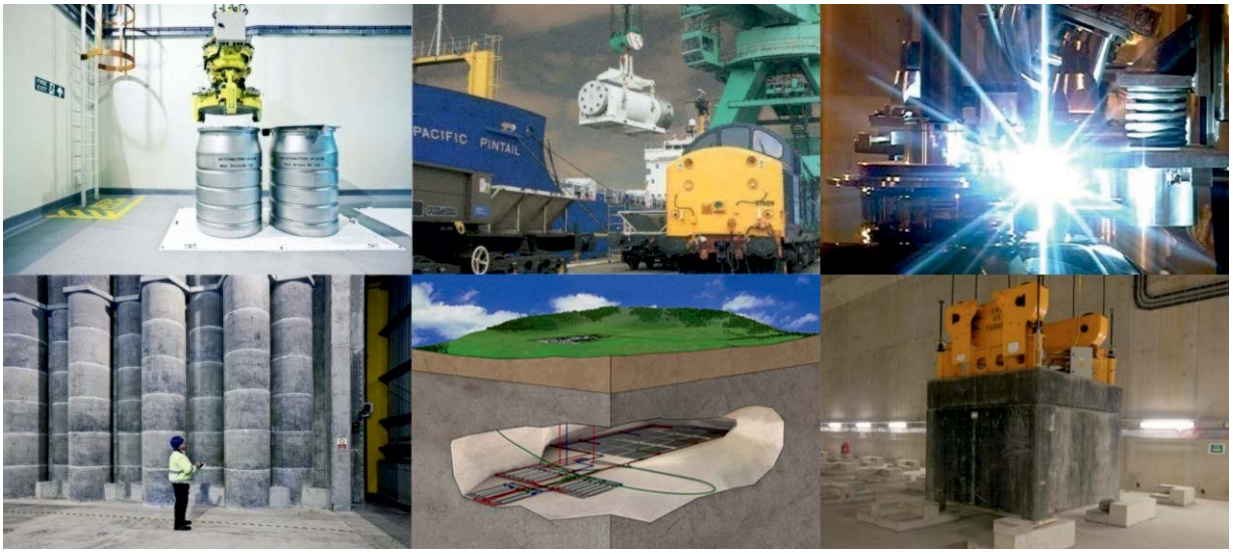
Nuclear
Decommissioning
Authority

WPSGD No. WPS/330/03

Geological Disposal

Waste Package Specification for 4 metre box waste packages

January 2013



WPSGD No. WPS/330/03

Geological Disposal

Waste Package Specification for 4 metre box waste packages

January 2013

Conditions of Publication

This report is made available under the NDA Transparency Policy. In line with this policy, the NDA is seeking to make information on its activities readily available, and to enable interested parties to have access to and influence on its future programmes. The report may be freely used for non-commercial purposes. However, all commercial uses, including copying and re-publication, require permission from the NDA. All copyright, database rights and other intellectual property rights reside with the NDA. Applications for permission to use the report commercially should be made to the NDA Information Manager.

Although great care has been taken to ensure the accuracy and completeness of the information contained in this publication, the NDA can not assume any responsibility for consequences that may arise from its use by other parties.

Bibliography

If you would like to see other reports available from NDA, a complete listing can be viewed at our website www.nda.gov.uk, or please write to the Library at the address below.

Feedback

Readers are invited to provide feedback to the NDA on the contents, clarity and presentation of this report and on the means of improving the range of NDA reports published. Feedback should be addressed to:

Head of Stakeholder Engagement and Communications,
Nuclear Decommissioning Authority (Radioactive Waste Management Directorate),
Building 587
Curie Avenue,
Harwell Oxford,
Didcot,
OX11 0RH, UK

WASTE PACKAGE SPECIFICATION AND GUIDANCE DOCUMENTATION

WASTE PACKAGE SPECIFICATION FOR 4 METRE 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 4 metre 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, to confirm that they are in possession of the latest version of any documentation used.

WPSGD DOCUMENT NUMBER WPS/330 - VERSION HISTORY		
VERSION	**DATE**	**COMMENTS**
WPS/330/01	July 2005	Aligns with GWPS (Nirex Report N/104) as published June 2005
WPS/330/02	March 2008	Updated to acknowledge NDA assumption of Nirex responsibilities Aligns with Issue 2 of GWPS (Nirex Report N/104) as published March 2007. Changes comprise: Changes to NII SAPs and modelling of DBAs
WPS/330/03	January 2013	Aligns with Generic Specification for waste packages containing low heat generating waste (NDA/RWMD/068) as published August 2012. Issued 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 4 metre 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 4 metre 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 such assessment by RWMD are referred to *Guidance on the preparation of submissions for the disposability assessment of waste packages* [6].

2 The 4 metre box waste container

The 4 metre 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 4 metre 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 4 metre box waste container

The 4 metre box waste container is used to manufacture 'shielded waste packages' which signifies that they 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, which is typically fabricated from relatively thin section stainless steel, incorporating a concrete liner, with a thickness of up to 300mm, which provides radiation shielding of the radionuclide contents of the waste package[1].

As well as being suitable for disposal in a GDF, 4 metre box waste packages are specified in a manner such as to qualify them as transport packages in their own right and are thereby capable of being transported through the public domain without the need for additional protection. Specifically 4 metre 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 (i.e. the wasteforms) to such as can satisfy the requirements for low specific activity (LSA) material or for surface contaminated objects (SCOs).

It is expected that, in most cases, the 4 metre box waste container will be used for the packaging of waste which has been conditioned involving the use of an immobilising medium. The possibility also exists for wastes to be packaged in 4 metre box waste containers in a non-encapsulated form. Guidance has been produced on the achievement of the requirements for both encapsulated and non-encapsulated wasteforms [8, 9].

[1] The container can also be used without such a liner for wastes with low external radiation dose rates (e.g. LLW).

3 Packaging criteria for 4 metre box waste packages

This WPS defines the key features of the 4 metre 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 [10] and that they have the following meaning:

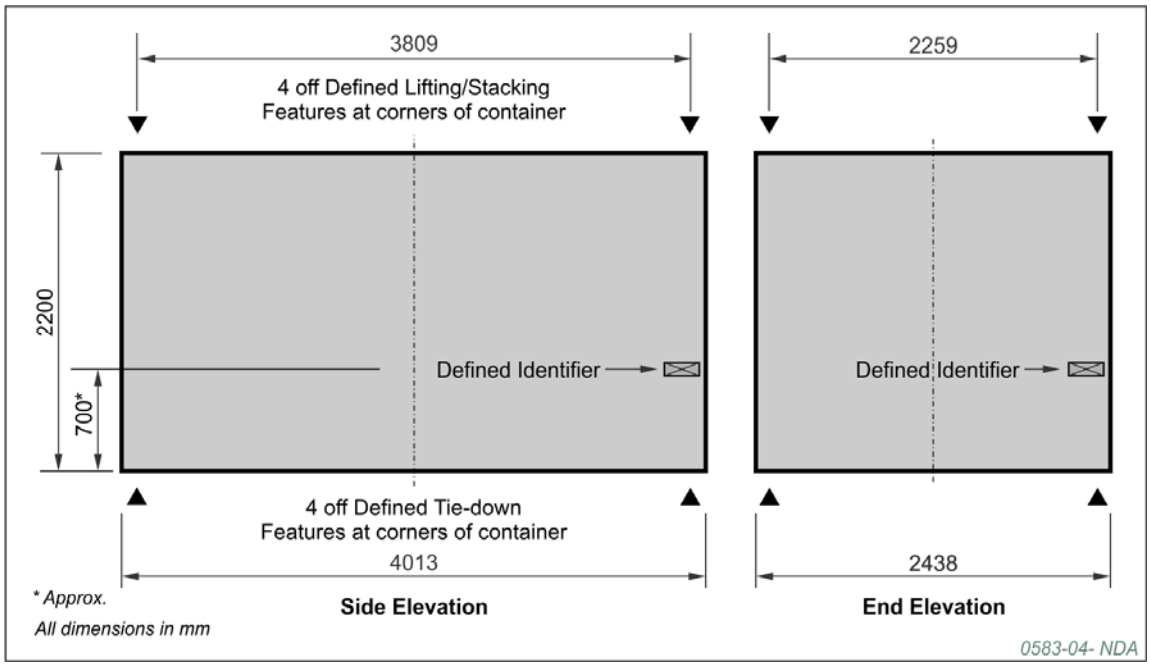
- '*shall*' denotes a limit which is derived from consideration of a regulatory requirement and/or from a fundamental assumption regarding the current designs of the transport or disposal facility systems;
- '*should*' denotes a target from which relaxations may be possible if they can be shown[2] not 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 4 metre box

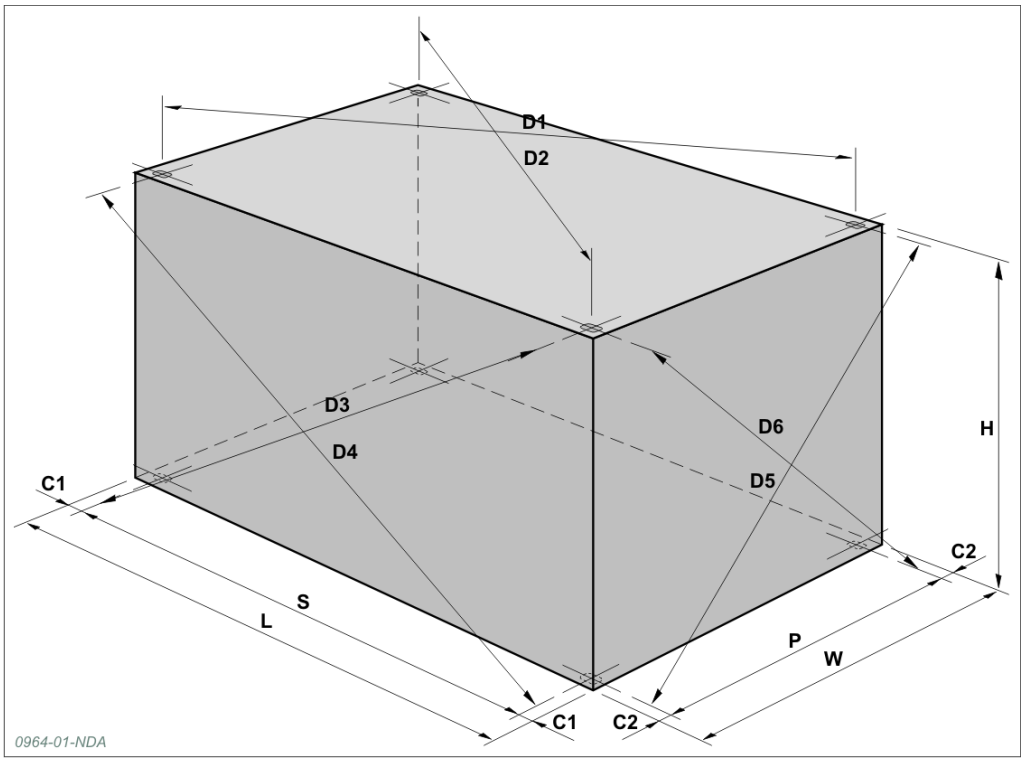


[2] This would generally be by way of the Disposability Assessment Process.

3.1.2 External dimensions

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

Figure 3 Key dimensions of 4 metre box



Label	Description	Dimension (mm)	Tolerance (mm)
L	Overall Box Length	4013	+0/-6
W	Overall Box External Width	2438	+0/-5
H	Overall Box External Height	2200	+0/-5
S	Length between Corner Fitting Aperture Centres	3809	ref.
P	Width between Corner Fitting Aperture Centres	2259	ref.
K1	Difference between D1 & D2 or D3 & D4 i.e. |D1-D2| or |D3-D4|	11	max.
K2	Difference between D5 & D6 i.e. |D5-D6|	11	max.
C1	Corner Fitting Measurement[3]	101.5	+0/-1.5
C2	Corner Fitting Measurement[3]	89.0	+0/-1.5

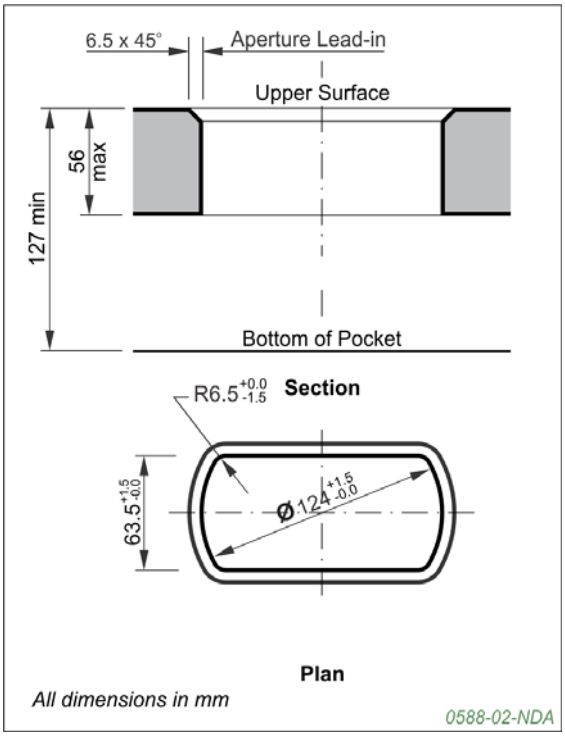
[3] From BS3951: Pt. 1: Section 1.2: 1985

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 [11].

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 2.6MN 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.

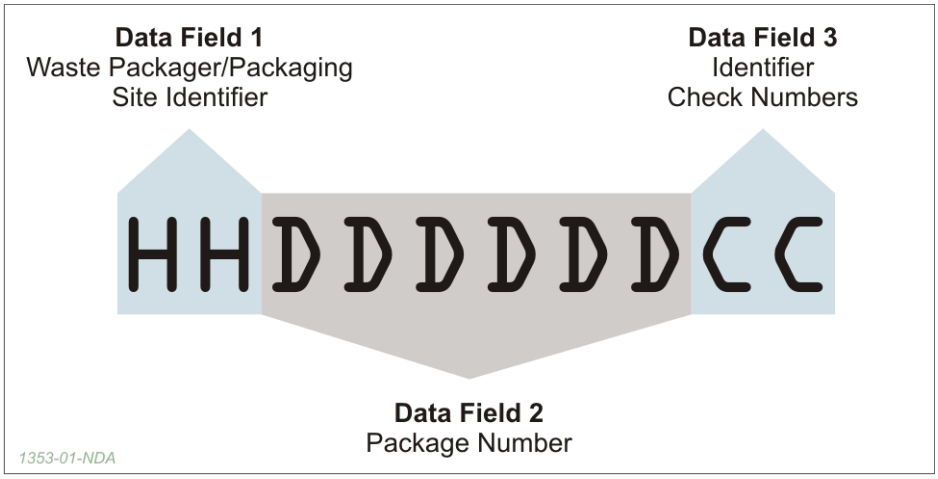
3.1.5 Identification

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 [12] (Figure 5).

The identifier *shall* be marked at the mid-point of each of the vertical surfaces of the waste container, on the centre line of each stacking post and located at a height of 700mm from the 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, 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 Activity content

The average specific activity[4] of the wasteform *shall* not exceed:

- $10^{-4}A_2\,g^{-1}$; in which the activity is distributed throughout a non-encapsulated wasteform; or
- $2x10^{-3}A_2\,g^{-1}$; in which the activity is essentially uniformly distributed throughout an encapsulated 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 10mSv h^{-1}.

3.3.2 Maximum gross mass

The gross mass of the waste package *shall* not exceed 65t.

3.3.3 External dose rate

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

3.3.4 Heat output

The heat generated by the waste package *should* not exceed 200W at the time of transport.

The heat generated by the waste package *should* not exceed 60W 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 300cm^2 of any part of the surface of the waste package, *shall* not exceed:

- Beta, gamma and low toxicity[5] alpha emitters: 4.0Bq cm^{-2}
- All other alpha emitters: 0.4Bq cm^{-2}

[4] 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.

[5] 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 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 release of activity in gaseous form from the waste package during transport *should* not exceed $10^{-6}A_2$ 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 [14] for the limitation of off-site radiation dose, and *should* not exceed:

- Hydrogen-3: 80kBq per hour
- Carbon-14: 1.8kBq per hour
- Radon-222: 1.5kBq per hour

3.3.7 Criticality safety

The presence of fissile material[6], 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[7].

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.

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.

---

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

[7] 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.

3.4.1 Quality management

Adequate management arrangements *shall* be applied to all aspects of the packaging of radioactive wastes 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 of the 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 materials

The safeguards status of any nuclear material[8] 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.

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

References

1 NDA, *Geological Disposal: Generic Waste Package Specification,* NDA Report No. NDA/RWMD/067, 2012.

2 NDA, *Geological Disposal: Introduction to the RWMD Waste Package Specification and Guidance Documentation,* WPS/100/04, 2013.

3 NDA, *Geological Disposal: Generic specification for waste packages containing low heat generating waste,* NDA Report No. NDA/RWMD/068, 2012.

4 NDA, *Geological Disposal: Guidance on the achievement of the Waste Package Specifications for unshielded waste packages,* WPS/701/01, 2013.

5 NDA, *Geological Disposal: Radioactive wastes and assessment of the disposability of waste packages*, NDA Report No.NDA/RWMD/039, 2010.

6 NDA, *Geological Disposal: Guidance on the preparation of submissions for the disposability assessment of waste packages*, WPS/908/04, 2013.

7 IAEA, *Regulations for the Safe Transport of Radioactive Material 2009 Edition,* IAEA Safety Standards Series No. TS-R-1, 2009.

8 NDA, *Geological Disposal: Guidance on the achievement of the required properties of encapsulated wasteforms*, WPS/502/01, 2013.

9 NDA, *Geological Disposal: Guidance on the achievement of the required properties of non-encapsulated wasteforms*, WPS/503/01, 2013.

10 British Standards Institution, *Guide to the Preparation of Specifications,* BS7373, 1998.

11 British Standard Institution, *British Standard Freight Containers, Specification and Testing of Series 1 Freight Containers - General Cargo Containers for General Purposes*, BS 3951, 1991.

12 NDA, *Geological Disposal: Specification of waste package identification system*, WPS/410/02, 2008.

13 NDA, *Geological Disposal: Wasteform specification for waste packages containing low heat generating waste,* WPS/501/01, 2013.

14 NDA, *Geological Disposal: Generic Environmental Safety Case main report,* NDA Report No. NDA/RWMD/021, 2010.

15 NDA, *Geological Disposal: Waste package quality management specification,* WPS/200/02, 2008.

16 Nirex, *The Identification of Radionuclides Relevant to Long-term Waste Management in the UK*, Nirex Report No. N/105, 2004.

17 NDA, *Geological Disposal: Specification for waste package data and information recording requirements,* WPS/400/02, 2008.

Certificate No 4002929

Certificate No 4002929

Nuclear Decommissioning Authority
Radioactive Waste Management Directorate
Building 587
Curie Avenue
Harwell Oxford
Didcot
Oxfordshire OX11 0RH

t +44 (0)1925 802820
f +44 (0)1925 802932
w www.nda.gov.uk