

## Geological Disposal

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### Waste Package Specification and Guidance Documentation

### WPS/912: Guidance on the Sentencing of Non-compliant Waste Packages

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January 2009



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**WASTE PACKAGE SPECIFICATION AND GUIDANCE DOCUMENTATION**

**GUIDANCE ON THE SENTENCING OF NON-COMPLIANT WASTE PACKAGES**

**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.**

This document has been compiled on the basis of information obtained by Nirex and 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 waste package specifications to enable the industry to condition radioactive wastes in a form that will be compatible with future transport and disposal.

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 waste packagers, 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*<sup>1</sup>.

To assist Site License Companies (SLCs) with particular aspects of the packaging of radioactive waste RWMD has produced, and continues to add to, a suite of thematic Guidance Notes. A full list of the Guidance Notes produced by RWMD, together with an abstract of each, can be found in *Introduction to the Waste Packaging Guidance Notes, WPS/900*.

The management of variations in waste package quality is of concern to an organisation responsible for their long-term management, because such waste packages may introduce behaviour or risks that could challenge the safety of a disposal system. This Guidance discusses the expectations of a GDF operator for the management of variations by SLCs, and suggests means by which confidence in the quality of all waste packages can be ensured. It pays particular attention to the procedures for managing variations once they have been identified and considers the key features of such procedures.

## 2 BACKGROUND

Waste packages are required to be manufactured using a packaging process that has been endorsed by way of the Letter of Compliance (LoC) assessment process. This should be done under a Management System (often termed a Quality Management System or QMS) that is compliant with the requirements of ISO9001 [2]. To ensure that the waste packages will meet all relevant requirements, this process must be carefully specified and controlled.

A waste packaging process, in common with any manufacturing process, has the potential to produce products that are outwith the relevant specifications or that exhibit more general defects that could be unacceptable to the customer. A number of terms

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

may be used to describe such variations, for example defective, non-compliant, non-conforming or out-of-specification.

Notwithstanding the terminology adopted, to maintain confidence in the quality of packaged wastes, it is important that variations are identified and dealt with appropriately. Within an approved Management System, such variations should be governed by a procedure for dealing with Non-compliance (such a procedure being mandatory in a certificated Management System). Commonly such an eventuality should instigate a review of the variations and potentially result in remedial action, both also under the control of the Management System.

The remainder of this Section provides summary descriptions of current plans for the geological disposal of higher activity radioactive wastes in the UK, the RWMD approach to the definition of packaging standards for such wastes, and the process by which the suitability of waste packages for disposal is assessed. This is the LoC Assessment Process<sup>2</sup>.

Section 3 provides definitions and discussion for a number of key features of a system for the management of variations, supported by Appendix A.

Sections 4, 5 and 6 provide more details of the way such a system would need to operate to fulfil RWMD expectations.

Section 7 presents conclusions in the form of a summary of the key features of an acceptable system for the management of variations.

## **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 facilities<sup>3</sup>. 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) [3], 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.

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<sup>2</sup> A full description of the LoC process can be found in *WPS/650*.

<sup>3</sup> The generic description 'ILW' is used in the remainder of this document to describe both these categories of waste.

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 complementary 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 waste 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.

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

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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 [4]. 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 [5] such endorsement is now seen by the regulators as an important component of the operator's Radioactive Waste Management Case (RWMC).

## **2.4 The Regulatory Position**

As mentioned above, the LoC process plays a key role in the overall regulatory arrangements for the conditioning and eventual disposal of ILW. The Radioactive Substances Act 1993 [6] provides the framework for controlling the creation, accumulation and disposal of radioactive wastes. Responsibility for regulation and control under this Act is exercised by the Environment Agency (EA) in England and Wales, and by the Scottish Environment Protection Agency (SEPA) in Scotland, who have published guidance on requirements for authorisation of LLW and ILW disposal facilities on land [7].

On the specific matter of the compliance of packaged waste with relevant specifications (for ILW this being the GWPS), the regulators highlight the importance of compliance and compliance checking in guidance issued in 2005 [8]. This also addresses the matter of compliance checking during waste package manufacture and subsequently (i.e. during interim surface storage), and the need for the periodic audit of manufacturing and storage facilities (see Section 6.2).

More recently [5] the matter of non-compliance has been specifically identified as an issue by the regulators:

*'Compliance of packages with specifications*

*We<sup>4</sup> will look for evidence that packaged wastes meet the specifications defined in the safety case. For packages that do not meet the specifications, we will look for evidence that:*

- appropriate actions have been taken to ensure their continuing safe management;*
- a strategy has been developed to ensure that the wastes can be disposed to an appropriate facility.*

*We also expect appropriate action to have been taken, or planned, to reduce or eliminate the causes of non-compliant packages.'*

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<sup>4</sup> i.e. EA/SEPA/HSE

### 3 TERMINOLOGY

It is necessary to clearly define the terminology that might be used in the consideration of non-compliant waste packages. As noted above, a variety of superficially similar terms may be adopted in different *Management Systems* with different meanings. The terminology adopted herein is proposed for use in the consideration of waste packaging to ensure consistency.

The term SLC is used in this document to describe one or more organisations which could have responsibility for the safe and environmentally responsible management of radioactive wastes, in accordance with regulatory requirements, and the funding thereof at any stage prior to final disposal. As such an SLC may be the organisation that:

- produced the waste in the first instance;
- is responsible for the conditioning of 'raw' waste and rendering it into a passively safe and disposable form, and/or;
- stores raw and/or packaged waste prior to onward management.

#### 3.1 Compliant Waste Package

By its simplest definition a *compliant waste package* is one manufactured in accordance with all aspects of the *Waste Product Specification* defined for the endorsed packaging process. However such a definition ignores the possibility of a previously compliant waste package evolving (i.e. during an extended period of interim surface storage) in such a way as to become non-compliant. Such a definition also ignores any change in the compliance criteria for disposal in an actual GDF (i.e. the Waste Acceptance Criteria (WAC)) which may be less bounding than the GWPS against which the original LoC endorsement was conducted. In principle the process of evolution of the GWPS to WAC could render a previously non-compliant waste package compliant where the area of non-compliance one that was relaxed during that evolution.

For the purposes of this guidance the former definition is assumed.

#### 3.2 Non-compliant Waste Package

It is proposed that the term *non-compliant waste package* should be adopted for any variation that is potentially outwith the specification for the packaging process as it has been endorsed or, more generally, where a waste package has an observed defect. This term is intended to be non-judgemental with regard to the significance of the variation, and hence is preferred to terms such as defective. The identification of a waste package as *non-compliant* would be expected to initiate a review of its status (see below).

It is commonly expected that the identification of a waste package as *non-compliant* would be based on an apparent lack of compliance with the relevant components of the *Management System* governing the manufacturing process (but also note discussion of the *Waste Product Specification* below). However, the concept of a 'general observed defect' could be broader, and potentially a wider range of events or defects, not previously foreseen and/or not explicitly covered by the *Management System*, also could initiate a review process.

This paper does not provide a detailed discussion of the reasons why a waste package might be judged to be *non-compliant* and indeed some such reasons may not be of direct relevance to the disposability of a waste package. Nevertheless, a brief summary of the principal issues that might be of concern to a GDF operator is provided in Appendix A (although this summary is not intended to be exhaustive).

### **3.3 Management System**

The high standards of safety and performance demanded of radioactive waste packages, and consequently of the packaging processes used to produce those waste packages, require the strict application of a suitable *Management System*, commonly certificated to the relevant standard (such as ISO 9000:2000).

### **3.4 Quality Plan**

Within a *Management System*, it is commonly expected that a packaging process would be explicitly controlled by a document such as a *Quality Plan* (or an equivalent controlling instrument). This would define all key process parameters and demonstrate how these are to be controlled to ensure the quality of the resulting waste packages. Within a *Management System*, the *Quality Plan*, or its equivalent, is likely to provide the primary basis for judging that waste packages are *non-compliant*.

In outline, a *Quality Plan* would define acceptable ranges for all relevant process parameters, together with acceptance criteria for the waste, other materials and other items such as waste containers. In practice, the implementation of a *Quality Plan* by different operators may vary, particularly in the level of detail included and in the structure of the documentation. In practice, some or all aspects of the *Quality Plan* are commonly implemented in subsidiary documentation, for example Plant Operating Instructions or Procedures.

### **3.5 Waste Product Specification (WPrS)**

The concept of the *WPrS* has been developed by RWMD to provide both a specification for the waste package and a linkage to the endorsement of the packaging process and the relevant Assessment of Disposability.

In practice, there may be considerable overlap between the concepts of the *WPrS* and the *Quality Plan* as described above. This may be clarified by noting that the *Quality Plan* controls the operation of a plant to meet customer/stakeholder expectations, whereas the *WPrS* summarises those expectations in the form of the requirements necessary to produce a disposable waste package.

To avoid duplication and to ensure consistency, it is recommended that the *WPrS* be smoothly integrated with, or form a part of, the relevant *Quality Plan*.

### **3.6 Customers and/or Stakeholders**

In common parlance, the recipient of a waste package would be deemed to be the customer for that product. The fulfilment of the requirements of the customer(s) is necessarily the primary aim of a *Management System*. Furthermore, in the event of a *non-compliant waste package* review, a focus on the needs of the customer(s) must form the basis of that review.

At present, the most immediate customer for a waste package would be a store that probably would receive the waste package after manufacture. Nevertheless, it should be recognised that there are other, different customers including the ultimate recipient of the waste package (i.e. the GDF operator), and the requirements of such a customer are currently represented by RWMD.

It should be noted that an inappropriate distinction between an immediate customer (the local store) and all other interested parties, the stakeholders, could result in an unacceptably narrow focus during the review of *non-compliant waste packages*. It is therefore recommended that the *Management System* should recognise all stakeholders.

### 3.7 Sentencing

It is proposed that the general term *sentencing* is adopted for the process of reviewing waste packages identified as *non-compliant*, with the aim of determining their final status and any necessary actions. The basis of, and authority for, the process of *sentencing* is therefore the primary concern of this paper.

### 3.8 Status of Non-compliant Waste Packages (Compliance)

It is expected that the process of *sentencing a non-compliant waste package* would result in that waste package being attributed a final status that reflects its acceptability to all stakeholders.

A *non-compliant waste package* nonetheless may be judged to be 'acceptable', or suitable for disposal, depending on the exact reason for its non-compliance and the significance of this non-compliance to the relevant stakeholder(s). It is proposed that such a waste package be designated a *disposable non-compliant waste package*. *Disposable non-compliant waste packages* potentially could be returned to the process and treated in the same manner as other *compliant waste packages*. In such cases the acceptability of the *non-compliant waste package* for disposal would be expected to be on the basis of compliance with a justified *concession*, derived from an analysis of the non-compliant feature(s) of the waste package.

Where a review has judged that the reason for the waste package being *non-compliant* is serious, and that the waste package cannot be accepted in its current form, the waste package should be designated an un-sentenced *non-compliant waste package*. Such waste packages would be expected to be isolated for observation and/or on-going storage, pending suitable remedial action, for example repair, re-working, over-packing or identification for special handling or other measures.

Further reference to the relevant stakeholder (in this case the GDF operator) also may allow *non-compliant waste packages* to be deemed compliant and therefore disposable as the relevant criteria may have changed, as part of the process of evolution of the GWPS to WAC, subsequent to the original endorsement.

### 3.9 Responsibilities

The primary responsibility for the *sentencing of non-compliant waste packages* should reside with the organisation managing the packaging process. Furthermore, the *sentencing of non-compliant waste packages* is likely to be regarded as an extension of the specification, implementation and operation of the packaging process itself. These responsibilities might be vested in individuals or groups, but always should be exercised under the control of the overall *Management System*.

It is important to recognise that whatever mechanisms are adopted, the responsible body also would be acting on behalf of the relevant customer(s) and/or stakeholders. Key stakeholders probably would include the funding body, regulatory or statutory bodies and the recipients of the waste packages.

An important example of such a necessary interaction is the LoC process, which provides a mechanism for endorsement by RWMD of plans for long-term management of waste. This mechanism provides a straightforward means of ensuring that the needs of this particular stakeholder are understood and can be implemented in a waste packaging process. RWMD will expect that the process that is implemented, and therefore the resulting waste packages, will be the same as that endorsed.

In the specific case of *sentencing non-compliant waste packages*, the responsible body would be required to judge whether the waste packages could be deemed to be

consistent with customer or stakeholder requirements. The basis of the authority, and the competence of the sentencing body to act or judge on behalf of specific stakeholders is an important issue that is often overlooked. This matter is discussed further in Section 4.

## **4 IMPLEMENTATION OF A SENTENCING PROCEDURE**

### **4.1 Establishment of the Sentencing Body**

The body charged with *sentencing of non-compliant waste packages* could take a number of different forms, depending on circumstances, for example:

- an *ad hoc* committee or group drawn together only when required to sentence *non-compliant waste packages*;
- a committee established primarily for some other purpose, the remit of which has been extended to include *sentencing of non-compliant waste packages* (for example a Safety Committee);
- a committee charged with the resolution of non-compliances under the Management System procedure covering non-compliance;
- a committee formally established solely or predominantly for the purpose of *sentencing of non-compliant waste packages* (for example a Quality Checking Committee).

In principle, an individual could take on the necessary role, although such an investment of responsibility places reliance on the skills and knowledge of that individual, and furthermore provides for limited checks and balances. Consequently, the use of a committee of some form is to be preferred.

It is suggested that the sentencing body should be formally constituted through the *Management System*, either using a general Non-compliance procedure or the *Quality Plan* relating to the specific packaging process. This should provide for the formal recording and endorsement of the Terms of Reference (ToR) of the body.

### **4.2 Terms of Reference and Competencies**

It is recommended that the principal purposes (i.e. ToR) of the sentencing procedure should include the following:

- confirmation that the identified waste packages are indeed *non-compliant*, and documenting the reasons for this conclusion;
- identifying relevant stakeholders and defining when they should be involved in sentencing;
- review of the expected performance of the *non-compliant waste package* and assessment of the significance of this performance to relevant stakeholders;
- determination of the status of the waste package (*compliant* or *non-compliant*);
- in the case of *non-compliant waste packages*, determination of the fate of the waste packages (potentially including recommendations for remedial actions) and either taking or passing-on responsibility for any necessary actions;
- documenting conclusions and ensuring that waste package records are amended.

It will be necessary for the *sentencing* body to include sufficient skills and competencies to allow such ToR to be fulfilled. It should be noted that the documentation of the review should include evidence that the *sentencing* body was competent to understand the requirements and to make decisions on the basis of knowledge. It must be recognised that the ultimate responsibility for such decisions should rest with the relevant customer, not with the operator.



### 4.3 Interface with RWMD

With respect to the requirements imposed by RWMD, the limits of competence of the sentencing body should be formally agreed with RWMD. The LoC process potentially provides a means of obtaining such agreement, through the endorsement of the *Management System* to be applied to the packaging process. This route would be particularly applicable where the *Quality Plan* were used as the basis for controlling *sentencing* (although relevant procedures from the general *Management System* also could be assessed as part of the LoC process, should this be necessary).

RWMD would expect that the ToR of the *sentencing* body would explicitly recognise the limits of its competence, and thereby identify the circumstances under which RWMD input to the *sentencing* process would be sought. Should RWMD input be required, this potentially would be provided through an assessment under the LoC process.

RWMD would also expect that the extent of the activities of the *sentencing* body should be made known to them on a regular basis. Furthermore, as a customer for the products of the packaging process, RWMD would expect to be able to undertake audit of the activities of the sentencing body to maintain confidence in the quality of the products.

## 5 RETENTION OF RECORDS

It is important that records to be preserved for packaged waste, and this should include records of the decision making of a *sentencing body*. Information relating to the basis for all decisions made by the *sentencing body* should be retained, in order to allow third parties to review the basis of the decisions, should this be required in the future. This information might include the minutes of the meetings and any other materials used to support the *sentencing* of drums, for example internally generated or sourced *concessions* and correspondence with the NDA or regulators.

It is important that *sentencing* records are also associated with the particular waste packages to which they relate. As a minimum, the waste package records should include a notation that the waste package is non-compliant and a record of the result of *sentencing*. Where remedial action had been taken, this also should be recorded.

The means of actually preserving material as records for the necessary time periods (potentially until a GDF is closed) is challenging. *Long-term Management of Information and Records: Explanatory Material and Guidance, WPS/870* is of relevance in this matter.

## 6 MECHANISMS FOR COMPLIANCE CHECKING

### 6.1 Routine Checking/Acceptance on Plant

Good practice requires a positive confirmation and recording of acceptance (compliance) for all waste packages. This should be controlled through the *Management System*. Furthermore, it is implicit in the concept of a *non-compliant waste package* that all completed waste packages have been subject to some form of inspection or checking, potentially including both physical examination and consideration of the records generated during manufacture. It is such checking that would allow *non-compliant waste packages* initially to be identified.

It is expected that the *compliance* of each completed waste package with the *Quality Plan* (or other such controlling document) would be actively checked. Provided that the *Quality Plan* incorporates or otherwise references the *WPrS*, such a check also should confirm compliance with RWMD requirements. The check should be performed by an appropriate authority (for example a Plant Engineer or Supervisor) and should be recorded in the waste package records.

It is less clear how a more general 'identified defect' would be recognised, and in practice this broader concept might be rather difficult to define within a *Management System* or to manage actively. Nonetheless, it is good practice to require a more general visual inspection of waste packages in addition to a check against the *Quality Plan*.

## **6.2 Technical Audit**

The concept of the Technical Audit of manufactured waste packages has been devised to ensure that stakeholders can be reassured that all waste packages are either *compliant* or identified as *non-compliant*. Such an audit would be based on the retrospective checking of waste package records against both the appropriate *Quality Plan* and, more importantly, against the basis of the LoC endorsement of waste packages by RWMD. This would provide confidence in both the quality of the waste packages and their expected performance in the disposal system.

Such auditing would necessarily address both the waste packages when manufactured and, at a later stage, when in storage. In practice, the latter would be based on audit of records of store environmental conditions, results of waste package monitoring and any additions to records during the storage period (i.e. waste package movements etc).

A Technical Audit may be considered to be a Second Party (customer or stakeholder) audit of the products of the packaging process. It may be distinguished from a Management System audit in that the focus would be on the detail of the product, rather than the system.

The responsibility for such auditing will ultimately, in the long-term, be with the disposal facility operator (i.e. RWMD) as a means on ensuring that waste packages will be compliant with the requirements for transport and with the WAC produced for the disposal facility. This would however be overseen by the disposal regulator, as outlined in the 2005 guidance [8] which identifies RWMD's role as providing '*Advice on compliance with respect to packaging specifications and assessment of the implications of non-compliant packages*' with the regulators being responsible for '*Inspection of process to ensure that packages are within agreed design envelope*' and for taking '*enforcement action if necessary*'.

In the shorter term, auditing would be carried out by RWMD, in cooperation with the packaging plant operator although, as noted in Section 2.4, the regulators would be expected to monitor the outcome of such auditing to ensure themselves that non compliant waste packages '*can be disposed to an appropriate facility*' [5].

## **7 CONCLUSIONS**

This Guidance has presented a discussion of the key features of a system for the management of variations in the quality of waste packages, with the aim of ensuring that waste packages would ultimately be consistent with the GWPS requirements and expectations for the production of disposable waste packages. The key features of such a system may be summarised as follows:

- waste packages should be checked at the time of manufacture by a suitably qualified authority to provide positive acceptance. Those failing such checks (variations) should be deemed to be *non-compliant*;
- all non-compliant waste packages should be reviewed by a suitably qualified and authorised *sentencing* body. This may be a standing committee or an *ad hoc* grouping;
- the activities, authority and composition of the *sentencing* body should be controlled through the *Management System*;

- the ToR of the *sentencing* body should recognise the NDA as a stakeholder, and identify the circumstances under which RWMD would be consulted about the status of *non-compliant waste packages* and any remedial actions necessary;
- the activities of a *sentencing* body would be subject to scrutiny by RWMD;
- non-compliant waste packages may be judged to be acceptable to stakeholders and thereby designated as *disposable non-compliant waste packages*. *Disposable non-compliant waste packages* may be returned to the process and treated as *compliant waste packages*;
- where the reason for identifying the waste package as *non-compliant* is serious or cannot be fully explained, the waste package cannot be accepted in its current form and should be designated a *non-compliant waste package*. *Non-compliant waste packages* commonly would be isolated pending suitable remedial action or consideration;
- the status of *non-compliant waste packages* should be recorded in waste package records;
- the record of the deliberations of the *sentencing* body is potentially a significant component of the records for *non-compliant waste packages*, and should be retained.

RWMD would be pleased to discuss the establishment and ToR of a *sentencing* body with any waste manager and to participate in the review of *non-compliant waste packages* as required.

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## APPENDIX A GUIDANCE ON ISSUES OF CONCERN FOR NON-COMPLIANT WASTE PACKAGES

This Appendix summarises the *non-compliant* characteristics and features waste package that are likely to be of most significance to a GDF operator. This is intended to contribute to the review and sentencing of non-compliant waste packages, and in particular whether RWMD should be consulted prior to final sentencing. Notwithstanding this guidance, any systematic changes to the waste packages and data or information recording systems should always be referred to RWMD for agreement.

Based on the examination of the needs of geological disposal, and from knowledge of waste package components and waste packaging processes, the issues have been divided into the following five general areas, relating to:

- criticality safety;
- activity levels;
- wasteform envelope and production parameters;
- waste container features;
- waste package data and information recording.

Further discussion of each of these issues is provided below.

### A1 Criticality Safety

Waste packages are required to be covered by a Criticality Safety Assessment (CSA), which would establish the safe fissile mass (SFM) for the waste packages. Factors affecting the SFM include the type of fissile material considered (generally U-235 and/or Pu-239), the design and composition of the waste packages, the degree of enrichment of uranium and the presence of neutron moderators or reflectors (for example graphite, beryllium or heavy water).

In order to fulfil the requirements of criticality safety, it will be necessary to demonstrate control of the fissile material content of waste packages to comply with the SFM. The necessary control and compliance measures would be recorded in the Criticality Compliance Assurance Documentation (CCAD) for the waste packages, the adequacy of this documentation being reviewed as part of the LoC assessment process. Typically the CCAD would report the control methodology and an analysis of the uncertainties associated with determining the fissile material content.

Instances of waste packages where the SFM is challenged should be rare, since it is expected that packaging plant controls would be robust. Nonetheless, in the event that the SFM is exceeded, the affected waste packages should be referred to RWMD and sentenced as non-compliant. Furthermore, any variations in other features of the waste package for which credit has been taken in the CSA, such as the thickness of grout annulus in some waste package types, also could result in non-compliance and therefore also should be referred to RWMD.

### A2 Activity Levels

The global limit for the activity content of waste packages (i.e.  $10^5 A_2$  per transport package<sup>5</sup>) as stated in the GWPS are generally not overly restrictive, although the management of the radionuclides with particular characteristics (i.e. heat generation, radioactive gas generation, fissile behaviour) may place more restrictive limits.

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<sup>5</sup> Work currently underway is expected to result in the removal of this limit for unshielded waste packages transported in the Shielded Waste Transport Container.

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Nonetheless, it is expected that only excessive variations in the total radionuclide inventory or the inventory of specific radionuclides are likely to affect the ability of waste packages to comply with the relevant limits. Clearly the waste packages most likely to challenge any restrictions would be those containing relatively large quantities of fissile materials and other alpha emitters, sufficiently long-lived gamma emitters such as Cs137, Eu154, and Co60, neutron sources (for example Ra/Be sources) and wastes that might produce significant quantities of radioactive gases (i.e. Ra-226).

In the case of waste packages transported as Type IP (i.e. the 2 metre and 4 metre Boxes) the GWPS specifies that the contents are to be *'solid Low Specific Activity (LSA) material or Surface Contaminated Objects (SCO) and capable of being excepted from the IAEA Transport Regulations for fissile material'*. This requirement places limits on mean specific activity, a minimum degree of dispersion of the activity in the conditioning medium and limits on the dose rate from the unshielded wastefrom. Details of the specific restrictions are provided in the GWPS.

With respect to GDF operations, variations of possible significance also relate to criticality safety and gross over-packaging of gamma or neutron emitters that could result in significant worker doses. Furthermore, under fault conditions where activity may be released from waste packages, variations affecting the performance of the waste package may be relevant. Consequently, variations affecting container and wastefrom design and condition are most likely to be of interest to the GDF operator, rather than variations in activity levels between waste packages.

A small number of radionuclides dominate the radiological risk within GDF post-closure safety assessment, and typically the risks relate to the total disposal inventory of these radionuclides. Consequently, it is not considered likely that variations between waste packages would affect the post-closure safety assessment.

### **A3 Wastefrom Envelope and Production Parameters**

The safety assessments that underpin geological disposal make assumptions regarding the robustness of wastefroms and their relatively benign evolution over time. The wastefrom provides a barrier to radionuclide releases during the normal operations of waste package transport and storage, and also under fault conditions such as dropped waste packages. The wastefrom also potentially plays a role after disposal, assisting in the containment of radionuclides and toxic elements by both chemical and physical means. Consequently, a sentencing body should appreciate which wastefrom properties are most likely to affect the disposal system safety assessments.

In summary, wastefroms would be expected to:

- immobilise radionuclides, especially those in particulate form, and limit releases during fault conditions;
- assist elimination of free liquids;
- assist making hazardous materials safe, such as pyrophoric materials;
- limit gas production and release, especially for radioactive gases;
- render combustible materials to a non-readily combustible form;
- minimise macroscopic voidage;
- meet specific criteria relating to transport of wastes as LSA material and SCO in Type IP transport waste packages. An example of such a criterion is the leachability criterion for LSA-III.

Features of non-compliant waste packages that could significantly affect the performance or evolution of a wastefrom with respect to any of the above characteristics may be important and should be explicitly considered.

#### **A4 Waste Container Features**

The waste container forms the first barrier to radionuclide releases during normal operations and enables waste packages to be lifted and, in some cases, stacked. Variations that might affect container performance both in the as-manufactured form and as they would evolve during a period of extended underground storage. Variations in waste packages that affect the following are likely to be of significance.

- the ability to safely lift, handle and stack waste packages now or in the future;
- those which result in waste package dimensions exceeding dimensional limits, at the time of packaging or after prolonged ageing;
- those which affect containment of radioactive material during prolonged storage, such as penetrations through the drum boundary, and gas venting or seal faults if relevant;
- those affecting corrosion performance of the containment boundary, at the time of manufacture or due to enhanced rates of internal or external corrosion, such as application of inappropriate markers or materials, surface contamination or out of specification waste feeds;
- those affecting performance during transport, handling and storage faults, such as wasteform or lid retention during dropped loads and radionuclide retention during exposure to fires;
- those which may prevent correct identification of waste packages, for example through obscuration or degradation of the specified waste package identifier.

A variation that has already been reported is that of lid bolting. It is feasible that other variations could occur, perhaps relating to lid seals, vents or to the container body or lid.

#### **A5 Data and Information Recording**

The GWPS defines that certain data and information be recorded on waste package contents, including radionuclide and physical/chemical contents. Proposals detailing what data and information would be recorded would normally have been provided by the SLC and assessed as part of the LoC process. The information gathered would be used not only by the store operator but also would be required to show compliance with the LoC and in the longer-term is likely to be required to enable transport and to show compliance with GDF Waste Acceptance Criteria (WAC).

Variations that reduce the amount of information recorded (for example equipment failure or poor calibration), or decrease the accuracy or precision of the data and information, may result in non-compliant waste packages. This would be particularly the case if the changes prevented the demonstration of compliance with CSAs, or grossly affected recording of other information.

The sentencing of a waste package should be performed in light of the data recording requirements imposed upon a particular packaging process, and also the underlying reasons for those requirements. Commonly these requirements are derived from the disposal system safety assessments, and consequently RWMD should be consulted in the event that they cannot be fulfilled.

#### **A6 Summary of Significant Waste Package Characteristics**

Waste packages that have been manufactured with the following variations should be referred to RWMD before sentencing, or should be automatically sentenced as non-compliant.

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1. Any waste package that has, or might have, exceeded the safe fissile mass. Variations associated with other features of the waste package for which credit has been taken in the relevant CSA.
2. Variations that result in gross increases in the radionuclide inventory for waste packages which would normally approach the limits applicable to the expected class of transport package (i.e. Type B or Type IP).
3. Faults in meeting the wastefrom envelope and production parameters that affect the ability of the as-manufactured or evolved wastefrom to:
  - immobilise radionuclides, especially those in particulate form, and limit releases during fault conditions;
  - assist elimination of free liquids;
  - assist making hazardous materials safe, such as pyrophoric materials;
  - limit gas production and release, especially for radioactive gases;
  - render combustible materials to a non-readily combustible form;
  - minimise macroscopic voidage;
  - meet specific criteria relating to transport of wastes as LSA in Type IP transport packages.
4. Waste packages affected by the following types of container variations:
  - those affecting the ability to safely lift, handle and stack waste packages;
  - those resulting in waste package dimensions exceeding dimensional limits;
  - those affecting containment of radioactive material during prolonged storage, such as penetrations through the boundary, and gas venting or seal damage;
  - those affecting corrosion performance of the containment boundary, such as application of inappropriate markers or materials, surface contamination or out of specification waste feeds;
  - those affecting performance during transport, handling and storage faults, such as dropped loads and fires;
  - those which may prevent correct identification of waste packages, for example through obscuration or future degradation of the waste package identifier.
5. Faults affecting the information to be recorded, or the accuracy or precision of the data and information, and the retention of suitable records in the long term.









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