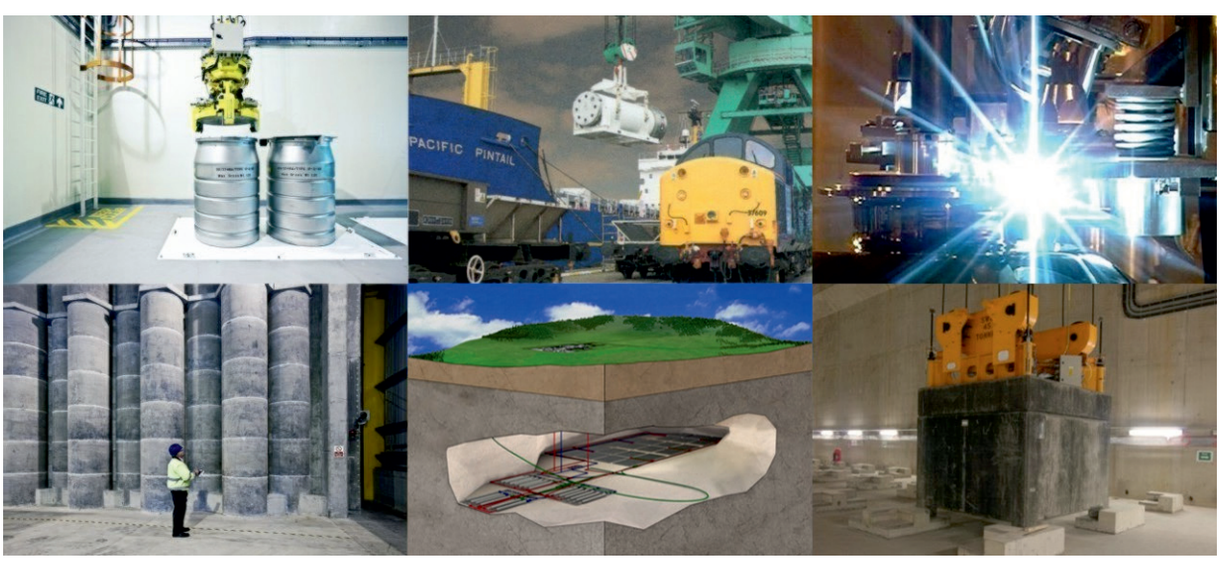
Nuclear Decommissioning Authority

WPSGD No. WPS/362/01

# Geological Disposal

## Waste Package Specification for 1 cubic metre concrete drum waste packages

**December 2014**



WPSGD No. WPS/362/01

# Geological Disposal

# Waste Package Specification for 1 cubic metre concrete drum waste packages

**December 2014**

## Conditions of Publication

This report is made available under the Radioactive Waste Management Limited Transparency Policy. In line with this policy, Radioactive Waste Management Limited 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 Nuclear Decommissioning Authority (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 cannot assume any responsibility for consequences that may arise from its use by other parties.

© Nuclear Decommissioning Authority 2014. All rights reserved.

Bibliography

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

Feedback

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

Head of Stakeholder Engagement and Communications

Radioactive Waste Management Limited

Building 587

Curie Avenue

Harwell Oxford

Didcot

OX11 0RH

UK

**WASTE PACKAGE SPECIFICATION AND GUIDANCE DOCUMENTATION**

**WASTE PACKAGE SPECIFICATION FOR 1 cubic metre CONCRETE 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 Radioactive Waste Management Ltd (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 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.

The WPSGD are intended to provide a 'user-level' interpretation of the RWM packaging specifications and to assist the holders of radioactive wastes in the development of plans and strategies for their long-term management.

This document provides a specification for waste packages containing low heat generating waste that are to be manufactured using the 1 cubic metre concrete 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 WPSGD is subject to periodic enhancement and revision. Users are therefore advised to refer to http://www.nda.gov.uk/RWM/producers/detail.cfm#specifications to confirm that they are in possession of the latest version of any documentation used.

| WPSGD DOCUMENT NUMBER WPS/362 - VERSION HISTORY | | |
|---|---|---|
| **VERSION** | **DATE** | **COMMENTS** |
| WPS/362/01 | December 2014 | Aligns with Generic Specification for waste packages containing low heat generating waste (NDA/RWMD/068) as published August 2012.<br>Conditions of exclusive use assumed for transport |
| | | |

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 (i.e. via http://www.nda.gov.uk/RWM/producers/detail.cfm#specifications).

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 1 cubic metre concrete 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 shielded waste packages* [4].

The suitability of proposals to package specific wastes using the 1 cubic metre concrete 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* [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 1 cubic metre concrete drum waste container

The 1 cubic metre concrete 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 our plans for the geological disposal of such wastes.

### Figure 1 The 1 cubic metre concrete drum waste container


The 1 cubic metre concrete drum 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 ~150mm thick which provide radiation shielding of the radionuclide contents of the waste package. If required, further radiation shielding can be provided by the means of an inner steel liner.

As well as being suitable for disposal in a GDF, 1 cubic metre concrete drum 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 1 cubic metre concrete drum 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], and transported under the conditions of exclusive use. This limits their contents to such as can satisfy the requirements for low specific activity (LSA) material or for surface contaminated objects (SCOs).

The 1 cubic metre concrete drum waste container is primarily intended for the packaging of wastes which have been conditioned by the use of an immobilising material such as a cementitious grout. Guidance has been produced on the achievement of the requirements for the wasteforms that could be produced by such a process [8]. The container can be used with non-encapsulated wasteforms for which guidance is also available [9].

# 3 Packaging criteria for 1 cubic metre concrete drum waste packages

This WPS defines the key features of the 1 cubic metre concrete 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 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:

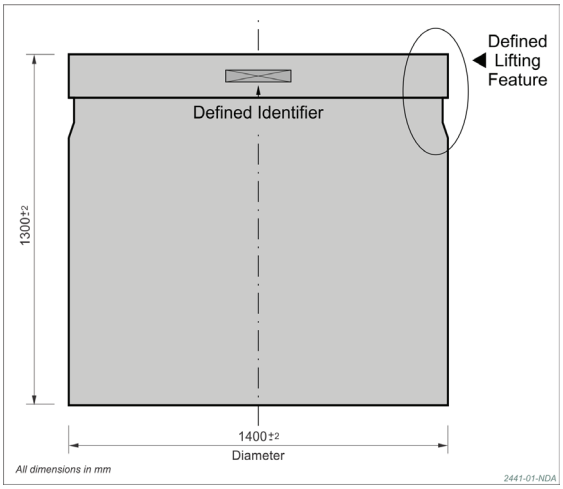
- '*shall*' denotes a limit which is derived from consideration of a regulatory requirement and/or from a fundamental assumption regarding the current designs of the transport or disposal facility systems;
- '*should*' denotes a target from which relaxations may be possible if they can be shown[1] not 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 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 1 cubic metre concrete drum waste container**




### 3.1.2 External dimensions

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

- Height: 1302mm
- Diameter: 1402mm

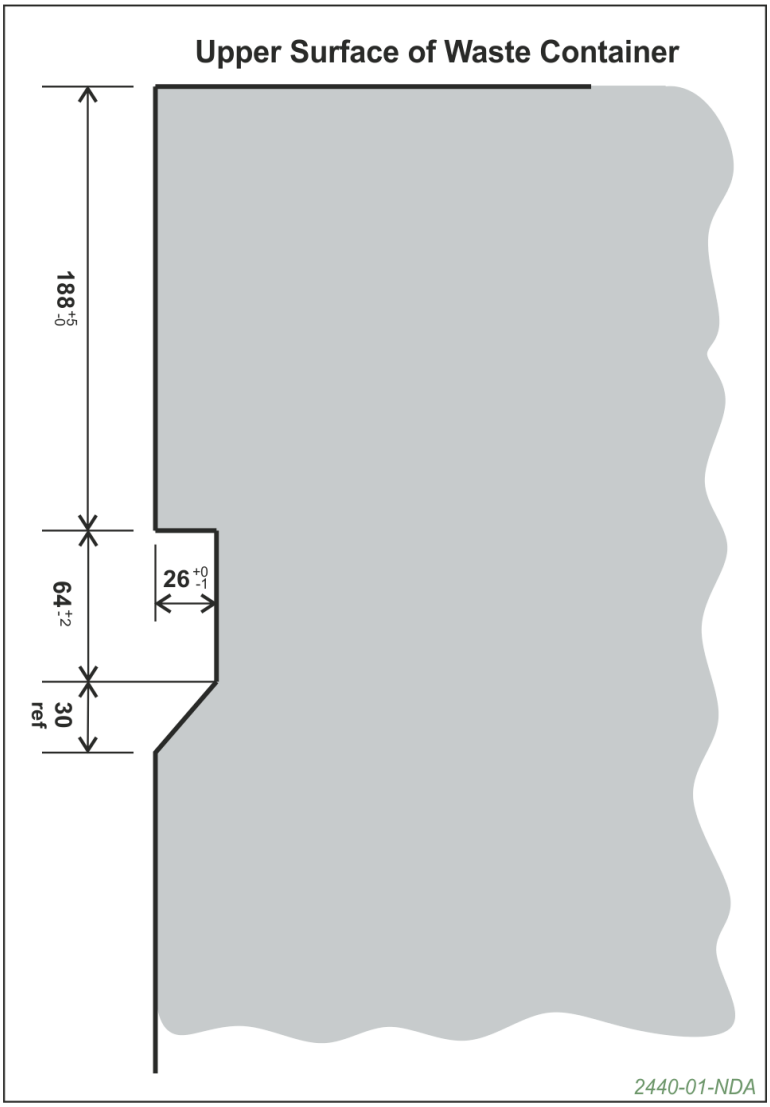
[1] This would generally be by way of the Disposability Assessment Process.

### 3.1.3 Handling feature

The waste package shall be capable of being lifted, by way of a standard three-clawed lifting grab, using an integral handling feature, in the form of a recessed channel, with dimensions and geometry as defined in Figure 3.

The waste package shall be capable of being lifted with a force of 160kN using this feature, with contact at no more than two positions, without exhibiting any permanent deformation or suffering any damage that would render it incompatible with any of the requirements defined in this WPS.

**Figure 3 Handling feature of 1 cubic metre concrete drum waste container**




### 3.1.4 Stackability

The waste package *shall* be capable of withstanding a compressive load equal to six 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 480kN 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.

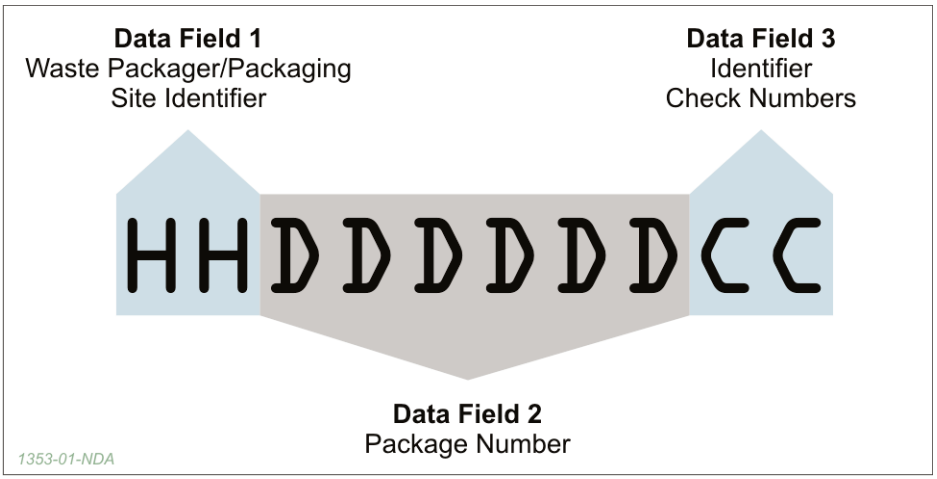
### 3.1.5 Identification

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 RWM specification [11] (Figure 4).

The identifier shall be marked at four locations on the vertical surface of the container lid, spaced at 90°around the circumference (Figure 2).

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 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[2] of the wasteform *shall* not exceed $2x10^{-3}A_2\,g^{-1}$.

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 10mSv $h^{-1}$.

### 3.3.2 Maximum gross mass

The gross mass of the waste package *shall* not exceed 8,000kg.

### 3.3.3 External dose rate

The external dose rate of the waste package at 2m from any external surface *shall* not exceed 0.1mSv $h^{-1}$ and the dose rate at its external surface *shall* not exceed 10mSv $h^{-1}$.

### 3.3.4 Heat output

The heat generated by the waste package *should* not exceed 12W 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$cm^2$ of any part of the surface of the waste package, *shall* not exceed:

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

---

[2] 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.

[3] Low toxicity alpha emitters comprise 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 $10^{-6}A_2$ 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: 16kBq per hour
- Carbon-14: 360Bq per hour
- Radon-222: 300Bq per hour

### 3.3.7 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 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.

---

[4] Fissile material is defined as material containing uranium-233, uranium-235, plutonium-239 and/or 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.

### 3.3.8 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 1.2m 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 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 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 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 material

The safeguards status of any nuclear material[6] 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.

---

[6] Nuclear material is defined as 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 RWM Waste Package Specification and Guidance Documentation,* WPS/100/04, 2014.

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 shielded waste packages,* WPS/702/01, 2014.

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/908/03, 2014.

7 IAEA, *Regulations for the Safe Transport of Radioactive Material 2012 Edition,* IAEA Specific Safety Requirements No. SSR-6, 2012.

8 NDA, *Geological Disposal: Guidance on the achievement of the required properties of encapsulated wasteforms*, WPS/502/01, 2014.

9 NDA, *Geological Disposal: Guidance on the achievement of the required properties of non-encapsulated wasteforms*, WPS/503/01, 2014.

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

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

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

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

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

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

16 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**
**Bu**ilding 587
Curie Avenue
Harwell Oxford
Didcot
Oxfordshire OX11 0RH

**t** +44 (0)1925 802820
**f** +44 (0)1925 802932
**w** www.nda.gov.uk
© Nuclear Decommissioning Authority 2014