documentation known as the **Waste Package Specification and Guidance Documentation** (WPSGD) is published and maintained for ready access (i.e. via the NDA website at [www.nda.gov.uk](http://www.nda.gov.uk)). The WPSGD includes a range of WPS for different waste package types together with explanatory material and guidance that users will find helpful when it comes to application of the WPS to practical packaging projects. For further information on the extent and the role of the WPSGD, reference should be made to the **Introduction to the RWM Waste Package Specification and Guidance Documentation** [2].

This WPS applies the requirements for waste packages containing low heat generating waste, which include those classed as intermediate level waste (ILW), as defined by the **Generic Specification for waste packages containing low heat generating waste** [3], to waste packages that are manufactured using the Miscellaneous Beta Gamma Waste Store (MBGWS) box waste container. It is supported by a number of other documents from the WPSGD, notably **Guidance on the achievement of the Waste Package Specifications for unshielded waste packages** [4].

The suitability of proposals to package specific wastes using the MBGWS box, such that they would result in the production of disposable waste packages, is assessed by way of the RWM **Disposability Assessment Process** [5]. At the conclusion of such an assessment a **Letter of Compliance** (LoC) can be issued to indicate that the proposed waste packages would be compliant with this WPS and thereby with the safety cases for the transport of the waste to, and its disposal in a GDF. Waste packagers intending to submit waste packaging proposals for assessment by RWM are referred to **Guidance on the preparation of submissions for the disposability assessment of waste packages** [6].
2 The Miscellaneous Beta Gamma Waste Store box

The MBGWS box (Figure 1) is one of a limited range of standardised designs of waste container that could be used for the packaging of low heat generating waste in a manner that is compatible with RWM's plans for the geological disposal of such wastes.

Figure 1 The MBGWS box

The MBGWS box was originally developed for the temporary storage of a range of wastes, arising from operations at Sellafield, with a view to it ultimately being used for the geological disposal of those wastes. MBGWS boxes are typically fabricated using relatively thin section stainless steel which provides little shielding of the radiation emitted by its radionuclide contents. Because of this the container would be used to manufacture ‘unshielded waste packages’ which signifies that remote techniques would generally be required for their handling, and that transport through the public domain would take place inside a transport container which provides both radiation shielding and mechanical and thermal protection. The transport packages that result from the combination of a MBGWS box waste package and such a transport container would normally be classed as Type B transport packages under the IAEA Regulations for the Safe Transport of Radioactive Material [7].

The MBGWS box can be used in the packaging of a range of heterogeneous wastes which would typically be conditioned by infilling the waste in the container with an immobilising material such as a cementitious grout. The possibility also exists for the MBGWS box to be used for the packaging of certain types of waste without the use of an encapsulant. Guidance has been produced on the achievement of the requirements for both encapsulated and non-encapsulated wasteforms [8, 9].
3 Packaging criteria for MBGWS box waste packages

This WPS defines the key features of the MBGWS box waste container and sets minimum standards of performance for the waste packages it can be used to manufacture. The requirements defined below are relevant to all stages of the long-term management of the waste package but, in some cases, are applied at particular times during that management.

It is assumed that MBGWS box waste packages will be transported to a GDF within a standard design of transport container which would provide a nominal shielding thickness of 150mm of steel with a density of 7700kg m⁻³.

It should be noted that, where the words *shall* and *should* are used in defining the requirements which make up this WPS, their use is consistent with the recommendations of BS 7373-1:2001 [10] and that they have the following meaning:

- *'shall'* denotes a limit which is derived from consideration of a regulatory requirement and/or from a fundamental assumption regarding the current designs of the transport or disposal facility systems;
- *'should'* denotes a target from which relaxations may be possible if they can be shown not to result in any significant reduction in the overall safety of the geological disposal system.

3.1 Requirements for the waste container

3.1.1 General properties

The properties of the waste container, the standard features of which are shown in Figure 2, *shall* be such that, in conjunction with those of the wasteform, it satisfies all of the requirements for the waste package.

Figure 2 Standard features of the MBGWS box

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1 This transport container is referred to as the SWTC-150
2 This would generally be by way of the Disposability Assessment Process.
3.1.2 External dimensions

The overall dimensional envelope of the waste package shall not exceed:

- Height: 1372mm
- Plan: 1853mm square

3.1.3 Handling feature

The waste container shall incorporate four lifting points, in the form of twistlock apertures of dimensions and geometry as defined in Figure 3, located as shown in Figure 4.

The waste package shall be capable of being lifted with a force of 240kN using two diagonally opposite twistlock apertures, without exhibiting any permanent deformation.

Figure 3  Twistlock geometry and dimensions
3.1.4 Stackability

The waste package shall be capable of withstanding a compressive load of 600kN applied along the vertical axis of the waste package. Under these load conditions, the waste package shall not exhibit any permanent deformation or abnormality that would render it incompatible with any of the requirements defined in this WPS.

3.1.5 Identification

The waste container shall be marked with a unique identifier, comprising ten alpha-numeric characters each with a height of between 6mm and 10mm, and in a form that complies with the relevant RWMD specification [11] (Figure 5).

The identifier shall be marked on each vertical surface of the waste container, 505mm from the centre line and of 720mm up from the bottom edge of the waste container (Figure 2).

The waste package shall remain identifiable by automated systems for a minimum period of 150 years following manufacture.
3.1.6 Durability of integrity

The integrity of the waste container (i.e. its safe handling by way of its handling feature, stackability, containment function and the functionality of any engineered vent) shall be maintained for a period of 150 years and should be maintained for a period of 500 years following manufacture of the waste package.

3.2 Requirements for the wasteform

The physical, chemical, biological and radiological properties of the wasteform shall:

- make an adequate contribution to the overall performance of the waste package; and
- have no significant deleterious effect on the performance of the waste container.

The properties of the wasteform shall comply with the Wasteform specification for waste packages containing low heat generating waste [12].

Evolution of the wasteform shall ensure maintenance of the waste package properties that are necessary for safe transport and operations at a GDF as defined by the GWPS [1].

Evolution of the wasteform shall ensure maintenance of the required safety functions for waste package post-closure performance as defined by the GWPS [1] and set out in the Environmental Safety Case (ESC) [13].

The required properties of the wasteform shall be maintained for a period of 150 years and should be maintained for a period of 500 years following manufacture of the waste package.

3.3 Requirements for the waste package

3.3.1 Maximum gross mass

The gross mass of the waste package shall not exceed 12,000kg.

3.3.2 External dose rate

The external dose rate of the waste package should be such that, when it is carried with in a transport container providing 150mm of shielding with a density of 7700kg m⁻³, the dose rate at 1m from any external surface of the transport package, under normal conditions of transport, does not exceed 0.1mSv h⁻¹ and the dose rate at its external surface does not exceed 2mSv h⁻¹.
3.3.3 Heat output

The total heat generated by the waste package should not exceed 400W at the time of transport. The heat generated by the waste package should not exceed 25W and shall not exceed 400W at the time of disposal vault backfilling.

3.3.4 Surface contamination

The non-fixed surface contamination of the waste package shall be kept as low as reasonably practicable and, when averaged over an area of 300cm$^2$ of any part of the surface of the waste package, should not exceed:

- Beta, gamma and low toxicity$^3$ alpha emitters: 4.0Bq cm$^{-2}$
- All other alpha emitters: 0.4Bq cm$^{-2}$

3.3.5 Gas generation

The generation of bulk, radioactive and toxic gases by the waste package shall comply with the requirements for safe transport and disposal. The waste package should incorporate a means by which internally generated gases can be vented. The design of the venting mechanism shall be such that:

- the release of activity in particulate form from the waste package is minimised;
- excessive pressurisation of the waste package does not occur at any time during a period of 500 years following manufacture; and
- the ingress of groundwater into the waste package in the post-closure period is minimised.

The total gas generated$^4$ and released by the waste package during transport shall not exceed 84 litres per day.

The release of gas from the waste package during transport should not exceed:

- Hydrogen: 0.4 litres per day
- Methane: 0.6 litres per day

The release of activity in gaseous form from the waste package during transport should not exceed 4.9E-04 $\text{A}_2$ per day.

The release of activity in gaseous form from the waste package during the GDF operational period shall be limited to ensure compliance with the assumptions made in the ESC [13] for the limitation of off-site radiation dose, and should not exceed:

- Hydrogen-3: 35kBq per hour
- Carbon-14: 800Bq per hour
- Radon-222: 700Bq per hour

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$^3$ Defined as: uranium-235, uranium-238, thorium-232, thorium-228, thorium-230 and any alpha emitter with a half-life of less than 10 days.

$^4$ All specified gas generation rates are for volumes of gas at standard temperature and pressure (i.e. 0°C and 101kPa).
3.3.6 Criticality safety

The presence of fissile material, neutron moderators and reflectors in the waste package shall be controlled to ensure that:

- criticality during transport is prevented;
- the risk of criticality during the GDF operational period is tolerable and as low as reasonably practicable; and
- in the GDF post-closure period both the likelihood and the consequences of a criticality are low.

The total quantity of fissile material in the waste package should not exceed 47g.

The quantities of fissile material, neutron moderators and reflectors in the waste package shall be controlled to ensure that, when it forms part of a transport package, it can satisfy the criticality safety requirements of the IAEA Transport Regulations.

A safe fissile mass (SFM) shall be defined and justified for the total quantity of fissile material in the waste package such as to ensure that the requirements stated above are achieved. Procedures shall be established to ensure that the SFM is not exceeded during waste package manufacture.

3.3.7 Accident performance

Under all credible accident scenarios the release of radionuclides and other hazardous materials from the waste package shall be low and predictable.

The waste package should exhibit progressive release behaviour within the range of all credible accident scenarios.

The impact and fire accident performance of the waste package shall be such as to ensure that, when it forms part of a transport package, it can satisfy the requirements of the IAEA Transport Regulations for Type B transport packages under accident conditions of transport.

The accident performance of the waste package shall ensure that, in the event of any credible accident during the GDF operational period, the on- and off-site doses resulting from the release of radionuclides from the waste package shall be as low as reasonably practicable and should be consistent with meeting the relevant Basic Safety Levels.

3.4 Requirements for the manufacture and storage of waste packages

Adequate controls shall be established and applied to ensure that manufactured waste packages have the properties and performance required of them.

Adequate controls shall be applied during any period of interim storage to ensure that waste packages retain their required properties and performance.

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5 Defined as uranium-233, uranium-235, plutonium-239 and plutonium-241.
6 This limit being the mass of plutonium-239, or the total mass of all fissile nuclides which would produce the equivalent reactivity of 47g of plutonium-239 with optimal shape and neutron moderation and reflection.
3.4.1 Quality management

Adequate management arrangements shall be applied to all aspects of the packaging of radioactive wastes, and the storage of waste packages, that affect product quality.

These arrangements, which shall comply with the relevant RWMD specification [14], shall be agreed with RWMD prior to the start of the activities to which they relate.

3.4.2 Waste package data and information recording

Information shall be recorded for each waste package covering all relevant details of its manufacture and interim storage. This information shall be sufficient to enable assessment of the characteristics and performance of the waste package against the requirements of all stages of long-term management.

Information shall be recorded regarding the quantity of those of the radionuclides of relevance to the disposability of the waste package [15].

The arrangements for data and information recording shall comply with the relevant RWMD specification [16] and shall be agreed with RWMD prior to the start of the activities to which they relate.

3.4.3 Controls on waste packages containing nuclear materials

The safeguards status of any nuclear material\(^7\) contained within the waste package shall be ascertained and recorded.

The quantity of nuclear material contained within a waste package should be such that the transport package will require physical protection no higher than that defined by the Office for Nuclear Regulations as Category II.

\(^7\) This being defined as all isotopes of uranium, plutonium and/or thorium.
References
