Nuclear Decommissioning Authority

# WASTE PACKAGE SPECIFICATION AND GUIDANCE DOCUMENTATION

## WPS/860: Waste Package Identification System: Explanatory Material and Guidance

**March 2008**
**Number: 9330939**

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## Conditions of Publication



### Bibliography

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John Dalton,

Head of Communications,

NDA Harwell

Radioactive Waste Management Directorate

Curie Avenue,

Harwell,

Didcot,

Oxon,

OX11 0RH, UK.

john.dalton@nda.gov.uk

**WASTE PACKAGE SPECIFICATION AND GUIDANCE DOCUMENTATION**

**WASTE PACKAGE IDENTIFICATION SYSTEM: EXPLANATORY MATERIAL AND GUIDANCE**

**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/860 - VERSION HISTORY | | |
|---|---|---|
| **VERSION** | **DATE** | **COMMENTS** |
| WPS/860/01 | September 2005 | Aligns with GWPS (Nirex Report N/104) as published June 2005 |
| WPS/860/02 | March 2008 | Responsibility for the WPSGD passed to the NDA RWMD.<br>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 latter 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.

# 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 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].

Every waste package destined for long-term management, including disposal in a GDF, must be allocated a unique identifier. This will be used to:

- allow the waste package to be identified at relevant points during its management;
- enable a record of the location the waste package to be maintained throughout each period of management, and;
- provide an unambiguous and permanent link between the waste package and the source data and information.

This document provides background explanatory material to assist waste packagers comply with the requirements of the *Specification for Waste Package Identification System, WPS/410.*

# 2 IDENTIFIER SYSTEM AND FORMAT

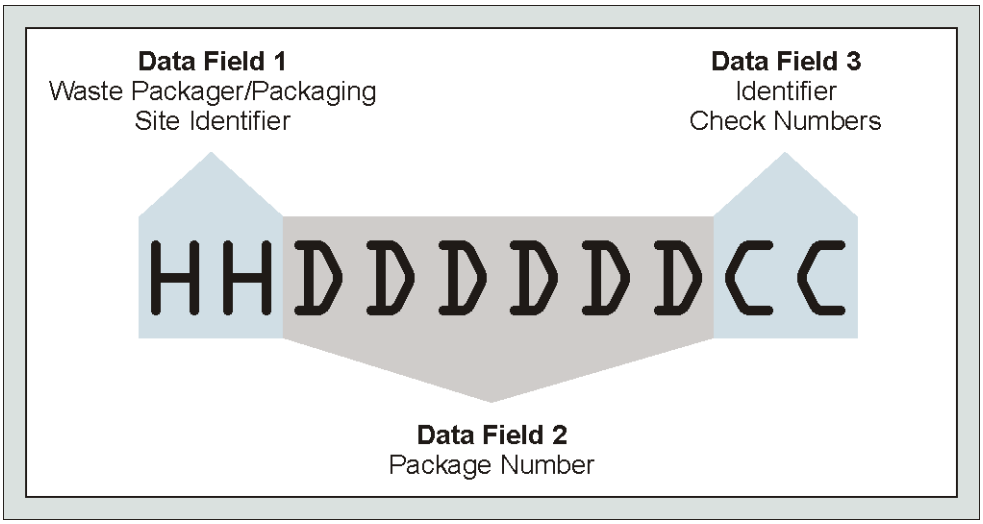
The identifier system specified for waste packages containing conditioned ILW and long-lived LLW consists of ten alpha-numeric characters, arranged in a horizontal sequence, marked on to the waste package in one or more specified locations. The general form of the identifier is shown in Figure 1.

The identifier comprises three data fields (waste packaging site or plant, package number and a check number) and allows up to $10^6$ waste packages to be uniquely identified, for up to 256 different waste packaging sites or plants.

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

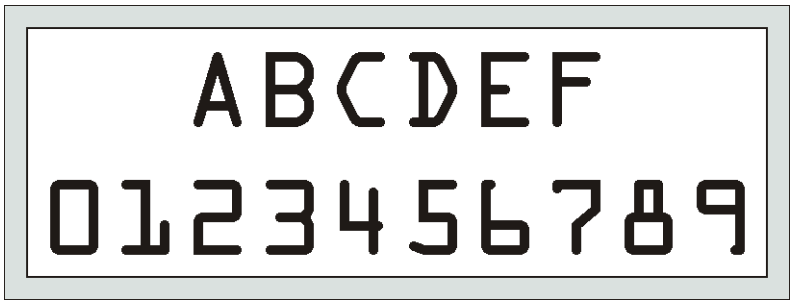
Such a system, providing one million identifiers per plant may be oversized in terms of waste package numbers for some users, but this can be overcome to some extent by subsequent allocation as described later. It is considered to be sufficient for the current estimate of ILW and long-lived LLW arisings together with a contingency allowance to cater for future requirements.

**Figure 1 Format of Waste Package Identifier**




The waste package identifier is marked on the waste package using OCR-A (Optical Character Recognition Type A) characters. The use of the OCR-A format is to provide the ability to machine-read the identifier thereby minimising the potential for errors in most circumstances. The OCR-A characters can be read by 'intelligent machines' even with significant levels of distortion and degradation. The format of these characters are defined in BS 5464: Part 1 [2] and shown in Figure 2.

**Figure 2 OCR-A Characters**




Each waste package identifier is created from the combination of three data fields comprising ten alpha-numeric characters. The three data fields are defined as follows:

## 2.1 Data Field 1:

Data Field 1 identifies the original source of the waste package (i.e. the SLC, waste packaging site or plant).

This field consists of two sequential hexadecimal characters (HH) each of which shall be one of the following:

0 1 2 3 4 5 6 7 8 9 A B C D E F

### 2.2 Data Field 2:

Data Field 2 uniquely identifies the waste package number produced by the waste packaging organisation or waste packaging site.

This field consists of six sequential decimal characters (DDDDDD) each of which shall be one of the following:

0 1 2 3 4 5 6 7 8 9

### 2.3 Data Field 3:

Data Field 3 is a check number which is derived mathematically from Data Field 1 and Data Field 2.

This field 3 consists of a two sequential decimal characters (CC) each of which shall be one of the following:

0 1 2 3 4 5 6 7 8 9

## 3 CHECK NUMBER SYSTEM

Whenever long numbers are keyed manually or even read electronically, errors can occur. The waste package identifier includes a check number which is used by the computer database system to check automatically that the number entered or read is valid. This is done by appending to the end of the basic eight digit identifier HHDDDDDD with two check digits CC, making a total of ten digits in the complete identifier HHDDDDDDCC. These check digits are chosen so that the resulting number is exactly divisible by 97.

The check digits are calculated using decimal arithmetic and to make this calculation meaningful the basic eight digit identifier has to go through two preliminary stages:

First the hexadecimal digits of Data Field 1 have to be converted to their decimal equivalents and then the identifier has two zeros added to its end (it is multiplied by 100).

The check digits are thus generated by the following algorithm:

$$CC = 97-R$$

Where $R = \{ (HHDDDDDD) \times 100\} \mod 97$

In this scheme:

a) HHDDDDDD is treated as a real number;

b) HH must be converted to their decimal equivalents, always consisting of four digits;.

i.e. FF becomes 1515

F2 becomes 1502

22 becomes 0202

c) The check number must always consist of two digits;

i.e. if R = 93 giving 97-R = 4, then CC = 04.

d) 97 is chosen because this is the largest prime number which will always give a two digit check number, and because it has been verified to give reliable detection of a wide range of common errors [3];

e) The factor of 100 is introduced to add two zeros at the end, which will be replaced by the two check digits;

f) 'mod' is short for the modulo function *nmodm* which gives the remainder when n is divided by m;

For example, 26*mod*4 equals 2 since 26 ÷ 4 = 6 remainder 2.

In this case, R is the remainder when (HHDDDDDD) x 100 is divided by 97.

(In fact, because 100 = 97 + 3, the remainder on dividing by 97 will be unchanged if HHDDDDDD is multiplied by 3 instead of by 100. This fact may be useful if check digits are generated by hand or by electronic calculator, since fewer significant digits are needed. An example of this is given in Appendix A).

This check number system, known as the 'Modified Streatfield Scheme' has been shown to have the following error detection rates [3].

| | |
|---|---|
| single transcription of a digit | 100% |
| double transcription of a digit | 100% |
| triple transcription of a digit | 100% |
| transposition of two digits | 100% |
| transposition of 'ded' to 'ede' | 100% |
| double independent transcription | 99.06% |
| all possible errors | 98.97% |

The validity of a waste package identifier can be readily checked when the check digits CC have replaced the two zeros, i.e. when they have been appended as Data Field 3 to Data Fields 1 and 2. The identifier is valid if (after replacing HH by its four digit decimal equivalent):

{HHDDDDDDCC} mod 97 = 0

i.e. division by 97 gives a zero remainder.

## 4 MARKING OF IDENTIFIERS ON WASTE PACKAGES

The location(s) of the identifier on a waste package, whether it is incorporated into the material of the waste container or attached as a label will be found in the relevant waste package specification for the waste package under consideration (i.e. the WPSGD Series 300 document).

The size of the identifier will be a function of specific waste package design and any requirements of the packaging process. Notwithstanding these limitations, the characters are specified in the WPS/300 documents to be between 6 and 10mm in height.

The identifier is required to be a permanent feature of the waste package that, as a minimum, will be readable accurately by machine and by eye during manufacture, interim storage and following receipt at a GDF, and remain readable by some means during at the operational period of the facility. For planning purposes a target of 200 years for the legibility of identifiers should be assumed.

Other markings and labels may be applied by a waste packager if required for in-house purposes etc. However these must not be in a location or of a form that could confuse man- or machine-reading of the RWMD identifier. Care should also be taken that the method used for such marking or labelling does not impair the long-term integrity of the containment of the waste package. For example, adhesives containing chloride should not be used.

# 5 ALLOCATION OF IDENTIFIERS

## 5.1 Allocation of Data Field 1 Identifiers

In order to maintain the integrity of the identifier system for the foreseeable future, RWMD will set up and retain the master file of Data Field 1 identifier allocation.

In order to prevent the introduction of errors and confusion into the record system, Data Field 1 identifiers will not be re-allocated to another waste packaging site or plant. Identifiers will normally be allocated identifiers in batches of $10^6$ since there is sufficient capacity in the system to avoid the need to economise in the use of identifiers. If, for example, a number of individual waste packaging plants were located on the same site, RWMD would allocate individual Data Field 1 identifiers to each plant, each with a capacity of $10^6$ waste packages.

It is envisaged that the initial allocation of identifiers should be adequate to allow decommissioning wastes from a given site to be given the same Data Field 1 identifier(s) as operational waste arising from that site.

## 5.2 Allocation of Data Field 2 Identifiers

Since the identifier system has sufficient capacity it is desirable to take advantage of this and to create an allocation which clearly differentiates between packaging sites and plants, waste package types and, where possible, waste streams. This will provide a simple means of checking the origin and type of waste package as a back-up to the computerised database system.

The waste packager would be expected to devise a scheme where blocks of unique waste packages numbers are sub-allocated to different waste package types and if possible to different waste streams. Waste packagers are advised to discuss their proposals with RWMD at an early stage.

The allocation scheme should be sufficient to cater for all wastes predicted to arise from a site, including decommissioning wastes, and should also include a contingency to allow for the use of different waste packages in the future or other unforeseen changes.

For example, a site which expects to use a combination of 500 litre Drums, 3 cubic metre Boxes and Drums, 4 metre and 2 metre Boxes may sub-allocate identifiers as shown in Table 1.

**Table 1 Suggested sub-allocation of a sites waste package identifiers**

| **Site Identifier (Data Field 1)** | AA |
|---|---|
| **Full allocation** | AA000001 to AA999999 |
| **Sub-allocation** | |
| 500 litre Drum (solids) | AA000001 to AA029999 |
| 500 litre Drum (solidified sludge) | AA030000 to AA059999 |
| 500 litre Drum (various) | AA060000 to AA099999 |
| 3 cubic metre Box | AA100000 to AA149999 |
| 3 cubic metre Drum | AA150000 to AA199999 |
| 4 metre Box | AA200000 to AA249999 |
| 2 metre Box | AA250000 to AA299999 |
| Reserved for Future Contingency | AA300000 to AA999999 |

It is accepted that total arisings may not be predictable with great accuracy, therefore any such sub-allocation would have to contain elements of contingency.

It should be noted that the system and extent of sub-allocation described is regarded as the optimum that waste packagers should seek to achieve. Matters such as whether the identifier is marked on or attached during waste package manufacture and where and how waste packages are stored and transferred to the packaging location, may influence a waste packager's ability to achieve this optimum sub-allocation.

The requirement to omit waste package numbers 000000 is to avoid the concept of ‘waste package number zero’.

## 6 QUALITY MANAGEMENT

All activities relevant to licensing of a GDF will be conducted in accordance with appropriate quality management arrangements. The objective in establishing and operating a quality management system is to provide an integral framework of procedures which will ensure that the work is adequately controlled, documented and correctly carried out. It is the responsibility of the waste packager to develop, operate and maintain an appropriate quality management programme which meets all the RWMD quality assurance requirements as specified in *Specification for Waste Package Quality Management Arrangements, WPS/200.*

## *7* REFERENCES

1 Nirex, *Generic Waste Package Specification,* Nirex Report N/104 Issue 2, 2007.

2 BS 5464: Part 1: 1977 (1984) *Character Set OCR-A, Shapes and Dimensions of the Printed Image,* 1984.

3 Nirex, *An Assessment of the Error Detection Rates of the Nirex Waste Package Check Number System*, Nirex Report 66, 1990.

## APPENDIX A EXAMPLE CALCULATION OF A CHECK NUMBER

The following is an example showing the calculation of the check number for the case of an identifier **B1987654**:

| Operation | Result |
|---|---|
| 1. Identifier | B1987654 |
| 2. Conversion of Data Field 1 to decimal | 1101987654 |
| 3. Multiply by 100 | 110198765400 |
| 4. Division by 97 | 1136069746<br>Remainder 38 |
| 5. Check Number = 97 – Remainder | 59 |
| 6. Full identifier | B198765459 |
| **Alternative method, multiplying by 3 instead of 100 at Stage 3** | |
| 1. Identifier | B1987654 |
| 2. Conversion of Data Field 1 to decimal | 1101987654 |
| 3. Multiplication by 3 | 3305962962 |
| 4. Division by 97 | 34082092<br>Remainder 38 |
| 5. Check Number = 97 – Remainder | 59 |
| 6. Full identifier | B198765459 |

The validity of this number can be checked as follows:

| Operation | Result |
|---|---|
| 1. Full Identifier | B198765459 |
| 2. Conversion of Data Field 1 to decimal | 110198765459 |
| 3. Division by 97<br>i.e. Test that {110198765459} mod97= 0 | 1136069747<br>Remainder 0 |

The remainder of 0 confirms the validity of the identifier.

Radioactive Waste Management Directorate
Nuclear Decommissioning Authority
Curie Avenue
Harwell, Didcot
Oxfordshire
OX11 0RH

t +44 (0)1235 825500
f +44 (0)1235 831239
w www.nda.gov.uk