

**WASTE PACKAGE SPECIFICATION AND
GUIDANCE DOCUMENTATION**

**WPS/620: Guidance on the Structure and
Format of Waste Product Specifications**

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Bibliography

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WASTE PACKAGE SPECIFICATION AND GUIDANCE DOCUMENTATION

GUIDANCE ON THE STRUCTURE AND FORMAT OF WASTE PRODUCT SPECIFICATIONS

This document forms part of a suite of documents prepared and issued by the Radioactive Waste Management Directorate (RWMD) of the Nuclear Decommissioning Authority (NDA).

The Waste Package Specification and Guidance Documentation (WPSGD) provide specifications and guidance for waste packages, containing Intermediate Level Waste and certain Low Level Wastes, which meet the transport and disposability requirements of geological disposal in the UK. They are based on, and are compatible with, the Generic Waste Package Specification (GWPS).

The WPSGD are intended to provide a 'user-level' interpretation of the GWPS to assist Site License Companies (SLCs) in the early development of plans and strategies for the management of radioactive wastes. To aid in the interpretation of the criteria defined by the WPSGD, and in their application to proposals for the packaging of wastes, SLCs are advised to contact RWMD at an early stage.

The WPSGD will be subject to periodic enhancement and revision. SLCs are therefore advised to contact RWMD to confirm that they are in possession of the latest version of any documentation used.

WPSGD DOCUMENT NUMBER WPS/620 - VERSION HISTORY

VERSION	DATE	COMMENTS
WPS/620/01	March 2006	Aligns with GWPS (Nirex Report N/104) as published June 2005
WPS/620/02	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.

This document has been compiled on the basis of information obtained by Nirex and latterly by the NDA. The document was 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.

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1 INTRODUCTION

The Radioactive Waste Management Directorate (RWMD) of the Nuclear Decommissioning Authority (NDA) has been established with the remit to implement the geological disposal option for the UK's higher activity radioactive wastes. The NDA is currently working with Government and stakeholders through the *Managing Radioactive Waste Safely* (MRWS) consultation process to plan the development of a Geological Disposal Facility (GDF).

As the ultimate receiver of wastes, RWMD, acting as GDF implementer and future operator, has established waste packaging standards and defined package specifications to enable the industry to condition radioactive wastes in a form that will be compatible with future transport and disposal. In this respect RWMD is taking forward waste packaging standards and specifications which were originally developed by United Kingdom Nirex Ltd, which ceased trading on 1st April 2007 and whose work has been integrated into the NDA.

The primary document which defines the packaging standards and specifications for Intermediate Level Waste (ILW), and certain Low Level Wastes (LLW) not suitable for disposal in other LLW facilities is the Generic Waste Package Specification (GWPS) [1]. The GWPS is supported by the Waste Package Specification and Guidance Documentation (WPSGD) which comprises a suite of documentation primarily aimed at SLCs, its intention being to present the generic packaging standards and specifications at the user level. The WPSGD also includes explanatory material and guidance that users will find helpful when it comes to application of the specification 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 Waste Package Specification and Guidance Documentation, WPS/100*¹.

A Waste Product Specification (WPrS) is the document produced by the waste packager which describes the quality (i.e. the composition and properties) and performance characteristics of each distinct type of waste package produced in a waste packaging plant. It should contain sufficient detail regarding the composition, properties and performance characteristics of the waste package, especially where they impact product quality. The WPrS is an important component of the 'package record' that will 'follow' a waste package through all subsequent stages of waste management and that will be used to assess the suitability of the waste package for acceptance into each stage.

The purpose of this document is to provide SLCs with guidance on the preparation of a WPrS by providing an outline as to the structure, format and required contents.

¹ Specific references to individual documents within the WPSGD are made in this document in *italic script*, followed by the relevant WPS number.

2 BACKGROUND

2.1 The Concept of Geological Disposal

In line with the MRWS consultation process, RWMD are continuing to develop concepts for the geological disposal for higher activity wastes which include ILW, and certain LLW not suitable for disposal in other LLW facilities². It is envisaged that the geological disposal of such wastes would comprise a number of distinct stages including:

- the retrieval and conditioning of the waste to create disposable waste packages, usually at the site of waste arising;
- a period of interim surface storage, also at the site of arising;
- transport of the waste packages to a GDF;
- transfer of waste packages underground and emplacement in disposal vaults;
- a period of monitored storage underground, during which retrieval by relatively simple means would be feasible;
- back-filling of the disposal vaults, followed by eventual sealing and closure.

The timing and duration of each stage would depend on a number of criteria, including the geographical location and host geology of the GDF as well as the disposal concept selected for implementation.

The Phased Geological Repository Concept (PGRC) [2], has been developed as one manifestation of geological disposal and has been adopted as the reference concept for the purposes of establishing packaging standards. The PGRC is supported by a suite of safety, security and environmental assessments intended to demonstrate that this concept will provide safety to workers and the public and provide the necessary level of environmental protection.

The safety philosophy adopted in the PGRC is one of containment of radionuclides by multiple barriers, of which that provided by the waste package is a key component. Included in these barriers are those provided by the waste package, which itself can be considered as two independent but complimentary barriers, the waste container and the wasteform, each of which plays an important role in the containment of radionuclides.

As the MRWS consultation process continues it is anticipated that the siting process, based on expressions of interest from volunteer communities, may lead to the identification of sites for investigation as to suitability to host a GDF. The disposal concept design and safety case will be developed to suit the specific characteristics of the site and packaging standards will be updated to reflect the new circumstances as appropriate.

2.2 The Generic Waste Package Specification

A major area of the RWMD's work is the provision of advice to the packagers of radioactive waste in the UK, by way of the definition of packaging standards and the assessment of individual waste packaging proposals against those standards.

² The generic description 'ILW' is used in the remainder of this document to describe both these categories of waste.

The primary document that defines packaging standards for ILW is the GWPS [1]. Derived from the PGRC and its associated generic documentation, which comprise the system specifications and safety assessments that define the PGRC, the GWPS provides the basis for assessing the suitability of waste packages containing ILW for disposal in a GDF.

The packaging standards defined by the GWPS are generic in two respects in that they are:

- derived from a full consideration of all future stage of long-term waste management; and
- independent of the location of the site of a GDF, which could be implemented at a range of different sites within the UK, representing a range of geological environments.

The format of the GWPS is to define:

- general requirements that are applicable to all waste packages;
- a range of standard waste containers;
- specific requirements for the standard waste package design that are created using the standard waste containers;
- requirements for the conditioned wasteforms that are placed into containers;
- requirements for quality management and for the creation and maintenance of records about each individual waste package.

The GWPS therefore defines the performance requirements for the two barriers to the release of radionuclides provided by the waste package, the waste container and the wasteform, against which the overall performance of waste packages can be assessed.

2.3 The Assessment of Packaging Proposals

Since the mid-1980s, waste producers in the UK have made significant investment in waste retrieval and packaging plant as a means of ensuring that such wastes are rendered passively safe and suitable for disposal. Historically Nirex was responsible for the assessment and endorsement of the suitability of packaging processes for this latter need, originally by way of the 'Letter of Comfort' assessment process. Over the ensuing two decades the Letter of Comfort process has developed and matured to a point that the assessments undertaken were established on a more structured footing with detailed advice being issued to waste producers highlighting further information needs, or need for further development and/or research before a Letter of Comfort could be issued. The assessment process was also modified to integrate better with the implementation of packaging plant projects, with staged interactions occurring at a number of stages before active operation of a packaging plant commenced. The status of the assessment process was strengthened in January 2004, when support was provided by UK nuclear regulators, and it was recognised within improved regulatory arrangements for nuclear licensed sites [3]. This was accompanied by significant changes to the assessment process which was renamed the 'Letter of Compliance' assessment process.

In April 2007 Nirex was dissolved and its responsibilities assumed by RWMD. This included the role of assessing and endorsing nuclear site operators' waste packaging proposals through the LoC assessment process.

In undertaking LoC assessments RWMD determines whether wastes, when packaged, will have characteristics compliant with plans for transport to, and operations at the GDF, and ultimately whether the wastes could be accommodated within the GDF long-term post-closure safety case. The main output of a LoC assessment is an Assessment Report which may be accompanied by the issue of a LoC endorsing the packaging proposal. In line with the recently updated regulatory guidance [4] such endorsement is now seen by the regulators as an important component of the operator's Radioactive Waste Management Case.

3 ROLE OF THE WASTE PRODUCT SPECIFICATION

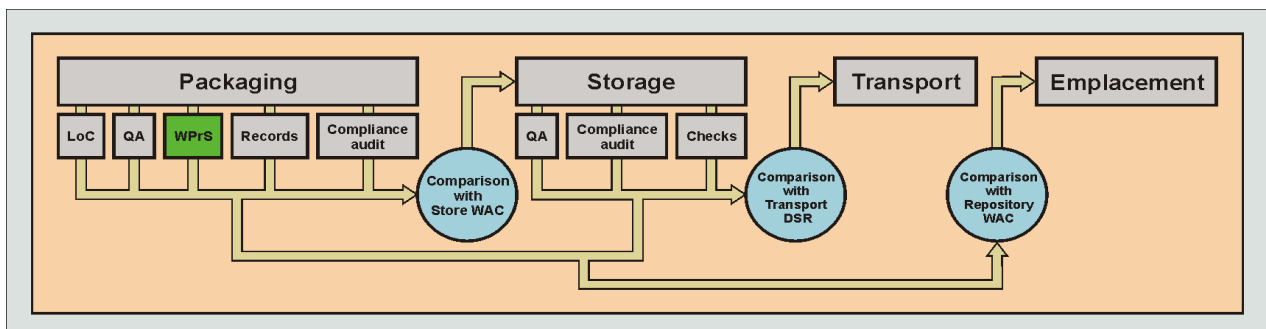
It is an important part of the safe long-term management of packaged waste is the establishment and continued maintenance of a complete history of the processes and conditions experienced by the waste package; the so-called 'package record'.

The package record comprises a number of key components:

- Letter of Compliance – provides link to the detailed assessments undertaken, and the disposability case;
- Waste Product Specification – the specification of what the site operator is setting out to manufacture and which is assessed under the LoC process;
- Data Records – the LoC process ensures that the appropriate records are kept based on measurement, assay or existing records to demonstrate conformance, or not, with the WPrS and basis of the LoC assessment;
- Quality Management System – development and production of the waste package is undertaken under appropriate quality management system;
- Compliance Audit – regulators check that the site operator makes the waste package that they set out to make.

The package record and, inter alia, the WPrS will follow a waste package throughout the stages of its long-term management and, as such, will play an essential role as the waste package passes from one stage of management to the next. This process is illustrated in Figure 1.

Figure 1 Role of the Package Record in Waste Acceptance



Specifically the role of the WPrS is therefore to:

- define the waste package that the waste packager is setting out to manufacture;
- provide a summary of the key characteristics of the packaging process and the resulting package that will influence product quality and the performance of the waste package during interim storage, transport and the operational and post-closure periods of a GDF;
- record the packaging process that has been assessed by RWMD and a LoC issued to indicate compliance with the GWPS and thereby provide the basis for determining the compliance of packages with that assessment;
- act as a component of the manufacturing specification for the product, which is likely to be embodied as a Quality Plan;
- provide, as a component of the package record, a vehicle for recording general information on the waste, the packaging process and references for key waste package development work.

Following manufacture it will usually not be practicable to use direct measurement and testing to describe a waste package in sufficient detail to allow an adequate assessment of current and future performance. It is therefore the purpose of the WPrS to define what is being made by specifying, in sufficient detail, all of the component parts, manufacturing processes and parameters and storage regimes that affect the properties and performance of the waste package.

4 GENERAL REQUIREMENTS FOR WASTE PRODUCT SPECIFICATIONS

As discussed in Section 3 one of the key components of the package record is the WPrS. For such a document to provide RWMD with the required level of assurance that waste is being packaged in a manner commensurate with all the requirements for safe long-term management including disposal, such a document should identify all key parameters that affect product quality and should be developed from consideration of the package properties and composition that are relevant to each of the stages of waste management.

The WPrS is a document which should describe and define the characteristics of significance to the quality of the product (i.e. the waste package) produced by a packaging plant. It should contain sufficient detail regarding all the factors which affect product quality, especially where they affect the ability of the product to be compatible with subsequent stages of long-term management.

A WPrS will apply to a distinct waste package type and, in some cases, more than one WPrS may be required for a single waste stream. Significant changes to any feature of waste package production (i.e. variations in the nature of the waste within a waste stream, changes in the specification of conditioning materials etc) would require a separate WPrS which would require assessment and endorsement by RWMD. A single waste packaging plant may therefore require several different WPrS's to cover the range of wastes being packaged.

In order to provide an adequate definition of a waste package as produced, and as evolved during storage, the WPrS should identify:

- Waste origin and composition;
- Waste container and furniture;
- Inactive waste conditioning materials;
- Formulation envelope;
- Process conditions;
- Waste product storage conditions;
- Supporting R&D.

5 ITEMS FOR INCLUSION IN A WASTE PRODUCT SPECIFICATION

The WPrS should normally be a concise document, with reference to supporting documents being clearly defined. The following represents the minimum information required in a WPrS.

5.1 Waste Origin and Composition

The WPrS should identify the origin of the waste to be packaged in order that the wastes covered by the particular WPrS are clearly defined. As a minimum this should comprise the UK Radioactive Waste Inventory Waste Stream Identifier. It should also include such information of the processes that gave rise to the waste so that the ranges of quantities of the key components in the waste and the limits on the significant parameters, can be adequately defined. The use of 'generic' descriptions (e.g. 'PCM'), without details on the actual composition of the waste, is discouraged as such descriptions often apply to a very wide range of wastes.

Typical factors that may need to be considered include ranges for:

- solids and/or liquids content;
- physical size and/or shape of solids;
- chemical composition of waste;
- heat output;
- radionuclide inventory;
- fissile material, including neutron moderators and reflectors, where relevant;
- reactive metals;
- excluded materials.

5.2 Waste Container and Furniture

The WPrS should identify technical information on the waste container and identify/list associated items of internal furniture e.g. paddles, anti-flotation plates, liners, etc. The WPrS should make reference to the manufacturing specification for the waste container, including details of manufacturing quality system, design drawings, materials specification, material control, non-conformance control, welding, testing, inspection reports and manufacturing records. The methods of control of the storage environment, including the limits on temperature, relative humidity etc, and the handling regime of the waste container following manufacture and prior to use should also be included.

5.3 Inactive Waste Conditioning Materials

The WPrS should make reference to the material controls and define limits on the physical and chemical composition of the intended encapsulation materials or conditioning agents insofar as they affect the product. This should include any relevant standards (i.e. British Standards etc) and specifications for such materials and, if available, list(s) of approved supplier(s) who are approved to supply materials to these standards and specifications.

Storage conditions of encapsulation materials or conditioning agents should also be specified where deterioration during storage might adversely affect the product.

5.4 Formulation Envelope

The WPrS should define the limits on the ratios of the waste to the encapsulant materials and any conditioning materials that may be used. This should include limits on the ratios of different encapsulation materials if blends are used and should also address variations in waste composition (see item 3.2). In particular the WPrS should make reference to underlying research and development studies undertaken to derive the formulation.

5.5 Process Conditions

The WPrS should contain limits on the key process parameters that influence product quality and provide references to the quality plans used to control the process. This could take the form of the operating instructions which control the process conditions and are likely to include:

- mixer design;
- mixer speed and mixing time;
- encapsulant and/or conditioning agent addition rate;
- fluidity of encapsulant;
- temperature of ingredients and process environment;
- encapsulant cure time.

5.6 Waste Product Storage Conditions

The WPrS should define the limits on handling of packages and storage conditions insofar as they affect the waste product. These should include limits on:

- temperature;
- relative humidity;
- atmospheric pollution (i.e. chloride) levels;
- ambient light levels;
- stacking conditions;
- monitoring regime.

In view of the possibility that this period of surface storage may extend for many decades, and to ensure that waste packages will still be able to meet the requirements for transport following this period, reference should be made to *Guidance on Environmental Conditions during Storage of Waste Packages, WPS/630*, and *Guidance on Monitoring Waste Packages during Storage, WPS/640*.

5.7 Supporting Research and Development

The WPrS should refer to supporting research and development reports insofar as the issues addressed affect product quality. There is no requirement to include R&D results in the WPrS itself, but the following issues are typical factors that may need to be referenced:

- Waste simulant design and testing;
- Wasteform grouting trials, including product quality indicators;
- Timed-based trends to indicate waste product evolution;
- Inactive commissioning trials;
- Active waste analyses;
- Active commissioning trials.

6 REVISIONS TO THE WASTE PRODUCT SPECIFICATION

It is important that the WPrS is reviewed and, where necessary, revised to ensure that it continues to define the characteristics of the waste package product, following any change in:

- waste composition;
- container design;
- inactive waste conditioning material;
- formulation envelope;
- process conditions, or;
- product storage conditions.

It should be noted that this does not mean that a WPrS can be modified retrospectively to acknowledge any of these changes but rather that the consequences of anticipated changes can be assessed and, if considered to be within the bounds of the original LoC, the production of further waste packages against a new WPrS can be endorsed.

7 EVOLUTION OF THE WASTE PRODUCT SPECIFICATION

The WPrS should be provided to RWMD for assessment as part of the normal LoC assessment process. The WPrS should be developed in an iterative fashion drawing on results from research and development, inactive and active commissioning as appropriate.

The WPrS should be used to define the product against which a LoC may be issued. It is important therefore that the WPrS includes the key parameters of relevance to product quality and that the WPrS is maintained up to date.

The definition of the WPrS is expected to evolve during successive LoC submissions as follows:

- At the Concept stage: There is no formal requirement for a WPrS at this stage although the waste packager may choose to produce a draft, in outline form, for RWMD's comment. This could describe the anticipated waste package type, waste and encapsulant, waste packaging process and storage arrangements. The production of such a draft may prove useful in identifying areas of R&D work that will be necessary to support the packaging proposal.
- At the Interim stage: This is the key stage for the production of the WPrS and it should have been developed sufficiently to have allowed the parameters of importance to product quality to be defined and ranges identified, as appropriate. The formulation envelope and process conditions should have been defined, including the identification of those which are fixed and those which are to be controlled.

- At the Final stage: The WPrS should fully describe the packages to be produced. It should provide a clear description of the formulation envelope and process, the storage conditions which will be applicable to the final product and the relevant supporting research and development reports.

8 REFERENCES

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