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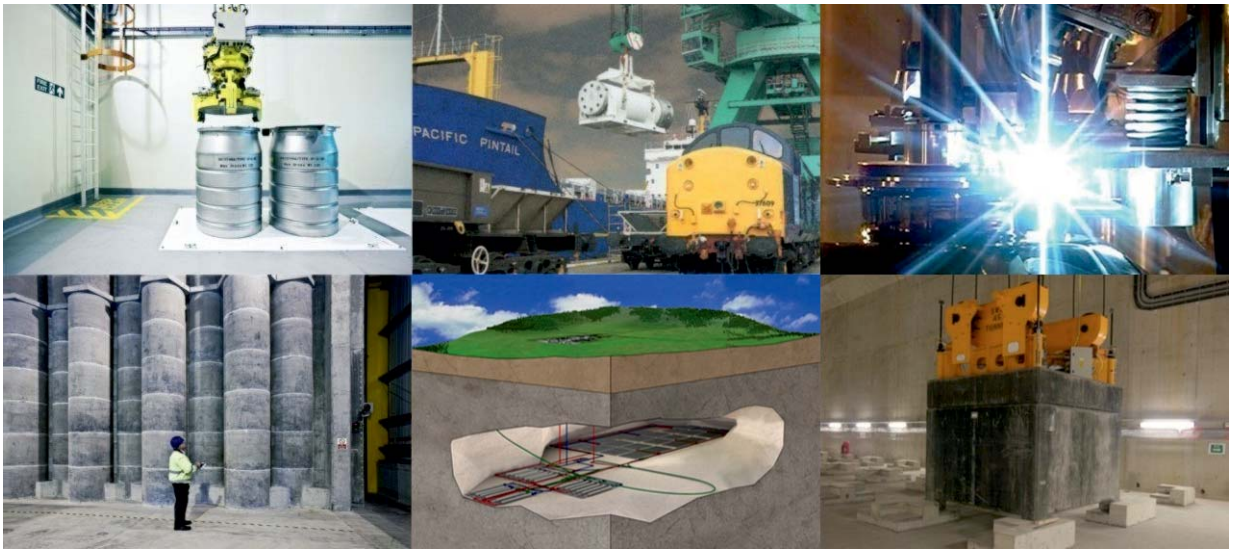
WPSGD No. WPS/300/03

Geological Disposal

Waste Package Specification for 500 litre drum waste packages

January 2013



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WASTE PACKAGE SPECIFICATION AND GUIDANCE DOCUMENTATION

WASTE PACKAGE SPECIFICATION FOR 500 LITRE DRUM WASTE PACKAGES

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 Directorate (RWMD) 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* (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* (GWPS) 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 drum, 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 revision which may lead to significant changes in packaging requirements. Users are therefore advised to contact RWMD, or refer to the NDA Bibliography at www.nda.gov.uk, to confirm that they are in possession of the latest version of any documentation used.

WPSGD DOCUMENT NUMBER WPS/300 - VERSION HISTORY		
VERSION	**DATE**	**COMMENTS**
WPS/300/01	July 2005	Aligns with GWPS (Nirex Report N/104) as published June 2005
WPS/300/02	March 2008	Responsibility for the WPSGD passed to the NDA RWMD. Aligns with Issue 2 of GWPS (Nirex Report N/104) as published March 2007.
WPS/300/03	January 2013	Aligns with Generic Specification for waste packages containing low heat generating waste (NDA/RWMD/068) as published August 2012. Issue for trial use by waste producers.

1 Introduction

RWMD 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 RWMD 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). 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 RWMD 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 drum 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 500 litre drum waste container, such that they would result in the production of disposable waste packages, is assessed by way of the RWMD *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 such assessment by RWMD are referred to *Guidance on the preparation of submissions for the Disposability Assessment of waste packages* [6].

2 The 500 litre drum waste container

The 500 litre drum (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 our plans for the geological disposal of such wastes. Variants of the basic design of 500 litre drum have been used over a period of more than 20 years for the packaging of such wastes with a wide range of physical, chemical and radiological properties.

Figure 1 500 litre drum waste container and stillage for waste packages

To permit the safe handling and stacking of 500 litre drum waste packages during most stages of their long-term management (including transport and disposal), 'stillages' containing a 2x2 array of waste packages will be used (Figure 1).

The 500 litre drum waste container is used to manufacture 'unshielded waste packages' which signifies that it is typically fabricated from relatively thin section stainless steel, which provides little radiation shielding of the waste package radionuclide contents. Because of this, remote techniques are generally utilised for the handling of such waste packages and their transport through the public domain will take place inside protective transport containers. The transport packages that result from the combination of a stillage of four 500 litre drum waste packages and such a transport container will generally be classed as Type B transport packages under the IAEA *Regulations for the Safe Transport of Radioactive Material* [7].

Within the standard dimensional envelope defined for the 500 litre drum waste container a number of variants have been developed to accommodate the process requirements for conditioning a wide range of wastes. This has resulted in the production of a number of different wasteform types which involve the conditioning of waste using an encapsulating medium. The possibility also exists for the 500 litre drum to be used for the packaging of certain types of waste without the use of an encapsulant. Guidance is available on the achievement of the requirements for both encapsulated and non-encapsulated wasteforms [8, 9].

3 Packaging criteria for 500 litre drum waste packages

This WPS defines the key features of the 500 litre 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.

It is assumed that 500 litre drum waste packages will be transported to and emplaced in a GDF in stillages, each containing a 2x2 array of identical waste packages. Transport will take place within a standard waste transport container (SWTC) of which three designs are currently envisaged, providing nominal shielding thicknesses of 70mm, 150mm and 280mm 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 that make up this WPS, their use is consistent with the recommendations of BS 7373:1998 [10] and that they have the following meaning:

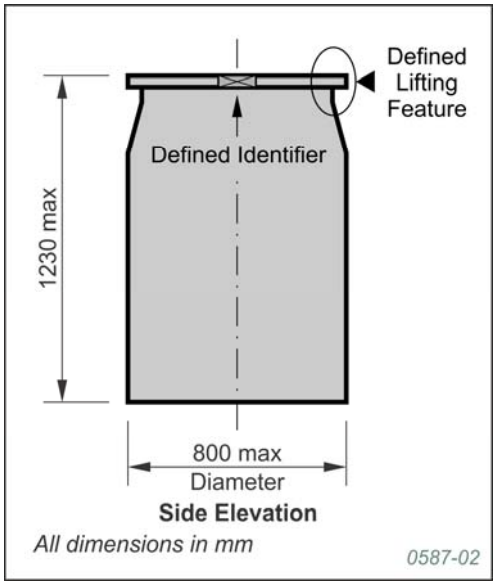
- '*shall*' denotes a limit which is derived from consideration of a regulatory requirement and/or from a fundamental assumption regarding the current designs of the transport or disposal facility systems;
- '*should*' denotes a target from which relaxations may be possible if they can be shown[1] not 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, in conjunction with those of the wasteform, it satisfies all of the requirements for the waste package.

Figure 2 Standard features of the 500 litre drum



[1] 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: 1230mm
- Diameter: 800mm

3.1.3 Handling features

The waste package *shall* be capable of being lifted by way of a standard lifting grab [11], using a handling feature in the form of a recessed flange (Figure 3). The flange *shall* be located on the top face of the drum and *shall* provide access to locate the claws of the lifting grab at any position around the periphery.

The waste package *shall* be capable of being lifted with a force of 40kN using this feature, with contact at no more than two diametrically opposite positions, without exhibiting any permanent deformation.

The top face of the lid of the waste container *shall* be provided with an annular space clear of any protrusions to allow the feet of the grab to locate correctly on the top of the waste package. The space *shall* have a maximum inside diameter of 580mm and be a minimum of 60mm wide (Figure 4).

Figure 3 Lifting feature of the 500 litre drum

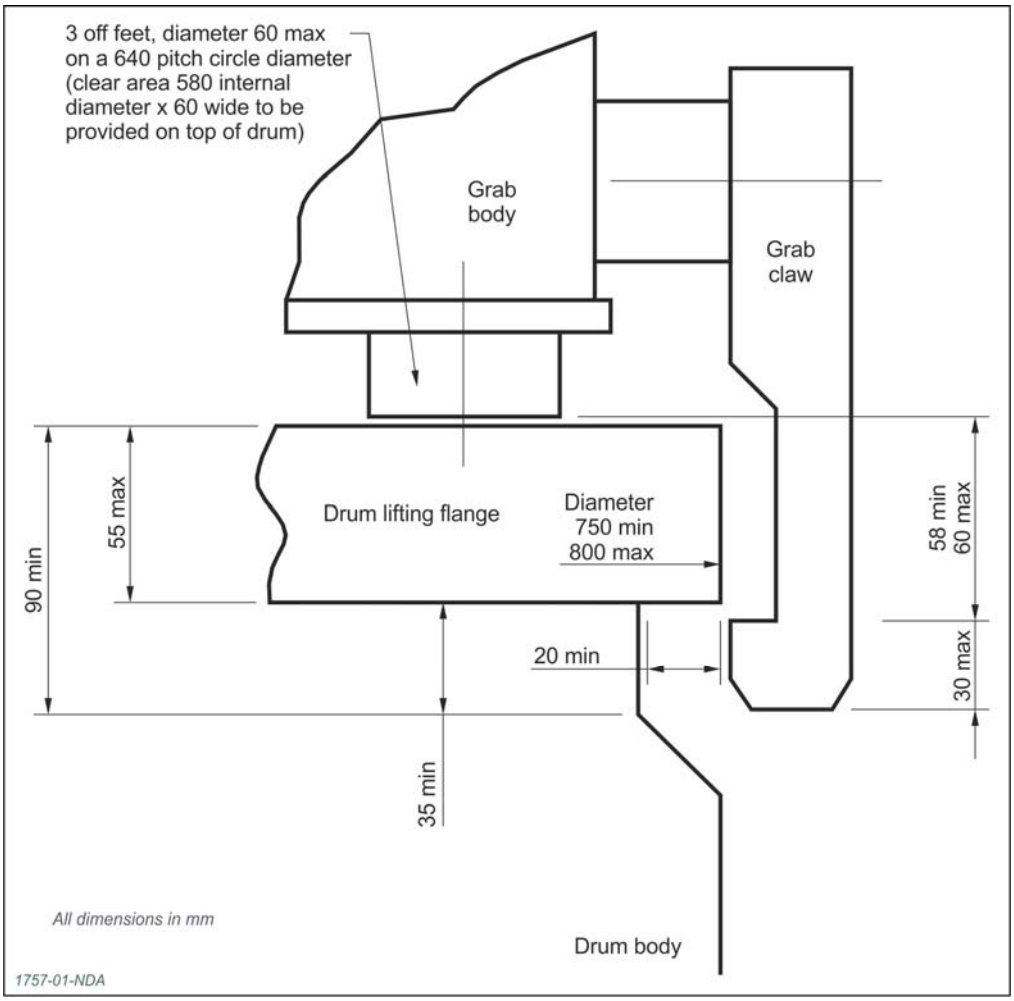
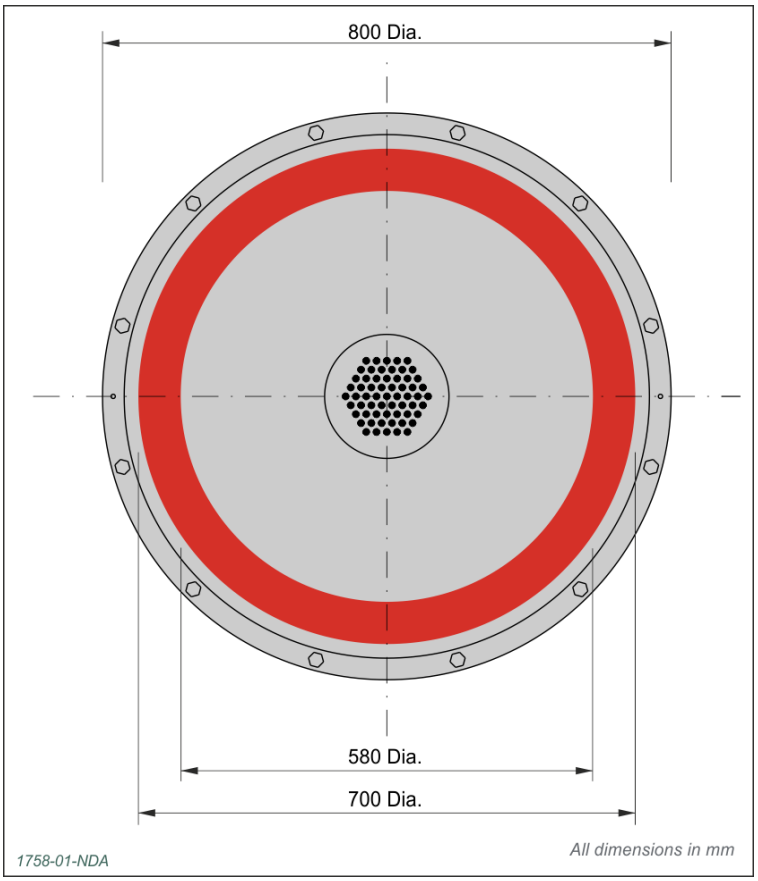


Figure 4 Required clear area on lid of 500 litre drum waste container



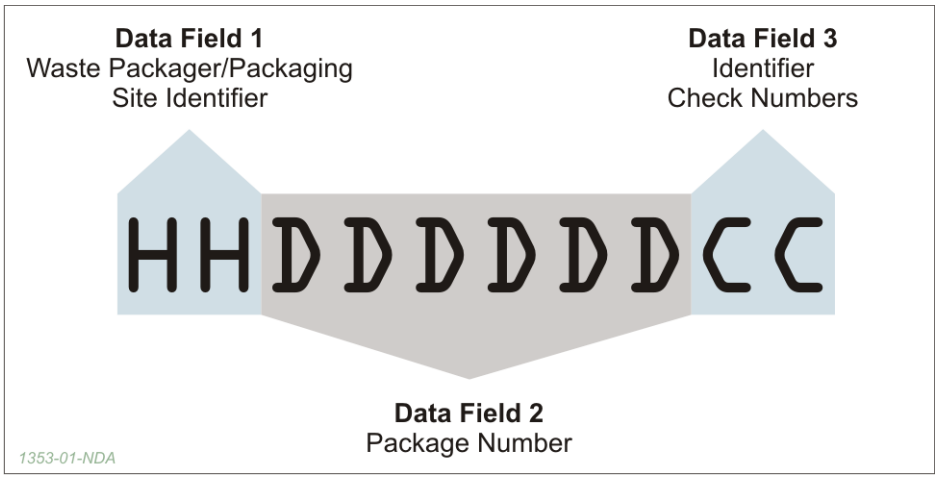
3.1.4 Identification

The waste container *shall* be marked with a unique alpha-numeric identifier, located at four positions, on the vertical surface of the lifting feature on the waste container body and spaced at 90º around the circumference of the waste container (Figure 2).

The identifier characters *shall* be between 6mm and 10mm high and their form *shall* comply with the relevant RWMD specification [12] (Figure 5).

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

Figure 5 Form of waste package identifier



3.1.5 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 those defined by the *Wasteform specification for waste packages containing low heat generating waste* [13].

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) [14].

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 *should* not exceed 2000kg.

3.3.2 External dose rate

The external dose rate of the waste package *should* be such that, when it is carried with three other identical waste packages in a transport container providing 280mm 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 heat generated by the waste package *should* not exceed 100W at the time of transport.

The heat generated by the waste package *should* not exceed 3W and *shall* not exceed 50W 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[2] 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.

A design pressure constraint *shall* be defined and justified for the internal pressure of an unvented waste package such as to ensure that the requirements stated above are achieved. The design pressure constraint *shall* not be exceeded for a period of 150 years and *should* not be exceeded for a period of 500 years following manufacture of the waste package.

The total gas generated[3] and released by the waste package during transport *should* not exceed 76 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 4.5E-04 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 [14] 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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[2] 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.

[3] 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[4], 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[5].

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 together with three identical waste packages, 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.

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[4] Defined as uranium-233, uranium-235, plutonium-239 and plutonium-241.

[5] 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 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 for the duration of such a period.

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 [15], *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 radionuclides of relevance to the disposability of the waste package [16].

The arrangements for data and information recording *shall* comply with the relevant RWMD specification [17] 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 material

The safeguards status of any nuclear material[6] contained within the waste package *shall* be ascertained and recorded.

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

[6] i.e. all isotopes of uranium, plutonium and/or thorium.

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