

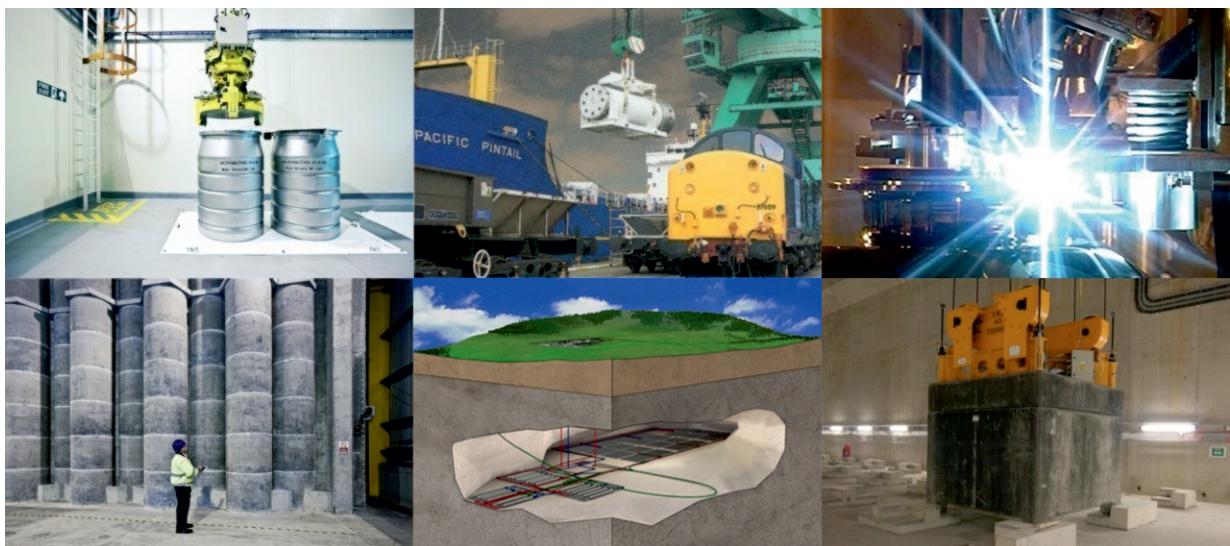
# Geological Disposal

## Waste Package Specification for 6 cubic metre concrete box waste packages

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**January 2014**

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**WASTE PACKAGE SPECIFICATION AND GUIDANCE DOCUMENTATION**

**WASTE PACKAGE SPECIFICATION FOR 6 CUBIC METRE CONCRETE BOX 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 6 cubic metre concrete box, 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](http://www.nda.gov.uk), to confirm that they are in possession of the latest version of any documentation used.

WPSGD DOCUMENT NUMBER WPS/360 - VERSION HISTORY		
VERSION	DATE	COMMENTS
WPS/360/01	January 2013	Aligns with Generic Specification for waste packages containing low heat generating waste (NDA/RWMD/068) as published August 2012.
WPS/360/02	January 2014	Corrections made to external dimensions and tolerances (Figures 2 and 3) Issued for trial use by waste producers.

This document has been compiled on the basis of information obtained by NDA RWMD. It has been verified in accordance with arrangements established by the NDA that meet the requirements of ISO 9001. The document has been fully verified and approved for publication by the NDA.



## 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](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 RWMD Waste Package Specification and Guidance Documentation* [2].

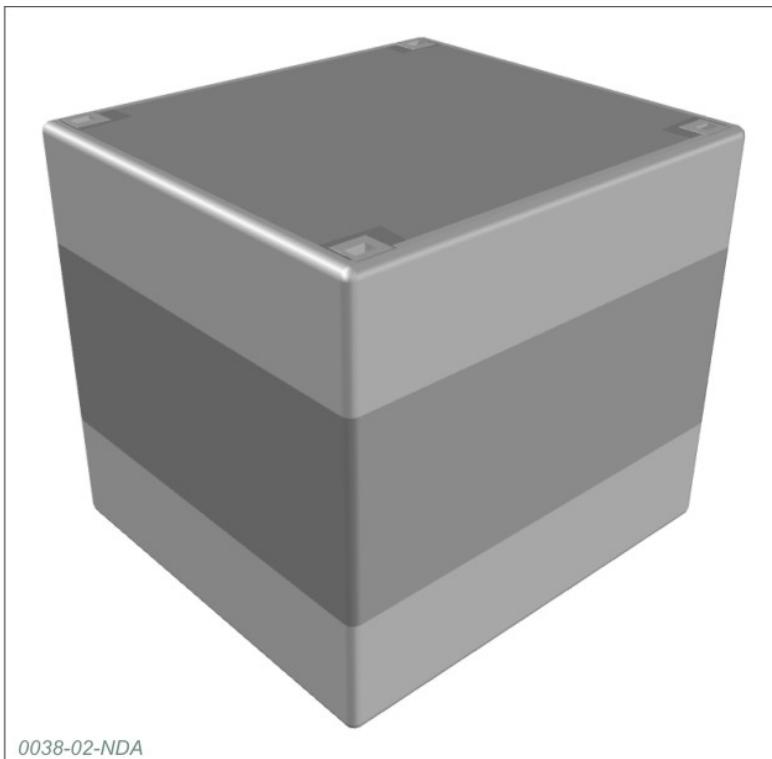
This WPS applies the requirements for waste packages containing low heat generating waste, which include those classed as intermediate level waste (ILW), as defined by the *Generic Specification for waste packages containing low heat generating waste* [3], to waste packages that are manufactured using the 6 cubic metre concrete 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 shielded waste packages* [4].

The suitability of proposals to package specific wastes using the 6 cubic metre concrete box 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 assessment by RWMD are referred to *Guidance on the preparation of submissions for the Disposability Assessment of waste packages* [6].

## 2 The 6 cubic metre concrete box waste container

The 6 cubic metre concrete box (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. The 6 cubic metre concrete box waste container is anticipated to be used for the packaging of a wide range of wastes arising from the decommissioning of nuclear facilities.

**Figure 1 6 cubic metre concrete box waste container**



The 6 cubic metre box waste container is used to manufacture 'shielded waste packages' which signifies that it can be handled without the need for remote techniques and can be transported without the need for additional radiation shielding. This is achieved by the container being manufactured from reinforced concrete with walls ~240mm thick which provide radiation shielding of the radionuclide contents of the waste package.

As well as being suitable for disposal in a GDF, 6 cubic metre concrete box waste packages are specified in a manner such as to qualify them as transport packages in their own right and are therefore capable of being transported through the public domain without the need for additional protection. Specifically 6 cubic metre concrete box waste packages will be classed as Type IP-2 transport packages as defined by the IAEA *Regulations for the Safe Transport of Radioactive Material* [7]. This limits their contents to such as can satisfy the requirements for low specific activity (LSA) material or for surface contaminated objects (SCOs).

The 6 cubic metre concrete box waste container would generally be used for the packaging of wastes which would be conditioned into a monolithic form by the use of an encapsulating medium. Guidance has been produced on the achievement of the requirements for such wasteforms [8].

### 3 Packaging criteria for 6 cubic metre concrete box waste packages

This WPS defines the key features of the 6 cubic metre concrete box 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 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 BS7373:1998 [9] and that they have the following meaning:

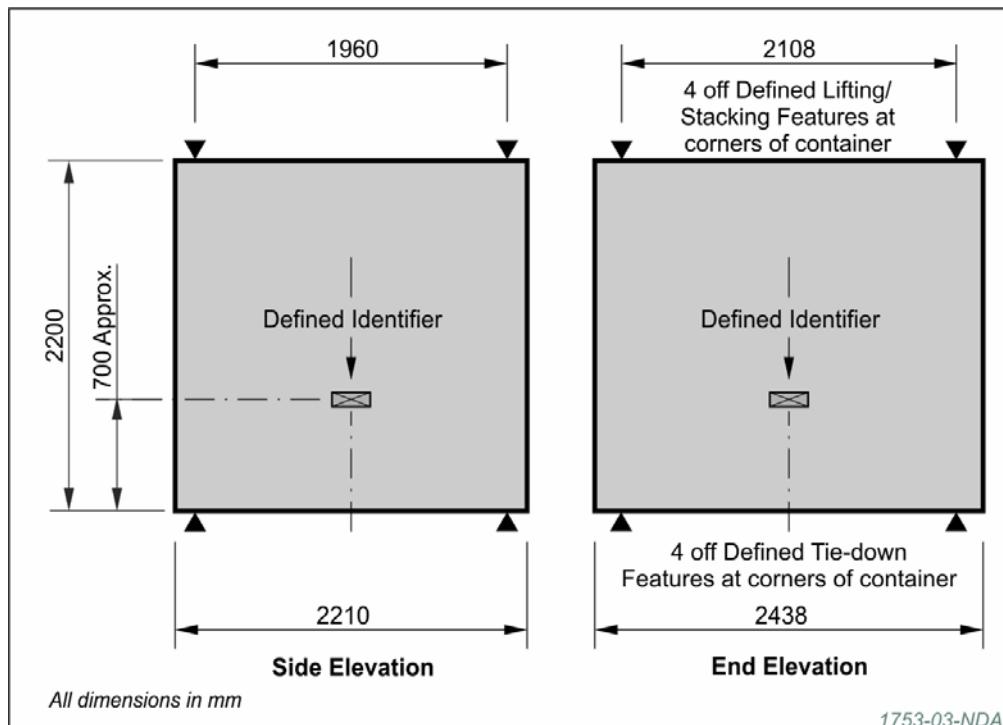
- '*shall*' denotes a limit which is derived from consideration of a regulatory requirement and/or from a fundamental assumption regarding the current designs of the transport or disposal facility systems;
- '*should*' denotes a target from which relaxations may be possible if they can be shown<sup>1</sup> 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 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 6 cubic metre concrete box**

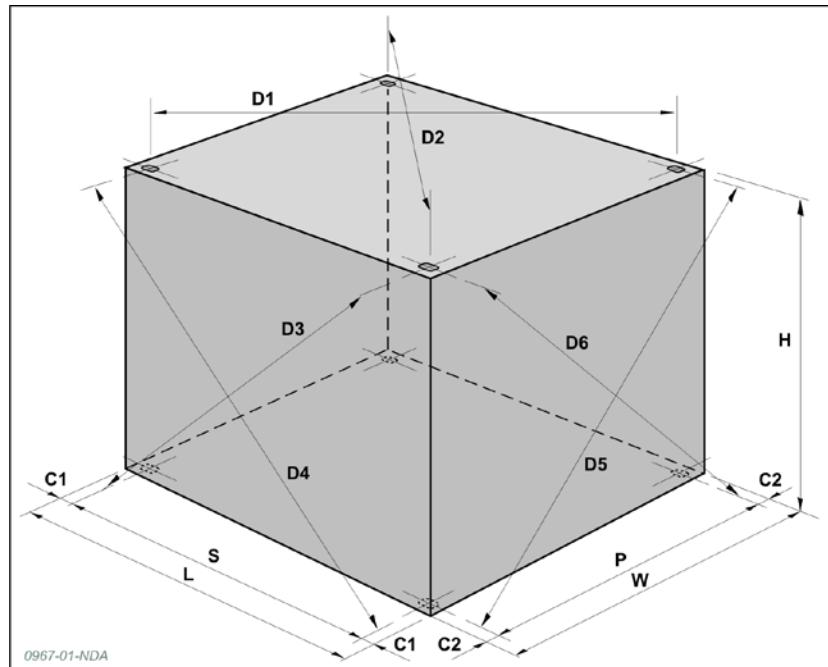


<sup>1</sup> This would generally be by way of the Disposability Assessment Process.

### 3.1.2 External dimensions

The overall dimensional envelope of the waste package *shall* comply with that defined in Figure 3.

**Figure 3 Key dimensions of 6 cubic metre concrete box**



Label	Description	Dimension (mm)	Tolerance (mm)
L	Overall Box Length	2438	+0/-5
W	Overall Box External Width	2210	+0/-5
H	Overall Box External Height	2200	+0/-5
S	Length between Corner Fitting Aperture Centres	2108	$\pm 2.5$
P	Width between Corner Fitting Aperture Centres	1960	$\pm 2.5$
K1	Difference between D1 & D2 or D3 & D4 i.e. $ D1-D2 $ or $ D3-D4 $	9	max.
K2	Difference between D5 & D6 i.e. $ D5-D6 $	11	max.
C1	Corner Fitting Measurement <sup>2</sup>	163.5	+0/-1.5
C2	Corner Fitting Measurement <sup>2</sup>	123.5	+0/-1.5

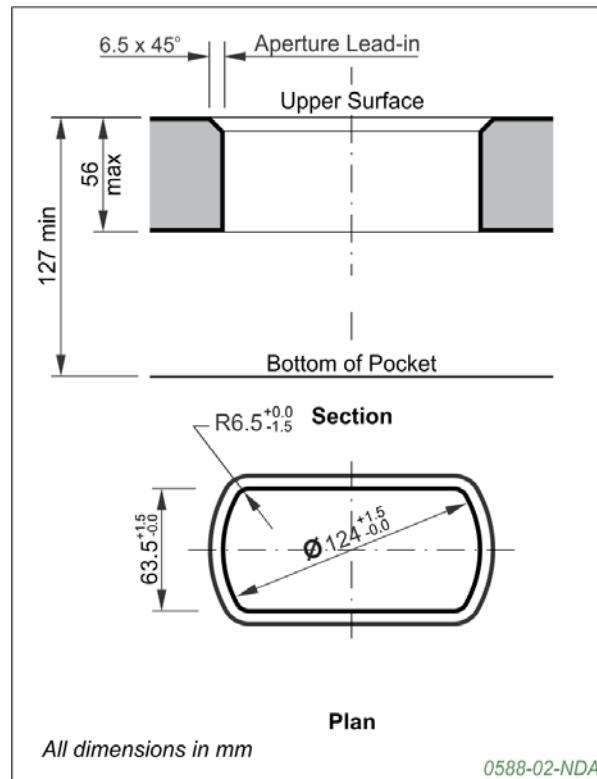
<sup>2</sup> From BS3951: Pt. 1: Section 1.2: 1985

### 3.1.3 Handling features

To allow lifting, handling and restraint of the waste package during transport the waste container *shall* incorporate corner fittings suitable for the maximum waste package mass, and compliant with the British and International Standards for Freight Containers [10].

The corner fittings *shall* comprise twistlock apertures of dimensions and geometry as defined in Figure 4, located as shown in Figure 3.

**Figure 4** Twistlock geometry and dimensions



### 3.1.4 Stackability

The waste package *shall* be capable of withstanding a compressive load equal to five times its own weight without exhibiting any permanent deformation or abnormality that would render it incompatible with the needs for transport.

The waste package *shall* be capable of withstanding a compressive load of 2.0MN 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.

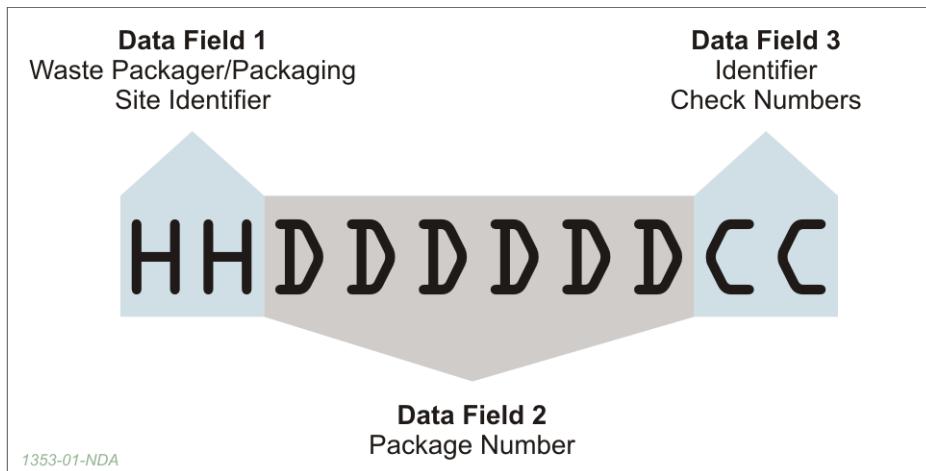
### 3.1.5 Identification

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 at the mid-point of each of the vertical surfaces of the waste container, the centre line being located at a height of 700mm from its lower surface (Figure 2).

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**



### 3.1.6 Durability of integrity

The integrity of the waste container (i.e. its safe handling by way of its handling feature, stackability and containment function) *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* [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 Activity content**

The average specific activity<sup>3</sup> of the wasteform *shall* not exceed  $2 \times 10^{-3} A_2 \text{ g}^{-1}$ .

The activity *shall* be essentially uniformly distributed throughout the wasteform.

The quantity of LSA material or SCOs in the waste package *shall* be restricted such that the external radiation level at 3m from the unshielded contents of the waste package does not exceed  $10 \text{ mSv h}^{-1}$ .

#### **3.3.2 Maximum gross mass**

The gross mass of the waste package *shall* not exceed 50t.

#### **3.3.3 External dose rate**

The external dose rate of the waste package at 1m from any external surface *should* not exceed  $0.1 \text{ mSv h}^{-1}$  and the dose rate at its external surface *should* not exceed  $2 \text{ mSv h}^{-1}$ .

#### **3.3.4 Heat output**

The heat generated by the waste package *should* not exceed 60W at the time of transport.

The heat generated by the waste package *should* not exceed 30W at the time of disposal vault backfilling.

#### **3.3.5 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  $300 \text{ cm}^2$  of any part of the surface of the waste package, *shall* not exceed:

- Beta, gamma and low toxicity<sup>4</sup> alpha emitters:  $4.0 \text{ Bq cm}^{-2}$
- All other alpha emitters:  $0.4 \text{ Bq cm}^{-2}$

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<sup>3</sup> The unit of activity adopted by the IAEA Transport Regulations is the  $A_2$ , a measure of activity defined for each radionuclide which has significance to transport safety and which is linked to possible exposure pathways to humans by the radiation emitted by that radionuclide.

<sup>4</sup> 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.

### 3.3.6 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 walls of the waste container *shall* be sufficiently permeable to gases to ensure that gases generated by the wasteform do not damage the integrity of the waste container or the wasteform. This property *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.

The release of activity in gaseous form from the waste package during transport *should* not exceed  $10^{-6} \text{A}_2$  per hour.

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: 40kBq per hour
- Carbon-14: 1.0kBq per hour
- Radon-222: 0.8kBq per hour

### 3.3.7 Criticality safety

The presence of fissile material<sup>5</sup>, 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<sup>6</sup>.

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

The quantities of fissile material, neutron moderators and reflectors in the waste package *should* be controlled to ensure that the transport package can be excepted from the requirements of the IAEA Transport Regulations for packages containing fissile material.

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.

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<sup>5</sup> Defined as uranium-233, uranium-235, plutonium-239 and plutonium-241.

<sup>6</sup> 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.

### **3.3.8 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 waste package *shall* be capable of being dropped, in any credible attitude, from a height of 0.3m onto a flat unyielding surface, whilst retaining its radioactive contents, without loss of shielding integrity that would result in more than a 20% increase in radiation level at any external surface of the package, and remaining 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.

## **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 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 material**

The safeguards status of any nuclear material<sup>7</sup> contained within a waste package *shall* be ascertained and recorded.

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

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<sup>7</sup> i.e. all isotopes of uranium, plutonium and/or thorium.

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