Geological Disposal:
Waste Package Specification for 500 litre robust shielded drum waste packages to be transported in a SWTC-150

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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 Radioactive Waste Management Limited (RWM). The WPSGD is intended to provide a 'user-level' interpretation of the RWM packaging specifications, and other aspects of geological disposal, to assist UK waste packagers 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 (WPS) 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 500 litre robust shielded drum waste container, a standardised design of waste container that has been shown to be suitable for the packaging of such wastes for transport and geological disposal.

The documents that make up the WPSGD will be subject to periodic enhancement and revision, which may lead to changes in the packaging requirements. Users are therefore advised to refer to the RWM website to confirm that they are in possession of the latest version of any documentation used.

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<td>Aligns with Generic Specification for waste packages containing low heat generating waste (NDA/RWM/068) as published August 2012. Developed on the assumption that transport operations will be conducted under the conditions of exclusive use, as defined by the IAEA Transport Regulations.</td>
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This document has been compiled on the basis of information obtained by RWM. It has been verified in accordance with arrangements established by RWM that meet the requirements of ISO 9001. The document has been fully verified and approved for publication by RWM.
1 Introduction

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 via the RWM website.

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 500 litre robust shielded drum waste container and that are to be transported in a SWTC-150 as a Type B transport package.

The suitability of proposals to package specific wastes using the 500 litre robust shielded drum waste container, such that they would result in the production of disposable waste packages, is assessed by way of the RWM Disposability Assessment process [4]. 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 [5].
2 The 500 litre robust shielded drum waste package

The 500 litre robust shielded drum waste container (Figure 1) is one of a limited range of standardised designs of waste container that have been shown to be suitable 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 500 litre robust shielded drum waste container

The nature of the containment provided by this design of waste container\(^1\) is such that it can be used to manufacture ‘robust shielded waste packages’. Specifically this means that the required performance of the waste package will derive largely from the properties of the waste container. The properties required of the waste package contents (i.e. the wasteform) are therefore principally limited to ensuring that they cause no significant deleterious effects on the performance of the waste container and, as a consequence, on the performance of the waste package as a whole. The 500 litre robust shielded drum waste container is therefore potentially suitable for the conditioning of waste with or without the use of an encapsulating medium. Guidance is available on the means by which the requirements for encapsulated and non-encapsulated wasteforms can be achieved [6, 7].

It is assumed that waste packages manufactured using the 500 litre robust shielded drum waste container will be placed into a stillage and transported through the public domain within a standardised design of transport container, the SWTC-150. The combination of waste package, stillage and transport container will be capable of satisfying the requirements defined by the International Atomic Energy Agency (IAEA) Regulations for the Safe Transport of Radioactive Material\(^2\) [8] for Type B transport packages.

\(^1\) Such waste containers would typically be fabricated from ductile cast iron.

\(^2\) This reference will be referred to as the ‘IAEA Transport Regulations’ in the remainder of this Specification.
3 Packaging criteria for 500 litre robust shielded drum waste packages

This WPS defines the key features of the 500 litre robust shielded drum waste container and sets minimum standards of performance for the waste packages that 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. In some instances a waste package property will be required to be maintained for a period of 150 years following manufacture. Such a period is defined to ensure that the waste package will maintain such a requirement up to the end of the operational period of a GDF.

It is assumed that 500 litre robust shielded drum waste packages will be transported within a SWTC-150, which will provide radiation shielding with a nominal thickness of 150mm and a density of 7,700kg m⁻³.

It should be noted that, where the words *shall* and *should* are used in defining the requirements that make up this WPS, their use is consistent with the recommendations of BS 7373:1:2001 [9] 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 requirements

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

The external features of the waste container *shall* be compatible with the anticipated mode of mounting within the transport container.

The waste package *shall* be capable of being removed from its stillage using remote handling techniques.

All external surfaces of the waste container *should* be protected with a water impermeable coating. The integrity of any such coating *shall* be maintained until the waste package is exported to the GDF.

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3 This would generally be by way of the Disposability Assessment process.
3.1.2 External dimensions

The overall dimensional envelope of the waste package as presented for disposal shall not exceed:

- Diameter: 1070mm
- Height: 1520mm

3.1.3 Handling feature

The base of the waste container should incorporate a handling feature which complies with that shown in Figure 3.

The waste package should be capable of being lifted with a force of 200kN using this handling feature without exhibiting any permanent deformation.

Figure 2  Standard features of the 500 litre robust shielded drum waste container

Figure 3  Base handling feature of the 500 litre robust shielded drum waste container
3.1.4 Stackability

The waste package should be capable of withstanding a compressive load of 400kN applied along the vertical axis of the waste package. Under these load conditions, the waste package should 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 alpha-numeric identifier, located at four positions on the vertical surface, spaced at 90° around the circumference at a height of 1160mm from the base (Figure 2).

The form of the identifiers shall be as shown in Figure 4, the identifier characters shall be between 6mm and 10mm high and shall comply with the RWM specification for waste package identification [10].

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

Figure 4 Form of waste package identifier

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 the 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 those defined by the Wasteform specification for waste packages containing low heat generating waste [11].

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.
Evolution of the wasteform shall not affect the ability of the waste package to maintain its required safety functions for post-closure performance, as set out in the Environmental Safety Case [12].

3.3 Requirements for the waste package

3.3.1 Maximum gross mass
The gross mass of the waste package shall not exceed 10t.

3.3.2 External dose rate
The external dose rate at 1m from any external surface of the waste package should not exceed 0.1 mSv h^{-1}.

The external dose rate of the waste package shall be such to ensure that the external dose rate of the transport package does not exceed:

- 0.1 mSv h^{-1} at 2 metres from any external surface; or
- 10 mSv h^{-1} on any external surface.

3.3.3 Heat output
The heat generated by the waste package shall not exceed 400W at the time of transport.

The heat generated by the waste package should not exceed 8W and shall not exceed 130W at the time of disposal vault backfilling.

3.3.4 Surface contamination
The non-fixed surface contamination of the waste package shall be 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:

- For beta, gamma and low toxicity\(^4\) alpha emitters: 4.0 Bq cm\(^{-2}\)
- For all other alpha emitters: 0.4 Bq cm\(^{-2}\)

\(^4\) Defined by the IAEA Transport Regulations as: uranium-235, uranium-238, thorium-232, thorium-228, thorium-230 and any alpha emitter with a half-life of less than 10 days.
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 shall 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 and released by the waste package during transport should not exceed 700 litres per day.

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

- Hydrogen: 4.0 litres per day
- Methane: 5.5 litres per day

The total activity released from the waste package, under normal conditions of transport, shall not exceed $4.3 \times 10^{-3} \text{ A}_2 \text{ per day}$.

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 Environmental Safety Case [12] for the limitation of off-site radiation dose, and should not exceed:

- Hydrogen-3: 4kBq per hour
- Carbon-14: 90Bq per hour
- Radon-222: 75Bq per hour

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5 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 quantities of fissile material, neutron moderators and reflectors in the waste package should be controlled such that the transport package can be excepted from the requirements of the IAEA Transport Regulations for competent authority approval to contain fissile material.

The quantities of fissile material, neutron moderators and reflectors in the waste package shall be controlled such that the transport package satisfies the 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 performance of the waste package shall be such 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 waste package shall be capable of being dropped, in any credible attitude, from a height of 1.0 metres onto a flat unyielding surface, whilst retaining its radioactive contents, and afterwards the waste package shall remain suitable for safe handling during transport and the operational period of a GDF.

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, as defined by the Office for Nuclear Regulation Safety Assessment Principles [13].

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6 Defined as material containing any of the fissile nuclides identified by Paragraph 222 of the IAEA Transport Regulations (i.e. uranium-233, uranium-235, plutonium-239 and plutonium-241).
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.

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 RWM specification [14], shall be agreed with RWM 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 all radionuclides of significance to the safe transport and disposal of the waste package [15].

The arrangements for data and information recording shall comply with the relevant RWM specification [16] and shall be agreed with RWM 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 material7 contained within the waste package shall be ascertained and recorded.

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

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7 i.e. all isotopes of uranium, plutonium and/or thorium.
References
