Nuclear Decommissioning Authority

WASTE PACKAGE SPECIFICATION AND GUIDANCE DOCUMENTATION

WPS/625: Guidance on the Preparation of Criticality Compliance Assurance Documentation for Waste Packaging Proposals

March 2008

Number: 8765294

Nuclear Decommissioning Authority

WASTE PACKAGE SPECIFICATION AND GUIDANCE DOCUMENTATION

WPS/625: Guidance on the Preparation of Criticality Compliance Assurance Documentation for Waste Packaging Proposals

March 2008
Number: 8765294

Conditions of Publication

Bibliography

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

Feedback

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

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

GUIDANCE ON THE PREPARATION OF CRITICALITY COMPLIANCE ASSURANCE DOCUMENTATION FOR WASTE PACKAGING PROPOSALS

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/625 - VERSION HISTORY		
VERSION	**DATE**	**COMMENTS**
WPS/625/01	May 2006	Aligns with GWPS (Nirex Report N/104) as published June 2005
WPS/625/02	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. Reference to methodology for the definition of LSL and USL included.

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.

CONTENTS

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* consultation process to plan the development of an underground 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 basis of the waste 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 Phased Geological Repository Concept (PGRC) [1]. 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 primary document which defines the packaging standards and specifications that are derived from the PGRC is the Generic Waste Package Specification (GWPS) [2]. 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*[1].

Because of its origin, a significant proportion of UK ILW and LLW will contain fissile radionuclides (predominantly U-235 and Pu-239) and accordingly it is necessary for the criticality safety of waste packages to be considered for all stages of their long-term management. This document provides an outline of the general requirements for the documentation that is required to show how the manufacture of waste packages will be controlled to ensure they satisfy these criticality safety, referred to by RWMD as Criticality Compliance Assurance Documentation (CCAD). Specifically this document describes the information that will be required from waste packagers to provide adequate CCAD in support of a Final Stage LoC submission.

---

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

2 BACKGROUND

Criticality refers to a self-sustaining fission chain reaction, usually involving the fissile radionuclides U-235 or Pu-239. Such an event releases energy in the form of heat, penetrating radiation (i.e. γ-radiation, X-radiation and neutrons) and results in significant changes to radionuclide inventory. The GWPS [2] outlines the general requirements for the criticality safety of waste packages during their long-term management, the aim of these being to avoid the accumulation of sufficient material for criticality to occur at any stage of waste management. Specifically the GWPS requires that:

> *'The presence of fissile materials[2], neutron moderators and reflectors in the waste package shall be controlled to ensure that they do not present a criticality safety hazard during any of the active phases of the PGRC. It shall also be ensured that, following closure of the repository, the possibility of local accumulation of fissile material such as to produce a neutron chain reaction is not a significant concern to long-term repository performance.*
>
> *Shielded waste packages shall, in addition, comply with the requirements of the IAEA Transport Regulations for fissile excepted transport packages.'*

During storage, transport and the operational period[3] of a GDF (i.e. up to vault backfilling), criticality could lead to damage to the waste packages, spread of contamination and the exposure of persons to radiation both during the event and in the remediation of the damaged waste packages and contaminated areas. In these periods, the potential for criticality is avoided, in individual packages and assemblies of packages, by the control of waste package design, in particular the control of the quantities of fissile material that are permitted in waste packages. In addition, package designs are robust to impact and fire accidents, which eliminates the possibility of criticality occurring as a result of such accidents. A full description of the risks and consequences of criticality in the operational period can be found in the Generic Operational Criticality Safety Assessment (GOCSA) [3].

After closure of a GDF, groundwater will cause gradual degradation of the waste container and wasteform so that radionuclides may migrate within the vaults and surrounding rock. Such processes could take several thousand years to occur but there exists the possibility that migration could lead to the accumulation of fissile radionuclides from more than one package, with an associated, but low, probability of criticality. The consequences of such an event are less than during transport or the operational period, as they would be contained by the geological barrier. RWMD has nethertheless carried out work to investigate the potential mechanisms and consequences of criticality incidents in the post-closure period of a GDF [4].

The RWMD approach to criticality safety during all stages of long-term management is outlined in and is based upon the production of 'benign' packages containing too little fissile material for a criticality to occur under any credible circumstances [5]. Modelling

---

[2] 'Fissile material' is usually defined as U-233, U-235, Pu-239 and Pu-241 although other materials (such as Np-237, and some fissile and fissionable isotopes of Pu, Am, Cm and Cf) may need to be considered in criticality safety assessments, if they have been separated from irradiated fuel.

[3] Known hereinafter as the 'active stages' of the long-term management of waste packages.

has shown that by setting a 'generic screening level' of 50g Pu-239 or equivalent[4] per waste package the accumulation of sufficient fissile material to result in a criticality[5] would be avoided during the active periods of long-term management [6]. Accordingly, for waste packages containing less than the generic screening level, it can be assumed that the possibility for criticality under any circumstances has been eliminated and the waste package can be considered benign. Following closure of a GDF, waste packages will remain benign for as long as there is no significant deterioration of the containment provided by the waste container and wasteform and the fissile material remains within the waste package. In the longer term, following the loss of integrity of those barriers, any subsequent redistribution of fissile material will be influenced by the evolution of the disposal system and, with this in mind, the system is designed to restrict the transport of fissile material and reduce the potential for sufficient quantities of fissile material to accumulate and result in a criticality.

Analysis of the 2004 UK Radioactive Waste Inventory [7] shows that 15-20% of projected ILW waste packages (i.e. up to ~25,000 waste packages) will contain more than the generic screening level of 50g Pu-239 or equivalent. However, waste packages containing quantities of fissile material above the generic screening level can be shown to be benign by way of a Criticality Safety Assessment (CSA) which takes into account characteristics of the waste package that will reduce the potential for criticality. The output of such a CSA would be the definition of a Safe Fissile Mass (SFM) for a particular waste conditioned by a specific process. For example, a waste package SFM significantly in excess of 50g could be accommodated by the presence of materials that inhibit neutron chain reactions (i.e. U-238) and/or the absence of neutron moderators and reflectors (i.e. graphite and beryllium) that may be present in the waste.

The methodology adopted for the determination of the generic screening level is acknowledged as being deliberately conservative and, following a review [8], the Environment Agency's Nuclear Waste Assessment Team (NWAT) recommended that the methodology under pinning the generic screening level should be further developed to consider both conservative and more-credible assumptions with regard to the behaviour of fissile material during the post-closure period of a GDF. The purpose of this approach is to enable balance of risk arguments to be made, with the aim of ensuring that limits on the quantity of fissile material in waste packages are proportionate and not unduly restrictive whilst still remaining safe.

RWMD's response has been the performance of CSAs for waste packages containing four distinct categories of fissile material commonly found in ILW, namely:

- irradiated natural uranium;
- low enriched uranium;
- highly enriched uranium; and,
- separated plutonium.

---

[4] 'Equivalence' in this context being the quantity of other fissile materials that would have the same reactivity as 50g of Pu-239.

[5] Calculations with very pessimistic assumptions (e.g. regarding geometry and neutron moderation etc) indicate that as little as ~500g of Pu-239 could constitute a critical mass.

This work has resulted in the definition of a Lower Screening Level (LSL) and an Upper Screening Level (USL) for each category of fissile material[6], the former being determined on a conservative basis and the latter using more realistic assumptions, including claiming benefit for other characteristics of the waste and packaging process.

A summary of this work and indicative values of LSLs and USLs for the different categories of material can be found in the GWPS [2].

In the case of the standard shielded waste packages (i.e. the 2 metre and 4 metre Boxes) additional controls exist on the quantities of fissile material that may be packaged. This category of waste package is specified so as to satisfy the requirements of the IAEA Transport Regulations [9] for Industrial Package Type 2 (Type IP-2) that are excepted from the requirements for packages containing fissile material. Paragraph 672[7] of the Regulations lists a number of categories of waste package contents that can be so excepted, giving limits on the quantities of fissile material[8] for each category.

RWMD has opted to use exception 672 (a) (i) as the basis for excepting standard shielded waste packages excepted from the requirements for packages containing fissile material. This exception requires that:

'…each individual package contains not more than 15g of fissile material…….'

and this value is used as the equivalent of the generic screening level for shielded waste packages and can be used as a SFM for such waste packages, assuming all other relevant conditions are satisfied. For shielded waste packages with the potential to contain more than 15g of fissile material it may be appropriate to use one of the alternative exceptions listed in Paragraph 672 to justify a higher SFM. RWMD would consider arguments to justify the use of any of these exceptions, during the LoC assessment process for a specific packaging proposal, provided that they did not conflict with the overall approach to criticality safety implicit.

3 GENERAL REQUIREMENTS OF CRITICALITY COMPLIANCE ASSURANCE DOCUMENTATION

As discussed above, it is important that the fissile material content of waste packages is controlled to eliminate the possibility of criticality incidents during all of the active stages of their long-term management. Whereas criticality safety assessments can be used to set SFMs to achieve this aim, such assessments would be of limited use without the assurance that waste packages were being manufactured in accordance with their conclusions and assumptions.

---

[6] For fissile material that is can not be shown to be compliant with any of the four assessed categories, a 'package specific' CSA would be required to define the LSL and USL, or the generic screening level used as the SFM.

[7] It should be noted that this aspect of the IAEA Transport Regulations is currently under review and that relaxation of some of the 'fissile exceptions', may result.

[8] In this context the IAEA Transport Regulations define 'fissile material' as U-233, U-235, Pu-239 and Pu-241, but excepting natural uranium or depleted uranium which is unirradiated or which has been irradiated in thermal reactors only (Para 222).

It is therefore the role of CCAD to show that robust procedures and controls exist during the manufacture of waste packages to ensure that the relevant SFM derived for those waste packages cannot be exceeded under any circumstances. This role is recognised as important by NWAT in a recent paper [10] which contained a proposal for the review of the practical implementation of controls, such as assay instrumentation, to ensure compliance with fissile material limits during waste packaging. As such, CCAD will form an important part of the Disposability Safety Case (DSC) that will accompany a Final Stage LoC endorsing a waste packaging proposal.

The CCAD should present information on a number of parameters and topics relevant to criticality safety and that should demonstrate the adequacy of the waste packager's arrangements for ensuring the criticality safety of waste packages during all stages of their long-term management. As such, CCAD should be seen as a guide to a packaging process and the controls incorporated to avoid the packaging of excessive fissile material or other materials that could enhance the possibility of a criticality occurring (e.g. neutron moderators and/or reflectors).

The CCAD should focus on the three key areas of:

- Waste packaging operations;
- Assay, and;
- Faults.

The main purposes of CCAD, normally produced as part of a Final Stage LoC submission[9], are therefore to:

- summarise how the waste packager has derived the SFM(s) for a particular packaging proposal, including the assumptions that have been made in that derivation;
- identify the faults in the proposed packaging process that could lead to the SFM being exceeded;
- identify the controls, physical and/or management, that will be in place during waste packaging to ensure that these faults do not occur;
- demonstrate how compliance with that SFM will be achieved in practise for all waste packages produced in the packaging plant and covered by the proposal, and;
- describe the arrangements, relevant to criticality safety, for quality management and information recording.

It is important to bear in mind that CCAD is primarily a document that defines the processes and controls that will exist in the packaging plant to ensure compliance with the assumptions made in the relevant criticality safety assessment(s). As such it is expected that CCAD will be produced by a person familiar with plant processes and operations rather than a person expert in criticality safety assessments etc. Similarly, internal review of CCAD should be carried out by a person with experience of plant processes etc.

[9] In some cases CCAD may need to be considered at the Interim Stage to demonstrate the feasibility of the plant design to meet the proposed packaging limits.

It should be noted that not all packaging proposals may require a formal CCAD of the type described in this guidance. Many waste streams contain little or no fissile material and RWMD acknowledge that that there may be little benefit in the production of CCAD for packaging proposals for such streams. Waste packagers are therefore at liberty to present arguments as to the necessity of a fully developed CCAD for specific waste streams containing a total of less than a *de minimus* level of fissile material, and that would not be capable of producing waste packages containing more that the generic screening level. In the event of such arguments being accepted by RWMD, a statement of justification, for inclusion in the DSC, will be required in lieu of fully developed CCAD. RWMD would require such arguments to made, and accepted, as part of the Interim Stage LoC assessment.

For guidance purposes, waste streams containing a total mass of fissile material of less than the generic screening level of 50g Pu-239 or equivalent, may not require a fully developed CCAD of the kind described in this document. However, in the case of packaging proposals involving the use of shielded waste packages, the IAEA Transport Regulations limit to allow for the exception from the requirements for packages containing fissile material (i.e. no more than 15g total fissile material) should be used.

It should be noted however that the lack of significant quantities of fissile material in a waste stream will not always obviate the need for a fully developed CCAD. Controls may have to be placed on the packaging of waste streams containing large quantities of materials that may lead to the enhanced accumulation of fissile materials in the post-closure period (e.g. ion exchange resins). The significance of such materials and their quantities and the need for any requirements for controls will be assessed by RWMD in response to the Conceptual Stage LoC submission.

4 INFORMATION REQUIRED IN CRITICALITY COMPLIANCE ASSURANCE DOCUMENTATION

It is important that CCAD can be viewed as stand alone documentation and that it is capable of being assessed without the need for extensive consultation of references etc. However, it is equally important that the clarity of the documentation is not compromised by the inclusion of excessive information.

To aid in the clarity of CCAD, in particular during its assessment by RWMD, the following basic structure should be followed:

1. Introduction
2. Facility and Process Description
3. Criticality Safety Assessments and Fissile Levels
4. Identification and Assessment of Fault Conditions
5. Factors Influencing Compliance
6. Control Methodology
7. Quality Management and Data Recording

8. Statement of Acceptability

The remainder of this Section outlines minimum information required under each of these headings. It is summarised for easy reference in Appendix A.

4.1 Introduction

This section should indicate that its purpose is to support a particular LoC submission, and that it is designed to demonstrate that the waste packages produced by the particular process will comply with the stated SFM for those waste packages.

4.2 Facility and Process Description

This section should provide a brief description of the source and nature of the raw waste stream, a description of any relevant associated plant and processes and the proposed method of waste package production. It should comprise three separate sub-sections, as detailed below.

4.2.1 Waste Stream Information

The waste stream requires identification against the UK Radioactive Waste Inventory with the relevant alpha numeric identifier. This should be followed by a brief but comprehensive description of the waste stream which should include the following information, where relevant:

- waste type (ILW or LLW);
- waste form (liquid, slurry, solid);
- current waste volume (i.e. in stock);
- future waste arisings expected,
- total fissile material content of the waste stream;
- expected fissile material content (average and maximum values) per waste package;
- isotopic distribution (for Pu) and/or enrichment (for U);
- approximate chemical composition with specific note of other materials (i.e. neutron moderators and/or reflectors) present in the waste which could affect criticality safety;
- other relevant information specific to the waste stream.

4.2.2 Process Plant Description

This sub-section should include information on the proposed method of treatment of the waste and should be sufficiently detailed to provide a basic understanding of the operation of the plant and the process.

The information required includes that necessary to allow an estimation of the fissile material content of individual waste packages and should include:

- the volume of the waste package;
- immobilisation matrix;

- waste conditioning factors.

Where appropriate, the engineered (or other) safety systems and controls that are likely to be used on the plant to maintain the plant in a safe condition with respect to criticality should be identified. This should include fissile material monitoring and assay systems.

This sub-section should also indicate the extent of commissioning trials that have been undertaken for the packaging plant, with particular emphasis on commissioning systems which affect criticality, including safe systems, control systems and any fissile material assay and monitoring systems. This should cover commissioning of the process, including any fissile material assay and monitoring systems, safety and control systems and working instructions.

4.2.3 Waste Package Description

This section should provide information on the nature of the waste packages to be produced by the process. This should include:

- type of waste container (500 litre Drum, 3 cubic metre Box etc.);
- the material(s) of manufacture;
- the maximum and minimum values for container wall thickness;
- the anticipated gross mass;
- any unusual or non-standard features of the container or wasteform.

4.3 Criticality Safety Assessments and Fissile Levels

This section should provide the basis for the derivation of the SFM(s) against which the CCAD is demonstrating compliance. This could be either:

a) a justification for the use of a particular screening level, or;

b) a summary of the criticality safety assessment(s).

In the case of the latter, all future stages of the management of the waste package should be considered, i.e.:

- interim storage at the waste packagers site;
- transport to a GDF;
- the operational period of a GDF, and;
- the post-closure period.

Basic details of the assumptions used and the features of the waste package for which credit has been taken in deriving the SFM will also be required. This will include such information as:

- fissile material compositions;
- encapsulant composition;
- the presence or absence of materials which could affect the criticality safety of the waste package.

The waste packager may opt to use existing criticality safety assessments of sufficiently similar packaging proposals to satisfy these requirements, if this can be supported by arguments proving the validity of such an approach.

4.4 Factors Influencing Compliance

This section should identify all areas of uncertainty which could result in the SFM defined in Section 4.3 being exceeded. These are likely to include, but are not limited to:

- monitoring errors including random errors (to three standard deviations) and systematic errors;
- sampling errors (to three standard deviations);
- uncertainties in sample variability;
- uncertainties in historical records;
- variations in burn-up;
- uncertainties in metering waste into the container.

4.5 Identification and Assessment of Fault Conditions

This section should identify and assess any potential faults or errors in the packaging process that could lead to waste packages containing more fissile material than the SFM. This should be achieved by way of a formal fault identification process, such as a HazOp, where faults are identified in the package production process in such a manner as to allow the definition of control mechanisms for their elimination.

Typical faults could include human error, monitoring and sampling faults, overbatching[10] or the absence of waste package features for which credit is taken in the criticality assessment (i.e. grout annulus, container furniture etc.). This should take the form of fault schedules, arising from hazard identification studies and consideration of safety critical systems etc. to demonstrate criticality safety.

This section should summarise the controls and safeguards that are in place to ensure that these faults are eliminated. Details should be given as to how this control is achieved, including the referencing of relevant documentation such as Operating Instructions, Supervisors Standing Instructions and Criticality Control Certificates.

4.6 Control Methodology

This section should describe how the packaging process will be controlled such that if all the worst case uncertainties, defined in Section 4.4, are added together the derived SFM cannot be exceeded.

[10] Overbatching is defined as the undetected failure to comply with specified quantities of fissile material or other materials that impact directly on criticality safety (i.e. neutron absorbers, moderators or reflectors) within a waste package. Overbatching is the only fault sequence identified in the GOCSA [3] that could result in a criticality incident outside of the disposal vaults. If all of the controls at a waste packager's plant failed, then it could be possible that criticality could occur while a package is in a transport container or within the vaults, with significant dose consequences to exposed persons.

Since it is unlikely that any meaningful measurements can be made of the fissile material content of a waste package after immobilisation, because of shielding effects etc., it is important that confirmation of the fissile material content will need to be made before immobilisation. This section should therefore include a description of the arrangements that will be in place to ensure, through sampling, monitoring, measurement or other means, that the amounts of fissile material in each waste package remain within the SFM specified in the documentation.

One of two equally valid approaches can be adopted to ensure that the SFM is not exceeded:

i) In the case of heterogeneous wastes, where a number of discrete batches of waste containing fissile material (i.e. super-compacted 'pucks' of PCM) are added to the waste container prior to encapsulation, a suitable approach may be to adjust assayed values of the fissile material content of individual batches upwards to represent the maximum possible fissile content when all measurement uncertainties etc. are taken into account. Further batches could then be added to the waste container until the addition of an further batch would result in the SFM being exceeded;

ii) For more homogeneous wastes, such as sludges, an alternative approach would be to combine the identified uncertainties in the determination of fissile content in the raw waste and apply them to the SFM to produce a value for a Safe Working Limit (SWL), the value of which is less than the SFM by a margin which ensures that the actual waste package fissile material content will be less than the SFM.

The use of in-process monitoring, where available, is particular useful as an advance indicator to the potential for exceeding the relevant fissile material limit. An example, used in the Enhanced Actinide Recovery Plant (EARP) at Sellafield, is to monitor samples of upstream liquor for α-activity and assuming this all to correspond to fissile species. Although this is a highly pessimistic determination of fissile content it does provide an early 'trigger level' for higher than expected fissile content and allows remedial action to be taken, if proved necessary by subsequent measurement of the actual fissile content, before encapsulation.

4.7 Quality Management and Data Recording

4.7.1 Quality Management

The waste packager will need to demonstrate to RWMD that CCAD is part of a quality management regime that meets the requirements of *Waste Package Quality Management Specification, WPS/200* and this section should provide a brief description of the quality management system for ensuring that these arrangements are complied with.

4.7.2 Data Recording

The waste packager will need to provide evidence that the requirements of *Waste Package Data and Information Recording Specification, WPS/400* will be satisfied during waste package manufacture.

WPS/400 specifies the requirements of a tailored system for data acquisition and recording for waste packages. Such a system needs to cover the complete history of the packaged waste from the time of waste arising; through to emplacement in a GDF, data generated during package production will clearly provide an important input to the record produced as a result of this system.

With specific regard to the control of fissile material in waste packages the following should be recorded:

- declaration of compliance or non-compliance with the CCAD;
- verification of compliance or non-compliance with the CCAD;
- details of any non-compliance of the package with the CCAD, and;
- details of remedial action taken to establish as compliant a waste package that had been found non-compliant with the CCAD.

The CCAD should include a description as to how this information will be recorded and stored as part of the waste package record.

4.8 Statement of Acceptability

This concluding section will pull together the results of the previous sections to confirm that waste packages produced in accordance with the processes described in the CCAD cannot exceed the SFM determined for the packaging proposal. It should therefore include a clear statement that the arrangements described provide full confidence as to the benign nature of waste packages from the point of view of criticality safety.

5 REFERENCES

1 Nirex, *The Nirex Phased Disposal Concept*, Nirex Report N/074, 2003.

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

3 Nirex, *Generic Operational Safety Assessment. Part 7 - Operational Criticality Safety Assessment*, Nirex Report N/079, 2003.

4 Nirex, *Post-closure Performance Assessment. Topical Report on Post-closure Criticality Safety Assessment*, Nirex Science Report No. S/98/004, 1998

5 P. Wood et al, *The Nirex Coherent Approach to Achieving Criticality Safety*, Proceedings of ICEM '03, 2003.

6 M. Wise et al, *The Development of a General Criticality Safety Case for Intermediate and Low Level Waste in a Deep Waste Repository,* Proceedings of the Topical Meeting on Criticality Safety Challenges in the Next Decade, American Nuclear Society, 1997.

7 Nirex, *The 2004 UK Radioactive Waste Inventory – Main Report,* Nirex Report N/090, 2006.

8 Environment Agency, *NWAT Assessment of Nirex's Approach to the Setting of Fissile Limits for Waste Packages and Assessment of Possible Post-closure Criticality Events,* NWAT/Nirex/04/002, 2005.

9 IAEA, *Regulations for the Safe Transport of Radioactive Material (As Amended 2003),* IAEA Safety Series No. TS-R-1, 2004.

10 P.K.Abraitis and A.J.Baker, *Regulatory Oversight of the Conditioning of UK Intermediate Level Radioactive Wastes: Post-closure Criticality Safety Aspects,* Proceedings of ICEM '05, 2005.

APPENDIX A: OUTLINE STRUCTURE AND CONTENT FOR CCAD

The following summarises Section 4 and outlines the preferred structure and minimum information that is required in the CCAD that should accompany a packaging proposal:

1. Introduction

This section of the document should indicate that its purpose is to support a LoC submission, and is designed to demonstrate that the encapsulated waste produced by the particular process complies with the derived safe fissile mass for that waste package.

2. Facility/Process Description

This section should provide a brief description of the raw waste stream, the packaging plant and process, the proposed waste container etc., so that the document can be viewed as being stand alone and self supporting.

3. Criticality Safety Assessments and Fissile Levels

This section should provide a summary of the criticality safety assessment(s); the assumptions made, features of the package for which credit has been taken and the SFM to which this document is demonstrating compliance.

4. Factors Influencing Compliance

This section should cover all areas of uncertainty which could result in the SFM defined in Section 3 above being exceeded.

5. Fault Identification

This section should cover any potential faults or errors in the encapsulation process that could lead to a waste package containing more than the SFM. This should be achieved by way of a formal fault identification process, such as a HazOp, where faults are identified in the package production process in such a manner as to allow the definition of control mechanisms for their elimination.

It should summarise the controls and safeguards that are in place to ensure that these faults are eliminated, including the referencing of any relevant documentation.

6. Control Methodology

This section should describe how the process will be controlled such that if all the worst case uncertainties, defined in Section 4, are added together the SFM cannot be exceeded. It may define a SWL for each package which takes account of all the uncertainties such that, if waste is packaged to this SWL, the SFM cannot be exceeded.

7. Quality Management and Data Recording

The CCAD should be part of a quality management regime that meets the requirements of *Waste Package Quality Management Specification, WPS/200*, and this section should provide a brief description of the quality management arrangements for ensuring that these arrangements are complied with.

The CCAD should provide evidence that the requirements of *Waste Package Data and Information Recording Specification, WPS/400* will be satisfied during waste package manufacture.

8. Statement of Acceptability

This concluding section will pull together the results of the previous sections to confirm that the waste packages produced by this process will not exceed the SFM, and make a clear statement to this effect.

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