

Geological Disposal:

Generic Guidance on the preparation of submissions for the disposability assessments of waste packaging proposals

July 2016

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**WASTE PACKAGE SPECIFICATION AND GUIDANCE DOCUMENTATION
GUIDANCE ON THE PREPARATION OF SUBMISSIONS FOR THE DISPOSABILITY
ASSESSMENT OF WASTE PACKAGING PROPOSALS**

This document forms part of the Waste Package Specification and Guidance Documentation (WPSGD), a suite of documents prepared and issued by Radioactive Waste Management Ltd (RWM). The WPSGD is intended to provide a 'user-level' interpretation of the RWM packaging specifications, and other aspects of geological disposal, to assist UK waste packagers in the development of plans for the packaging of higher activity waste in a manner suitable for geological disposal.

Key documents in the WPSGD are the Waste Package Specifications (WPS) which define the requirements for the transport and geological disposal of waste packages manufactured using standardised designs of waste container. The WPS are based on the high level requirements for all waste packages as defined by the Generic Waste Package Specification and are derived from the bounding requirements for waste packages containing a specific category of waste, as defined by the relevant Generic Specification.

This document provides guidance on the preparation of submissions to RWM for the disposability assessment of proposals to package waste in a form suitable for disposal in a geological disposal facility.

The WPSGD is subject to periodic enhancement and revision. Users are therefore advised to refer to the RWM website to confirm that they are in possession of the latest version of any documentation used.

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WPS/908	August 2006	Aligns with GWPS (Nirex Report N/104) as published June 2005.
WPS/908/02	July 2009	Responsibility for the WPSGD passed to the NDA RWM. Aligns with Issue 2 of GWPS (Nirex Report N/104) as published March 2007.
WPS/908/03	October 2010	Guidance broadened to cover submissions for the disposability assessment of packaging proposals for all categories of higher activity waste. Extended to include the Periodic Review process.
WPS/908/04	April 2014	Updated to reflect 2012/13 update of packaging specifications, changes to the Disposability Assessment process and changes to DAAPs. Extended to include container-only assessments, Standard Waste Package Descriptions and early engagement.
WPS/908/05	July 2016	Section 3.6 (Transport safety) added Section 2.4 extended to include reference to Expert View

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Abbreviations and acronyms used in this document

ALARP	as low as reasonably practicable
AoD	Assessment of Disposability
BAT	best available technique
CCAD	Criticality Compliance Assurance Documentation
CoA	Certificate of Approval
CSA	Criticality Safety Assessment
DAAPs	Disposability Assessment Aim and Principles
DECC	Department of Energy and Climate Change
DSS	Disposal System Specification
DSSC	Disposal System Safety Case
DSTS	Disposal System Technical Specification
GDF	Geological Disposal Facility
GWPS	Generic Waste Package Specification
HLW	high level waste
HSE	Health and Safety Executive
IAEA	International Atomic Energy Agency
ILW	intermediate level waste
LLW	low level waste
LoC	Letter of Compliance
NDA	Nuclear Decommissioning Authority
ONR	Office for Nuclear Regulation
RWM	Radioactive Waste Management Ltd
SAPs	Safety Assessment Principles
SFM	safe fissile mass
SWPD	Standard Waste Package Description
UK RWI	United Kingdom Radioactive Waste Inventory
WAC	waste acceptance criteria
WPrS	Waste Product Specification
WPS	Waste Package Specification
WPSGD	Waste Package Specification and Guidance Documentation

1 Introduction

The Nuclear Decommissioning Authority (NDA), through Radioactive Waste Management Ltd (RWM), is responsible for implementing UK Government policy for the long-term management of higher activity radioactive wastes, as set out in the *Implementing Geological Disposal* White Paper [1]. The White Paper outlines a framework for managing higher activity radioactive waste in the long term through geological disposal, which will be implemented alongside the ongoing interim storage of waste packages and supporting research.

RWM produces packaging specifications as a means of providing a baseline against which the suitability of plans to package higher activity waste for geological disposal can be assessed. In this way RWM assists the holders of radioactive waste in the development and implementation of such plans, by defining the requirements for waste packages which would be compatible with the anticipated needs for transport to and disposal in a geological disposal facility (GDF).

The packaging specifications form a hierarchy which comprises three levels:

- The *Generic Waste Package Specification* (GWPS) [2]; which defines the requirements for all waste packages which are destined for geological disposal;
- *Generic Specifications*; which apply the high-level packaging requirements defined by the GWPS to waste packages containing a specific type of waste; and
- *Waste Package Specifications* (WPS); which apply the general requirements defined by a Generic Specification to waste packages manufactured using standardised designs of waste container.

The WPS, together with a wide range of explanatory material and guidance that users will find helpful in the development of proposals to package waste, make up a suite of documentation known as the *Waste Package Specification and Guidance Documentation* (WPSGD). For further information on the extent and the role of the WPSGD, all of which can be accessed via the RWM website, reference should be made to the *Introduction to the RWM Waste Package Specification and Guidance Documentation, WPS/100* [3].

This document has been produced to assist waste packagers in the preparation of a submission for the assessment of a packaging proposal, and its ability to result in disposable waste packages, by way of the RWM *Disposability Assessment process*. Users new to the process are referred to *An Overview of the RWM Disposability Assessment process* [4], which provides a full description of the assessment process and its role within current regulatory arrangements for the packaging and disposal of intermediate level waste (ILW).

1.1 Key terms

The Disposability Assessment process considers the performance and safety of waste packages during their transport to a GDF, handling and emplacement at that facility, and in the longer-term post-closure period. The assessment process also considers interim storage of waste packages prior to transport to a GDF, as far as this may influence their subsequent performance and safety. The term 'disposal' is used hereafter to denote all these periods as they are considered in a disposability assessment.

In all cases, the waste package is taken to comprise a waste container, a wasteform and any internal barriers that form part of the waste package. A 'waste container' is any vessel into which a wasteform is placed to form a waste package suitable for handling, transport, storage and disposal. The term 'wasteform' refers to the waste in the physical and chemical

form in which it will be disposed of, including any conditioning media and container furniture (i.e., in-drum mixing devices, dewatering tubes etc.) and any inactive capping material.

A 'disposable' waste package is one that has been shown to be compliant with the relevant packaging specification and the underlying needs for safe transport to and emplacement in a GDF.

Throughout this document, the generic term 'waste packager' is used to describe the organisation that is progressing the development of plans to retrieve and package waste. As such, the waste packager may not be the organisation that produced the waste in the first instance or that has the ultimate responsibility or liability for the waste. In practice, a waste packager is generally the holder of the nuclear site licence for the site where the waste is held, or their contractor. However, the term could also represent organisations, such as commercial suppliers of waste containers or waste conditioning processes etc., who are making submissions for the assessment of such products or processes.

1.2 Document structure

A brief outline of the Disposability Assessment process is provided in Section 2, discussing its aims, application, conduct and possible outcomes. Section 3 provides guidance on the type of information that should be included in a submission in order to permit a disposability assessment to be carried out effectively. The requirements are presented using a sub-section structure that may be used as an outline guide for the structure of such a submission.

Section 4 discusses additional applications of the Disposability Assessment process, including endorsement of packaging proposals against a Standard Waste Package Description (SWPD) and for the Periodic Review of the outcomes of historic Final stage disposability assessments. More detailed guidance is provided in Section 4.2 on the required content of a topic-specific disposability assessment.

2 The RWM Disposability Assessment process

This Section provides a brief discussion of the Disposability Assessment process in order to inform the required contents of a submission for disposability assessment, as discussed in Section 3. However, the reader is referred to the companion document, *An Overview of the RWM Disposability Assessment process* [4], for a fuller description and explanation of the process.

As described in the *RWM Disposability Assessment Aim and Principles* (DAAPs [5]; see Appendix A) the principal aim of the Disposability Assessment process is to minimise the risk that the conditioning and packaging of radioactive wastes results in packages incompatible with geological disposal, as far as this is possible in advance of the availability of WAC for a GDF). As such, it is an enabler for early hazard reduction on UK nuclear sites.

2.1 Application of the Disposability Assessment process

RWM has established a standardised approach for staged disposability assessments, based on an idealised packaging development project. The following stages are recognised in this approach when applied to waste packages intended for disposal:

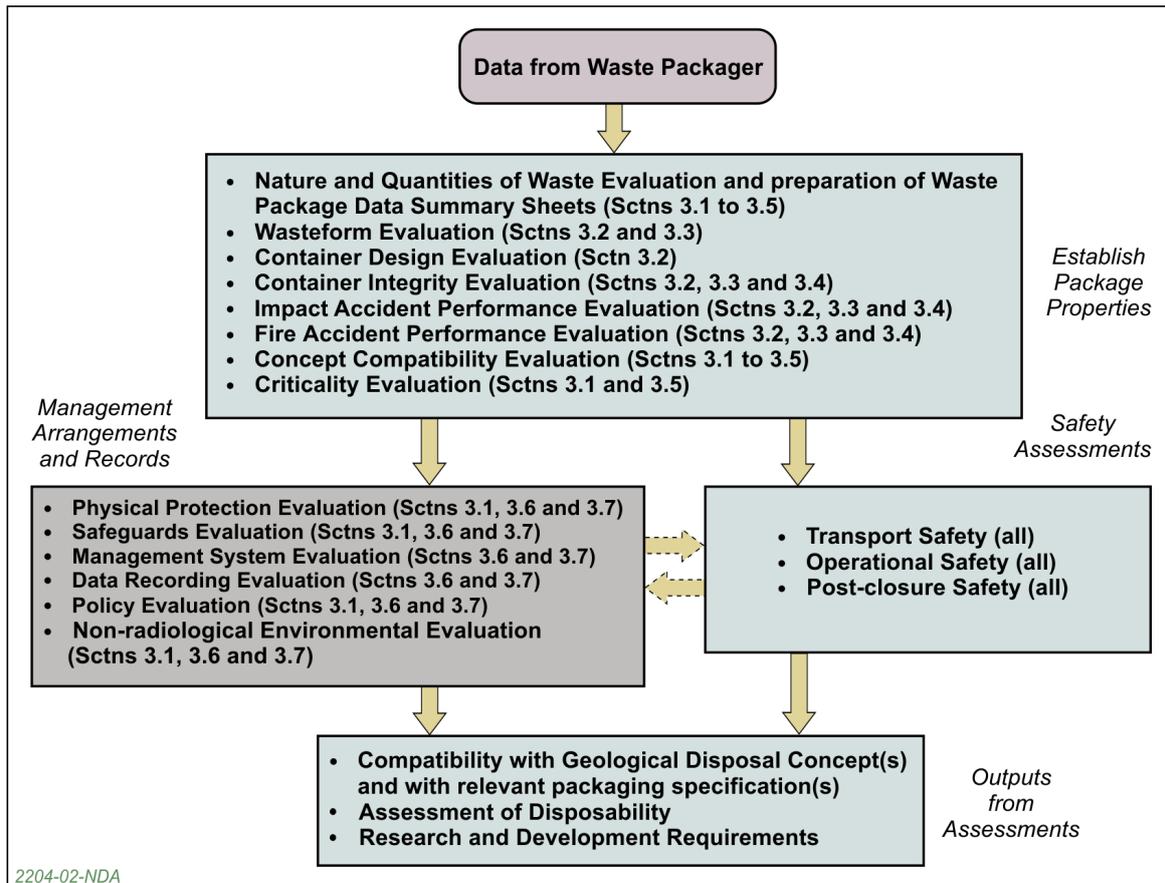
- Pre-conceptual assessment (option development and review stage) – interaction and advice as packaging options, and other waste management approaches, for a particular waste stream are reviewed and eliminated by the waste owner;
- Conceptual stage (focusing on analysis of feasibility) – establish whether, in principle, and when suitably developed, the proposed waste packages are likely to be compliant with RWM requirements;
- Interim stage (seeking underpinning evidence) – determine whether the evidence allows demonstration that the as-designed waste packages are compliant with RWM requirements; and
- Final stage (confirming plant characteristics) – determine whether the evidence allows demonstration that the waste packages as they would be manufactured would be compliant with RWM requirements.

Endorsement of a packaging proposal may be provided at any of the stages, with the exception of the Pre-conceptual stage, by way of the issue of a Letter of Compliance (LoC). Gaps in compliance and key areas for further development can also be identified at any of the stages to assist development of waste packaging proposals.

2.2 Conduct of a disposability assessment

Figure 1 illustrates the various evaluations and assessments that may be performed as part of a disposability assessment. The identified activities are undertaken at appropriate stages in the assessment process and need not be repeated at subsequent stages if the previous assessment met all the relevant requirements, all issues were resolved and there have been no changes in the packaging proposal. Summaries of the purpose of the Disposability Assessment process, the information expected, the assessment objective and the requirements for endorsement at each assessment stage are provided in Appendix B.

Figure 1 Evaluations and assessments that may be performed in a disposability assessment¹



2.3 Outcomes of the Disposability Assessment process

Application of the assessment process results in the production of an *Assessment Report* at the end of each assessment stage. The Assessment Report is intended to show in a transparent and visible way whether the implementation of a packaging proposal would result in the production of waste packages which would be compliant with the relevant packaging specifications and with the underlying safety, environmental and security assessments for transport and disposal. Depending on the extent of an assessment a full Assessment Report (as described in Section 5.1 of [4]) may be issued, alternatively it might take the form of a more limited technical report or a letter containing advice on a specific aspect addressed by a packaging proposal.. In general a full Assessment Report will include an *Assessment of Disposability (AoD)*, a formal statement of the reasoning that allows the disposability case for the proposed waste packages to be made. The Assessment Report may also include *Action Points* as a formal means of identifying specific matters which will require resolution prior to the issue of an LoC, and issues or priority areas expected to be resolved at the next stage of an assessment.

At the request of the waste packager, RWM can also produce interim updates on the findings as they arise during an assessment, for example, to support discussions with regulators before the full disposability assessment is completed.

¹ The figure indicates the sections in this Guidance where the information requirements for each evaluation are discussed.

The production of an Assessment Report may be accompanied by the issue of an LoC if RWM are satisfied that the implementation of the packaging proposal would result in the production of waste packages that are compliant, at that assessment stage, with the relevant packaging specifications and with the geological disposal concept and its associated safety cases.

2.4 Early and sustained engagement

A flexible and staged approach is applied in the Disposability Assessment process whereby RWM engages with waste packagers to establish the most appropriate way forward for a particular proposal, consistent with maintaining the integrity of the overall assessment process. To this end, RWM is keen to promote early, sustained and positive engagement with waste packagers, before the preparation of a formal submission and/or assessment of a packaging proposal at any stage of the Disposability Assessment process. This is aimed at enabling early identification of key issues as a means of reducing the number of iterations that will be required during the overall assessment process and the achievement of the earliest endorsement of a packaging proposal.

RWM's approach to early engagement may be formalised by way of the 'Expert View' process. The process is an optional means of formal engagement between RWM and a waste packager in advance of a disposability assessment and provides a relatively rapid means for waste packagers to obtain formal advice on the risks and issues arising from a proposed waste packaging process.

The conclusions of an Expert View are presented in the form of a letter which will include a clear and explicit tabulation of the risks to disposability arising from any identified issues, noting a judgement as to the potential severity of the risks they present to the eventual endorsement of the proposed approach to packaging.

3 Contents of a submission for disposability assessment

This Section provides guidance on the type of information that should be included in a submission in order to permit a disposability assessment to be carried out effectively and expeditiously. The structure of this Section may be used as an outline guide for the structure of such a submission; it is advised that the submission is not structured to address each assessment topic in turn because this would lead to needless repetition of data. The individual Sections also refer back to Figure 1 which illustrated the various assessments and evaluations that may take place as part of a disposability assessment.

It is important to note that the submission information requirements are significantly affected by the assessment stage of the submission: earlier stage submissions require background information and outline proposals, whereas later stage submissions focus on the provision of evidence on specific issues and information to support the close out of particular Action Points. However, it is also important to note that the Disposability Assessment process is flexible. Notwithstanding the recognition of the four stages in the standard approach, since the stages represent a step-wise progression towards endorsement at the Final stage, RWM also accepts that some or all of the stages preceding the Final stage may be omitted. Under such circumstances, the requirements of the omitted stage(s) would be considered at subsequent stages. For example, in a case where an existing packaging plant is to be used to condition a different waste stream, it may be possible to commence the assessment process at the Interim or Final stage. RWM will engage with waste packagers to establish the most appropriate staging for a particular proposal, consistent with maintaining the integrity of the overall assessment process.

A checklist showing the scope and basic contents of an idealised waste packaging submission is shown in Appendix C. The checklist illustrates how the focus of the various topic areas varies for the different submission stages and should be read in support of the remainder of this section.

A submission for disposability assessment may be single large document that is self-contained or may consist of a collation of documents, with the evidence to support arguments contained in more detailed reports. Any supporting references are also considered to form part of the submission. A submission may also consist of smaller documents produced in order to address specific Action Points or requests for additional information.

3.1 Nature of the waste

3.1.1 Waste origins and project plans

To ensure that the correct range of wastes and waste characteristics are considered during an assessment, an appropriate understanding of the origin of the waste, its current storage arrangements, project history and project plans is necessary. This information also helps define the scope of the disposability assessment and any subsequent endorsement.

The Conceptual stage submission is the key stage with regard to this subject area and at this stage the waste packager should describe:

- the site, plant and processes which generated, or will generate, the waste;
- the current, historic and/or planned storage arrangements for the waste;
- the history of the current project, including details of any preliminary optioneering work and restrictions placed on the project by site infrastructure, the waste owner, regulatory requirements, etc. This should include details of relevant site Integrated Waste

Strategies (IWS), non-radiological environmental assessments, best available technique (BAT) and as low as reasonably practicable (ALARP) studies; and

- project plans, such as planned waste retrieval dates, project completion dates and likely dates at which LoC endorsement will be required.

At subsequent submission stages the waste packager should notify RWM of any changes to project details, plans and timescales, and seek to resolve any uncertainties identified at previous stages.

3.1.2 Physical, chemical and radionuclide characteristics

The characteristics of the raw waste will significantly affect the properties of the manufactured waste packages and, therefore, a good understanding of the physical, chemical and radioactive characteristics of the waste is required. This information forms the basis and scope of the majority of the technical evaluations discussed in Section 2.2.

The Conceptual and Interim stage submissions are the key submission stages with regard to this subject area. Most information is expected at the Conceptual stage such that it should only be necessary at the Interim stage to respond to, and close out, any issues raised at the Conceptual stage. However, development work prior to an Interim stage submission may identify new or additional waste characteristics of significance or result in an updated waste inventory. The implications of revised information for waste stream or waste package inventories at the Interim stage will need to be evaluated by RWM. For example, it is possible that waste may have been sampled and analysed since the Conceptual stage LoC was issued.

RWM would not normally expect there to be any changes with respect to the characteristics of the waste at the Final stage.

The submission should describe:

- the physical characteristics of the waste (e.g., the nature of sludge, physical sizes of solids, etc.);
- the major chemical components of the waste (e.g., types of solid materials, major species in sludges or liquids, organic compounds, etc.), including the expected or known inventory of chemically toxic species, such as heavy metals; and
- the nature of the radionuclides in the waste and in any specific components of the waste (e.g., irradiated fuel, sealed sources), including the source(s) of that information.

The submission should include a discussion of the manner in which the information has been derived, together with any limitations in that derivation and the steps that have been taken to minimise their consequences. Bounding, or maximum, data should be provided, as well as representative data.

RWM has conducted work to identify radionuclides that may be potentially significant for the transport and disposal of packaged waste in a GDF; based on current understanding RWM has determined *Guidance Quantities* (GQs) for 112 radionuclides [6]. Experience has shown that in most cases only a limited number of these radionuclides will actually be at significant levels within a specific waste stream. The identification of which of the 112 relevant radionuclides that are actually significant for the packaging proposal should form part of a Conceptual stage submission.

Information on the process(es) which generated the radionuclides should be used to supplement a known, but limited, radionuclide inventory. This information is likely to include, where relevant, the irradiation history of materials, the chemical composition of the specific waste materials, and information on the extent to which radionuclides may have been segregated by subsequent processes and storage arrangements. This information should be provided, if available, at the Conceptual stage and extended, if necessary, at the Interim stage.

Waste package submissions should state whether the waste described in the submission is included within the most recently published UK Radioactive Waste Inventory (UK RWI), or whether it is additional and is to be declared at the next update. If the waste is included in the UK RWI, the waste stream identifier(s) should be stated and any differences between the UK RWI information and the submission information should be explained, for example, with respect to the radionuclide inventory or composition of the waste.

3.1.3 International safeguards

Most waste streams will contain nuclear materials (NM) that are the subject of international safeguards (i.e., isotopes of uranium, plutonium and thorium) [7]. All organisations possessing civil safeguarded materials in the UK are required by law to declare information about the use of NM and the operating regime of any facility where these materials can be found. This includes a requirement to permit representatives of the European Atomic Energy Community (Euratom) to inspect the facilities and associated records. Under current international arrangements, this would include any national facility for the long-term storage or disposal of radioactive waste that contains significant quantities of NM. It is therefore necessary that RWM has sufficient information to allow a full consideration of the implications of accepting waste that contains safeguarded materials and, in particular, the likely impact on facility operations.

A waste packager is required to ensure that the relevant safeguards authority (i.e. Euratom via ONR-Safeguards) is aware of plans to package such materials for disposal before commencement of such operations. This involves the waste packager identifying the quantities and safeguards status of any NM and discussing their plans with their local safeguards controller, or directly with Euratom.

At the Conceptual stage, the waste packager should recognise the presence of any safeguarded materials associated with the waste to be packaged and inform RWM of their intentions as to how its safeguards status will be managed. At the Interim stage, RWM would seek confirmation that such plans have been confirmed as suitable by the relevant local safeguards controller, or Euratom. Evidence of Euratom's approval of the packaging plans and the manner in which they will be implemented during waste retrieval and packaging is required at the Final stage.

3.2 Production of the waste package

An important aspect in defining the proposed waste packages is establishing an understanding of the waste retrieval, treatment and packaging processes. The Conceptual and Interim stages are key for this subject area, with justification for the proposed process expected at the Conceptual stage and results of the necessary research and development work to be provided at the Interim stage. At the Conceptual stage, compliance is assessed against the relevant Generic Specification (or the WPS for the specific waste package type², if one exists). Compliance with the relevant WPS is required at the Interim and Final stages.

² WPS are only available for waste packages manufactured using one of the range of standardised designs of waste container which are identified by the Disposal System Specification. Alternative waste container designs are evaluated for potential impacts on the disposal system via the RWM *Geological Disposal System Change Management Procedure*. The procedure sets out a method for assessing, categorising, evaluating and implementing all proposed changes to ensure that the significance and impact of proposed changes are assessed and that they are appropriately underpinned. A WPS cannot be produced for the innovative container and Interim stage assessments undertaken until the change management procedure has been applied (more detail is available in Section 3.3 of [4]).

The Conceptual stage submission should provide an outline description of the proposed waste retrieval process and any waste treatment processes to be applied prior to packaging, such as de-watering of sludges, segregation or diversion of specific materials or items, treatment of hazardous materials or objects, etc. Details of the proposed assay techniques to characterise the waste should be outlined. The final details of the proposed waste retrieval process and any waste treatment processes to be applied prior to waste packaging should be confirmed at the Interim stage.

The waste container type intended for use in the packaging of the waste should be stated at the Conceptual stage, along with the outline container design and dimensional envelope; detailed designs are not required at this stage, although drawings are preferred. The relevant Generic Specification should be specified at the Conceptual stage in the submission, but if the proposed container is intended to comply that defined by an existing WPS, then this should also be indicated. The Conceptual submission should therefore include sufficient information to permit assessment of the compatibility of the waste container and the waste packages with the geological disposal concept, as defined by the relevant Generic Specification. Additional information about the container to be provided at the Conceptual stage includes:

- specification and justification of the container materials and provision of an outline of the fabrication methods (additional evidence would be required for novel materials not previously considered by RWM);
- definition of the gross mass and consequential restrictions on density of payload, etc.;
- description the handling arrangements (tie-down for transport, lifting etc.). Consideration should be given to any need to restrict handling during container and package manufacture, for example, whether containers with un-grouted wastes could be lifted;
- demonstration that stacking requirements could be fulfilled for packages of the maximum gross mass; and
- definition of the expected transport arrangements for the transport package. Proposals for obtaining transport certification, if required, should be stated, including definition of any necessary testing.

Container manufacturing drawings and materials specifications should be provided at the Interim stage to permit assessment of the compatibility of the waste container and the waste packages with the geological disposal concept. RWM assesses the final design of the waste package at the Interim stage, including results from research and development work. At the Interim stage the waste packager should:

- specify the relevant WPS;
- finalise the container design, providing full manufacturing drawings and the manufacturing specification;
- confirm the construction materials, construction techniques and surface finish;
- specify all handling arrangements and confirm compliance with the WPS; and
- demonstrate through testing or modelling, as necessary, that the WPS requirements are fulfilled.

The expected transport arrangements for the transport package should be defined at the Conceptual stage. It should be demonstrated that the requirements of the appropriate transport regulatory regime are understood and arguments or evidence should be provided that these would be fulfilled by the resulting packages. Proposals for obtaining transport certification, if required, should be stated, including definition of any necessary testing. The transport arrangements should be confirmed at the Interim stage.

The waste packaging process and waste conditioning process and materials should be described at the Conceptual stage. This should include details of the proposed conditioning

process, including details of the proposed encapsulant material and any anticipated limiting factors or waste components affecting the overall wasteform composition. Any plans to not encapsulate the radioactive wastes should be justified, including discussion of any additional requirements that may be placed on the waste container. These details should be confirmed at the Interim stage, including details of the wasteform production process and wasteform envelope, and key process conditions.

Details of the relationship between the information provided in the submission and the waste packaging information provided for the most recently published UK RWI should be provided. This should include whether details of the waste container type, conditioning process and anticipated conditioning factor will be essentially unchanged in the UK RWI, or will require significant revision as a consequence of the proposals at the next UK RWI update.

The Final stage submission should report any changes to the information supplied at earlier stages and respond to and close out issues raised at the Interim stage. Evidence to confirm that the as-built packaging plant is capable of making the proposed package is required at the Final stage, for example, by using objective evidence from commissioning reports or test results. This is likely to require information obtained during both inactive and active commissioning of a new packaging plant (where active tests are possible without a Final stage LoC) and/or on-site inspection of records as part of a technical audit.

3.3 Waste package properties and expected performance

The range of waste package contents that will arise from the waste retrieval, treatment and packaging processes should be described in this section. Evidence supporting demonstration of compliance with the packaging specification requirements (where relevant) is necessary for waste packages assumed to contain the proposed maximum radionuclide inventory. This includes, for example, specified requirements for activity content, external dose rate, heat output, surface contamination and gas generation limits. The expected performance of the proposed waste package under impact and fire accident conditions should also be demonstrated.

The waste packager should provide information demonstrating achievement of adequate wasteform characteristics, including requirements on mechanical strength, voidage, leachability and heterogeneity. For some waste package designs, the wasteform may play a significant role in achieving aspects of the required waste package performance (e.g. for ILW packaged in thin-walled waste containers) and, therefore, greater levels of wasteform performance would be required.

To permit evaluation of the proposed waste packages, a robustly derived waste package inventory is required, both in terms of the best estimate inventory for the waste packages and a suitable bounding inventory that could be present in any individual waste package. As stated in Section 3.1, the Conceptual stage submission should provide information on the waste stream physical, chemical and radionuclide composition. This chapter of the submission should explain how the information requested in Section 3.1.2 has been interpreted and extrapolated to produce a per package inventory that will arise from the proposed waste packaging process. The submission should also discuss the expected variability in the package contents.

A key aspect of the assessment process, particularly in the performance of the concept safety assessments, is the development of an 'assessment inventory' for the packaging proposal. This should bound the expected number, type and contents of the waste packages that will result from the proposal, with an appropriate degree of conservatism. The assessment inventory is typically produced by RWM using the information on the waste, its origins and the proposed waste packaging process provided as part of the submission. Alternatively, the waste packager may choose to produce the assessment inventory. It should be noted that RWM may choose to supplement any information provided, either to

enhance the information available for assessment or to ensure the full potential range of package compositions is assessed.

At the Conceptual stage the information is unlikely to be complete, although estimates can be provided based on analogues and knowledge of similar waste packages, wasteforms and encapsulating materials. The Conceptual stage submission should provide outline descriptions of the methods to be applied to derive a waste stream and waste package physical, chemical and radionuclide inventory. The testing regime required to establish waste package performance should also be specified at the Conceptual stage.

The Interim stage submission is the key submission stage with regard to this subject area. At the Interim stage RWM assesses final design specifications, including results from research and development work. The waste packager should therefore provide arguments, supported by research and development, to confirm the anticipated waste package physical, chemical and radionuclide composition and properties that will arise from the proposed waste packaging process. Evidence should be presented to demonstrate that the performance of the resulting packages under normal conditions meets the requirements, including behaviour during transport, capacity for gas generation and means of accommodating gas generation through venting and/or toleration of pressurisation. Argument and/or evidence should also be presented to demonstrate that the performance of the resulting packages under accident conditions meets requirements.

Confirmation is required at the Final stage that the as-built packaging plant is capable of making a product that will be compatible with requirements for transport and disposal as defined by the relevant packaging specification, for example, by using objective evidence from commissioning reports or test results. The plant inactive commissioning report may provide supplementary information concerning waste package properties and characteristics, typically in relation to the ability of the plant to encapsulate waste materials.

3.4 Waste package evolution and maintenance of integrity

The progressive evolution of waste packages is inevitable, particularly during any extended period of interim surface storage and the operational period of a GDF. Information on the likely extent to which the properties of the waste packages may evolve after manufacture and the likely effect of this evolution on waste package properties, characteristics and integrity needs to be established, potentially requiring specific areas of research and development work.

The environmental conditions waste packages are exposed to during this period have the potential to affect package longevity and therefore are particularly pertinent to the AoD. It is important that the challenges to maintaining waste package properties are identified so that the environment in a store can be maintained so as to minimise the deleterious effects of package evolution. The condition of waste packages must also be monitored to identify waste packages that have evolved in such a way that they are no longer compliant with the needs for their ongoing management or they are showing signs of deterioration that may lead to them being non-compliant prior to transport.

The relevant packaging specification lists the properties and characteristics of waste packages that are of relevance to their safe long-term management; it is important that evolution of the waste package does not result in any of these changing to the extent that the requirements are no longer satisfied. Accordingly, evidence should be provided to show that waste packages will continue to comply with the basic requirements of the relevant packaging specification (i.e., limits on external dose rate, heat output, gas generation, integrity of the waste container, etc.) and that any deterioration of the waste package contents will not compromise the ability of the waste package to perform in an appropriate manner under both normal and accident conditions.

At the Conceptual stage, package-specific development work is unlikely to be complete and therefore reasoned arguments based on analogues and other information should be provided concerning the likely evolution of waste package properties and characteristics. The waste packager should demonstrate that the proposed waste containers and any handling structures (e.g., stillages) would be capable of maintaining integrity (i.e., containment, surety of lifting features and ability to be stacked) for the required period before GDF closure. The role of the container in ensuring integrity should be defined and understood and the ability to maintain compliance with the transport certification for an extended period prior to transport should also be considered, where relevant. The high-level requirements on package storage conditions necessary to maintain container integrity should be identified and outline details of package monitoring arrangements should be provided.

RWM assesses final design specifications at the Interim stage, including results from research and development work. The waste packager should provide arguments, supported by research and development results, to confirm the expected evolution and integrity of the waste package. Any constraints on the waste package properties, and any resulting store environmental conditions, should be identified. This should include a full description of the control measures and the permitted range of conditions. Sufficient detail should be provided to give confidence that the store would be constructed with adequate provisions to ensure the longevity of waste packages. In the event that an existing store is to be used, details of the control measures should nevertheless be provided. In addition, details of the arrangements for monitoring the condition of the packages should be provided, sufficient to give confidence that they could be effectively implemented. RWM has produced guidance on control of the environmental conditions during interim surface storage [8] and on the waste package monitoring regimes that should be instituted during such storage [9].

At the Final stage, the effective implementation of environmental controls and the waste package monitoring system should be demonstrated and a suitably detailed specification for the operation of the store and for monitoring the packages should be provided. Additional information from longer-term monitoring of samples to support the case for benign waste package evolution can be provided at the Final stage.

3.5 Criticality safety

Details of the fissile content of the waste packages should be provided and the criticality safety of the waste packages considered. For wastes containing fissile radionuclides, the waste packager is required to determine a value for the safe fissile mass (SFM) of these radionuclides to be applied during packaging of the waste. Derivation of the SFM can be achieved either by reference to an existing generic criticality safety assessment (CSA) or by way of a package-specific CSA. The definition of the SFM will need to consider such information as the uranium-235 content (i.e. the enrichment) of any uranium present, the isotopic composition of any plutonium, consideration of any other fissile nuclides present, and details of the presence and quantity of neutron moderators or reflectors (e.g., graphite, beryllium, deuterium compounds, polythene, etc.). Guidance on the definition of SFMs can be found in [10].

A Conceptual stage submission should provide sufficient information to justify that a CSA could be made and that the proposed packages would comply with the resultant fissile limits. This could make use of the generic CSAs or argue that a plausible package-specific case could be made.

At the Interim stage it is expected that the waste packager will have developed a CSA and determined the most appropriate SFM for the waste package.

Draft Criticality Compliance Assurance Documentation (CCAD) should also be prepared as part of the Interim stage submission. The aim of CCAD is to provide direct assurance of the criticality safety of the proposed waste packages by recording the parameters required to

ensure criticality safety and demonstrating the waste packager's arrangements for meeting those requirements during all stages of long-term waste management, including package manufacture, storage and disposal. Preparation of the CCAD requires an in depth understanding of the waste, the waste packaging plant, the waste assay techniques, and the control of and uncertainties in fissile materials determination.

Guidance on the preferred structure and required contents of the CCAD is available in [11]. The CCAD should be completed and submitted for assessment and agreement with RWM at the Final stage.

3.6 Transport safety

The transport of waste packages to a GDF will require the issue of a Certificate of Approval (CoA). The CoA can be produced by the Competent Authority or, for self-approved designs³, by the Design Authority at any time during the design and/or manufacture of the transport container and/or the waste packages. However, a valid version must be available at the time of the transport of the waste packages. Included in the CoA will be a specification of the allowable contents: either directly or by reference to a separate Contents Specification. This will define limits on the radionuclide contents of the transport package, such that the various constraints on the transport package (e.g. heat output, external dose rate, criticality safety) will be met.

The LoC endorsement of a packaging proposal at the Final stage⁴ will require a demonstration that the proposed waste packages will be safe to transport. This requires demonstration that, for example, the maximum radionuclide of the proposed waste packages lies within the envelopes defined by a valid CoA or Contents Specification. Following waste package manufacture, the waste producer will be responsible for maintaining the validity of the relevant CoA and/or Contents Specification throughout their interim storage.

For transport packages where RWM is the Design Authority a Contents Specification will be available and will be used to determine whether the contents of the proposed waste packages are within the limits it defines. In the case of proposed waste packages that would not comply with the relevant Contents Specification, RWM will be able to advise what needs to be achieved to bring the submitted design within specification. Such waste packages may be endorsed at earlier stages in the Disposability Assessment process provided that at the Final stage the transport package Contents Specification has been revised to allow such waste packages to be transported. Such work will be flagged in the Assessment Report as an Action Point, and would be undertaken by RWM with the cost being borne by the waste producer. When applying for a Final stage LoC, the waste producers would need to allow sufficient time for any such work to be carried out.

Where RWM is not the Design Authority, packaging proposals will be assessed against the transport package CoA and/or Contents Specification provided by the Design Authority. Where the submitted design is found not to be within specification RWM will advise the waste producer of this finding, explaining the rationale and refer the applicant to the Design Authority for further advice and/or design changes. The transport of radioactive materials is subject to the requirements defined by the IAEA *Regulations for the Safe Transport of Radioactive Material* [12], as implemented into UK law. As part of a disposability assessment, RWM assesses the compliance of proposed transport packages directly against these requirements. However, as the design knowledge will not reside within RWM, this assessment cannot be as effective and the level of confidence will therefore be lower. Again,

³ In general, Competent Authority approval will be required for Type B transport packages, whilst Industrial Packages (Type IP) will be self-approved.

⁴ Endorsement at the Interim stage will require a demonstration of compliance of the proposed waste packages with at least a draft CoA or Contents Specification.

the cost of generating any new CoA and/or Contents Specifications will be borne by the waste producer but, in such cases RWM would not normally be involved in the production of these documents.

Where the waste package design is such as to provide a significant transport package function (i.e. for waste packages which are also transport packages ‘in their own right’⁵) RWM will assess the ability of the waste package to fulfil its transport function at the time of transport. Where RWM is not the Design Authority, the waste producer, if necessary in collaboration with the Design Authority, will provide all of the necessary information to permit such assessment.

The regulatory requirements for transport outlined above will require a proposal to package waste to include, for assessment at the Interim stage, the information necessary for RWM to be able identify the applicable route to the transport approval of the proposed waste packages. This will include determining whether a relevant CoA and/or Contents Specification exist, or if such documentation needs to be prepared and approved. An Interim stage submission should include sufficient inventory information to allow RWM to show that the proposed waste packages would, in principle, be compliant with the relevant CoA. The information provided as part of a Final stage submission should permit compliance to be confirmed.

3.7 Management systems

RWM requires waste packagers establish, implement and maintain a formal and effective management system to ensure arrangements are in place covering all safety, quality and data recording related aspects throughout the lifetime of a waste package. This should include arrangements for the preservation and handover of all relevant documentation in the event that there is a change in waste ownership. The management system should apply to all activities, interactions and aspects that can affect the product quality of the packaged wastes, including early project planning and development work, as well as the waste packaging process and interim storage. RWM’s requirements for the management system are set out in *WPS/200 Waste Package Quality Management Specification* [13].

The content of the submission with respect to quality arrangements will depend upon the stage of the submission. The content should develop to be more extensive and comprehensive as the submission progresses between the three disposability assessment stages. The Conceptual stage submission will generally comprise statements of intent and outline plans, moving to draft management system procedures at the Interim stage, as well as providing evidence that all R&D required to support the Interim stage submission has been carried out under an appropriate quality management system. However, the Final stage submission is the key submission stage with regard to this subject area.

At the Conceptual stage the submission should include a clear statement of intent to comply with WPS/200 and describe how the design and development of the waste package and the waste packaging plant will take place within an effective management system complying with ISO 9001. The submission should also describe how RWM’s requirements have been identified and embodied within the development plans.

Other evidence that is desirable at this stage includes a Quality Programme, Project Plan or equivalent which clearly describes the following:

- the project objectives and scope, which should include obtaining and complying with the Disposability Assessment process;

⁵ These are waste packages which are intended to be transport without significant additional physical protection.

- an outline project plan identifying and describing the key stages of the project such as waste characterisation, container design, process development, testing and commissioning;
- a programme of design and development review stages, which include independent verification;
- the key hold points and milestones of the project, including submissions to RWM; and
- a description of the key roles and responsibilities involved in the project.

Evidence that the organisation responsible for the project and major sub-contractors operate management systems complying with ISO 9001 should be demonstrated, either by submission of appropriate quality system certificates or quality system documentation (e.g., manuals, procedures, etc.).

The Interim stage submission should provide evidence to demonstrate that waste package and packaging plant development activities have been undertaken under appropriate quality assurance arrangements and provide a quality programme or project plan for the remainder of the project, i.e., for commissioning and operation of the plant.

The Interim submission should provide records of the completion of the independent reviews of research, design and development identified in the project plan, and should provide the draft *Waste Product Specification* (WPrS). The WPrS defines the waste package that is to be manufactured by stating the limits and controls on the waste package production process. This key document will eventually be used, together with other records, to demonstrate that compliant waste packages meet the waste acceptance criteria for a GDF and are compatible with all future stages of waste management. The WPrS can also be used by an auditor to seek confirmation that the packaging process and resultant product are compliant with that endorsed by the assessment. Guidance on the preferred structure and required contents of the WPrS is available in [14].

Other evidence that is desirable at the Interim stage includes:

- an updated quality programme or project plan;
- records that demonstrate an adequate system is place to control advice, Action Points or LoC conditions and caveats arising from the Conceptual stage submission;
- copies of independent audits of the project;
- detailed plans for plant installation, commissioning and acceptance testing;
- selection criteria, specifications and requirements for key suppliers; and
- outline quality plans or operating procedures for the plant that demonstrate how compliance with the WPrS will be assured.

The Final stage submission should include a description of the scope and status of the management system, providing details of when objective evidence has been, and will in future be, provided. An overview of the plant management system structure and final documentation (Quality Plans, Operating Instructions, etc.) should also be provided. The submission should:

- provide evidence that commissioning and testing of the waste packaging plant has been undertaken under a verified quality management system;
- demonstrate that recommendations from the Interim stage assessment have been addressed; and
- ensure that quality assurance and control arrangements for the routine operation of the plant are adequate and address RWM's requirements, including the arrangements for any non-conforming product.

Essential evidence required at this stage includes the final WPrS; a quality plan for the packaging process, which defines the process control measures that will be in place and

identifies the tests, measurements or inspections will be undertaken and what acceptance criteria will be applied; and a procedure for the identification, assessment, and disposition of non-conforming product. Other evidence sought at this stage includes:

- records of the commissioning and testing of the plant;
- records of independent review of testing and commissioning;
- copies of any independent audits of the project;
- operating procedures for the plant;
- details (or samples) of the records that will be generated and retained for the process and the waste packages produced;
- a procedure for change control of the WPrS;
- an internal audit programme for the process;
- a risk register for the process; and
- evidence of third party assessment of the process (e.g., a copy of the ISO 9001 certificate covering the plant).

3.8 Package records

Waste package information is required to support all future stages in the long-term management of the waste. Therefore, RWM requires that waste packagers establish a data recording system for acquiring, recording and subsequently managing information for each waste package such that it can be used to establish, infer or predict package properties and performance under all relevant circumstances. Ultimately, this information will be used to demonstrate conformance with future WAC for transport and a GDF. The waste package record will eventually be transferred to the operator of the GDF at the time of waste package acceptance.

Waste packages require an associated waste package record that should:

- describe the physical, chemical and radionuclide content of the waste package;
- identify and define the properties and performance of the waste package that are relevant to its ongoing management;
- provide a comprehensive radionuclide inventory; and
- provide sufficient data to allow prediction of the evolution of the waste package with time, the effect of interactions with other packages and the various GDF components, and the effect of environmental conditions on package integrity.

The data recording system needs to cover the entire lifetime of the packaged waste, from the time of waste arising, through initial waste characterisation, process conception and development, to waste package production, storage, transport and emplacement in a GDF.

Information associated with a waste package includes:

- information that applies to the waste type as a whole, in particular the documents that define the origin of the waste, storage and retrieval methods, the packaging process, the results of the development programme, manufacturing specifications and the properties of the waste package;
- information relating to a batch of packages, for example manufacturing records for a batch of containers and assays results for package components that apply to a batch of waste;
- information for individual waste packages as manufactured, primarily required to demonstrate conformance with specifications or limits; and
- other information required to fulfil particular regulatory or administrative requirements.

The information to be incorporated into the package records and the methods of obtaining that information before and during the waste packaging process should be outlined in the Conceptual stage submission. The data recording proposals should be more developed by the Interim stage, ideally in the form of a draft Waste Package Data Recording Methodology, to show how the requirements of the *WPS/400 Waste Package Data and Information Recording Specification* [15] will be met during waste retrieval and packaging. Specifically this should include a description of:

- planned data acquisition, recording and retention methods;
- potentially relevant radionuclides to be recorded;
- methodology to be used to derive a waste package physical, chemical and radionuclide inventory; and
- key compositional and process parameters and any necessary limits (the WPrS and CCAD are key documents in support of this).

The methods of obtaining information on the radionuclide, physical and chemical contents of the waste stream and waste packages could include the use of records of known provenance and reliability concerning the origins and history of the waste and their consignment into the current storage facility, observations during waste retrieval and packaging, and the results of radiometric measurements and other assay techniques.

At the Final stage the waste packager will be required to confirm that the waste package data acquisition, recording and retention systems proposed at the Interim stage are in place.

4 Additional applications of the Disposability Assessment process

4.1 Using Standard Waste Package Descriptions to obtain Final stage endorsement of packaging proposals

RWM has developed a ‘fast track’ route to the Final stage LoC endorsement of a packaging proposal where a waste packager has opted to use a previously endorsed packaging concept for a new waste stream. This approach relies on the waste packager demonstrating that a packaging proposal would be compliant with a *Standard Waste Package Description* (SWPD), which has been defined using information produced during a previous disposability assessment that resulted in the issue of an unqualified Final stage LoC.

A description of the means by which Final stage LoC endorsement of a packaging proposal can be achieved using a SWPD, and the manner in which submissions for such endorsement should be made, is available in *Guidance on the preparation of submissions for the disposability assessment of waste packages by use of a Standard Waste Package Description*, WPS/921 [16].

4.2 Application of the Disposability Assessment process to topic-specific assessments

Whilst disposability assessments are generally carried out to consider the suitability of proposals to package a specific waste in a specified container, the process can also be applied to consider particular aspects of a packaging proposal. Such topic-specific assessments can be undertaken to determine the suitability of a new design of waste container or a new waste conditioning process, for example. Topic-specific assessments may also be carried out to consider specific aspects of a packaging proposal, such as criticality safety, or in response to limited submissions that have been provided by waste packagers as a result of individual Action Points or requests for further information made by RWM at earlier assessment stages.

A topic-specific disposability assessment would generally take the same form as that for a full packaging proposal but would be limited to consideration of the issues directly related to the assessment topic. Therefore, a topic-specific submission would be expected to contain only those items discussed in Section 3 that are of direct relevance.

To illustrate the option of topic-specific assessments, the high-level expectations of a container-only submission are presented below.

4.3 Submission for a container-only disposability assessment

As discussed in [4], container-only assessments are limited to ensuring that a proposed waste container for appropriate wastes is compliant with the container-related requirements of the relevant packaging specification and that it is, in principle, capable of being used to manufacture disposable waste packages.

A Conceptual stage container-only assessment comprises determining whether the proposed waste container would be compliant with the relevant Generic Specification. If the container design does not comply with any WPS, the RWM *Geological Disposal System Change Management Procedure* will be invoked. This will involve a preliminary assessment of the container design to establish the basis for pursuing an innovative packaging proposal through the Conceptual stage assessment and to define a work programme that will deliver the necessary additional or expanded contributions to the Conceptual assessment.

Satisfactory completion of the preliminary assessment, confirming any necessary changes to the disposal system concept and safety case are feasible and appropriate, is required before Conceptual stage LoC endorsement of the container design can be offered.

Issues identified in the Conceptual stage assessment can subsequently be addressed by the waste packager; RWM is happy to review these as part of an Interim stage assessment of the proposed container design. However, RWM would generally not endorse a new container design by issue of an Interim stage LoC, because information about the combined behaviour of the waste and the waste container (if both are necessary to meet the package performance requirements) would not be available in a submission dealing only with the design of a container.

If an Interim stage disposability assessment were undertaken, then the format would largely follow that outlined above for the Conceptual stage and would comprise:

- review of the finalised container design and testing of compliance with relevant aspects of the disposal concepts, system designs and the relevant WPS;
- demonstration of compliance of the waste packages that could be manufactured using the container with the requirements for transport to and disposal in a GDF; and
- demonstration of the adequacy of the management system and data recording arrangements proposed to be applied to the development and manufacture of the containers.

The content of a container-only packaging submission, as would be expected, is focussed on the container-specific information requirements identified in Section 3. Key aspects of those requirements are summarised below, focused on the Conceptual and Interim stage container-specific requirements.

Production of the waste package

At the Conceptual stage the waste packager should describe the container type and provide outline container design details in order that the submission can be assessed for compliance with the relevant packaging specification(s). The construction materials and methods should be described, with additional evidence required for novel materials, and the handling arrangements for manufacture, transport and GDF operational should be outlined.

At the Interim stage the waste packager should present the finalised design, providing full manufacturing drawings and the manufacturing specification, and confirm all construction materials, techniques and handling arrangements, in order to demonstrate compliance with the relevant WPS.

Waste package properties and expected performance

At the Conceptual stage the waste packager should outline details of the potential wastes that might be packaged and/or define the intended wastes (if known) and demonstrate that limitations imposed by the Generic Specification, transport regulations and general performance issues are understood and have been considered in the container design. It should be made clear whether the containers are designed to be used for un-encapsulated wastes or if encapsulation is essential, or if both options are intended to be accommodated. The waste package properties should be demonstrated to be acceptable across all the expected environmental conditions for disposal.

At the Interim stage the waste packager should recognise any design details specific to particular wastes and demonstrate that these can be accommodated if necessary (e.g., internal furniture, waste baskets etc.). The submission should demonstrate that the performance of the resulting packages under normal and accident conditions meets requirements, including behaviour during transport, capacity for gas generation and means of accommodating gas generation through venting and/or toleration of pressurisation. This should be supported with modelling and other evidence as necessary.

Waste package evolution and maintenance of integrity

At the Conceptual stage the waste packager should demonstrate that the proposed containers would be capable of maintaining integrity (i.e., containment, surety of lifting features and ability to be stacked) for the required period before GDF closure. The role of

the container in ensuring integrity should be defined and understood, although it is noted this may also depend on a contribution from the wasteform.

At the Interim stage the waste packager should confirm that proposed containers would be capable of maintaining integrity for the required period, providing additional evidence and testing as necessary. Evidence to support the proposed monitoring arrangements should be provided.

Management systems and package records

At the Conceptual stage the waste packager should provide evidence that the design and development work has been performed under a suitable management system and demonstrate that the need to retain all relevant records has been recognised.

At the Interim stage the waste packager should continue to provide evidence that the design and development work has been performed under a suitable management system.

4.4 Periodic Review of Final stage LoCs

RWM has established a process for the Periodic Review of Final stage LoCs as a means of ensuring their continued validity over the extended period from the original endorsement of a packaging proposal to the time when waste packages are consigned for final disposal in a GDF [17]. The performance of a Periodic Review allows the disposability of the waste packages to be considered in the light of RWM's current plans for geological disposal and can use more recent assessment tools than those originally used at the time of the disposability assessment.

The conduct of a Periodic Review is similar in many respects to that of a Final stage disposability assessment, in that much of the process is aimed at confirming the validity of information considered previously. In addition, a Periodic Review will consider the outcomes of the previous Final Stage assessment and/or Periodic Review. Guidance on the conduct of and information requirements for Periodic Reviews is available in [17].

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- 14 NDA, *Waste Product Specifications: Guide to structure and format*, WPS/620/02, 2008.
- 15 NDA, *Waste Package Data and Information Recording Specification*, WPS/400/02, 2008.
- 16 NDA, *Guidance on the preparation of submissions for the disposability assessment of waste packages by use of a Standard Waste Package Description*, WPS/921/01, 2010.
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Appendix A RWM Disposability Assessment Aim and Principles

Disposability Assessment Aim	
The principal aim of the Disposability Assessment Process is to minimise the risk that the conditioning and packaging of radioactive wastes results in packages incompatible with geological disposal, as far as this is possible in advance of the availability of Waste Acceptance Criteria for a geological disposal facility. As such, it is an enabler for early hazard reduction on UK nuclear sites.	
Disposability Assessment Principles	
1	Independent disposability assessments are undertaken against published RWM Packaging Specifications and the documented disposal system concept and safety case.
2	A Letter of Compliance can be issued when proposed waste packages are assessed to be compliant with published RWM Packaging Specifications.
3	Proposed waste packages should not unnecessarily or disproportionately consume the resources for geological disposal or disposal system capacity.
4	A staged approach to the submission of information and, hence, the assessment and endorsement of proposed waste packages is encouraged, supported by active engagement with waste owners.
5	Resolution of outstanding issues arising from the assessment of proposed waste packages will be managed in a systematic manner to facilitate timely resolution.
6	The adoption of common waste packaging approaches and sharing of substantiated good practice in waste packaging is encouraged, subject to consistency with other principles.
7	Innovative approaches to the packaging of wastes that reflect the hazard presented will be facilitated, subject to consistency with other principles and an appropriate justification.
8	Where there are proposed to be multiple waste management steps prior to the production of a disposable package, these should not jeopardise, and ideally should facilitate, production of a disposable package.
9	The continued validity of Letters of Compliance will be ensured by a process of periodic review of the supporting disposability assessments and related information.
10	The principles of openness and transparency will be applied to the Disposability Assessment Process and RWM will engage with interested stakeholders in the process, subject to the constraints of security and commercial considerations.
Principles applying to Higher Activity Wastes arising in Scotland	
11	RWM recognises Scottish Government Policy and provides advice and endorsement of proposed packages for Scottish wastes based on Principles 1-10, based on the requirements of the geological disposal system.

Appendix B Disposability assessment objectives and requirements by stage

Conceptual Stage – standard approach
Purpose of Disposability Assessment process at this stage:
Establish that the proposed waste packages would, in principle, be compliant with RWM requirements as expressed under Principles 1-3.
The assessment process typically will be based on:
<ul style="list-style-type: none"> • suitably justified radionuclide inventory, and physical and chemical characteristics of the waste; • inferred package properties and performance under normal and accident conditions, based on analogy, reasoned argument or previously reported development work; • Generic Specification for packages containing the relevant type of waste; • the existing Disposal system concept and safety case.
The assessment process will have the objective of:
<ul style="list-style-type: none"> • reviewing consistency with the Generic Specification for packages containing the relevant type of waste; • producing an initial version of an Assessment of Disposability for the packages; • identifying development required to demonstrate compliance with detailed WPS for the package type; • requirements for the further development of the AoD
Requirements for endorsement:
<ul style="list-style-type: none"> • proposed packages shall comply with the Generic Specification for packages containing the relevant type of waste; • the initial AoD identifies no areas where compliance with RWM requirements cannot be demonstrated with sufficient confidence (Compliance Gaps); • no Conceptual stage Action Points remain open; • justified description of the waste, including radionuclide and physical/chemical characteristics; • commitment to meet RWM Management System and Data Recording requirements.

Interim Stage – standard approach
Purpose of Disposability Assessment process at this stage:
Determine that evidence has shown that the as-designed waste packages would be compliant with RWM requirements as expressed under Principles 1-3.
The assessment process typically will be based on:
<ul style="list-style-type: none"> • justified radionuclide inventory, and physical and chemical characteristics of the waste; • demonstrated package properties and performance under normal and accident conditions, substantiated as necessary by validated modelling; • draft documentation for the packaging process; • detailed Waste Package Specification for the package type; • the existing Disposal system concept and safety case, modified as necessary to accommodate initially innovative packages through change control.
The assessment process will have the objective of:
<ul style="list-style-type: none"> • reviewing consistency with the detailed Waste Package Specification for the package type; • confirming that all wasteform, waste package and container design development issues are resolved; • establishing that the properties and performance of the as-designed waste packages provide a satisfactory basis; • Identifying a draft CoA and/or Contents Specification, and showing compliance of the proposed waste packages with them. • producing an AoD based on the disposal system concept and safety case and using proven waste package characteristics; • identifying requirements for the development and implementation of management system arrangements for the operation of the packaging plant, including data recording and criticality compliance arrangements.
Requirements for endorsement:
<p>As for Conceptual stage, plus:</p> <ul style="list-style-type: none"> • proposed packages shall comply with the detailed WPS for the package type; • completion of the AoD with no areas where compliance with RWM requirements cannot be demonstrated (Compliance Gaps); • no Interim stage Action Points remain open; • waste packaging process fully developed and substantiated, and a viable processing envelope defined; • finalised waste container design and any associated stillages; • methodology for production of waste package records, including Criticality Compliance requirements; • outline Management System requirements defined, including arrangements for on-site interim storage; • demonstration that development work has been performed under a suitable Management System.

Final Stage – standard approach
Purpose of Disposability Assessment process at this stage:
Determine that evidence has shown that the as-manufactured waste packages would be compliant with RWM requirements as expressed under Principles 1-3.
The assessment process typically will be based on:
<ul style="list-style-type: none"> • an existing understanding of the waste and the process as determined previously at Interim stage; • description of the Management System arrangements governing the operation of the packaging plant and the on-site interim storage of completed packages; • approved documents as required by RWM, including WPrS, CCAD and methodologies for data recording and the monitoring and inspection of stored packages; • evidence of satisfactory operation based on plant commissioning.
The assessment process will have the objective of:
<ul style="list-style-type: none"> • confirming that the conclusions of the Interim stage assessment remain valid and that the AoD is applicable; • establishing that the Management System arrangements are suitably comprehensive and that the process will be implemented as it has been understood by RWM, including all arrangements for obtaining and managing waste package data; • Identifying a fully developed CoA and/or Contents Specification, and showing compliance of the proposed waste packages with them. • using inactive commissioning information to confirm plant functionality and that process variability is consistent with established compositional envelopes; • substantiating conclusions using active commissioning information (if the plant is actively commissioned), or defining the objectives of active commissioning (if the plant is to be actively commissioned after receipt of a Final stage LoC).
Requirements for endorsement:
<p>As for Interim stage, plus:</p> <ul style="list-style-type: none"> • all Final stage Action Points are closed; • all management system requirements defined, including data recording, criticality safety compliance and on-site interim storage; • all necessary documentation in place; • inactive commissioning completed, active commissioning completed or success criteria for active commissioning agreed.

Appendix C Submission contents checklist

The table below comprises a checklist that could be used as part of a quality plan for the preparation of a submission for a disposability assessment.

Submission topic area	Coverage	Submission stage focus		
		Conceptual	Interim	Final
Nature of the waste	<p>The site, plant and processes which generated the waste</p> <p>The current and historical storage arrangements</p> <p>The history of the current project, including optioneering, IWS, BAT</p> <p>Project plans</p> <p>Physical characteristics of the waste</p> <p>Major chemical components of the waste</p> <p>Radionuclide inventory of the waste and radiation sources</p> <p>Relationship between the information provided in the submission and the information provided for the most recently published UK RWI</p> <p>Safeguards status of the waste and future plans</p> <p>Description of nuclear materials accountancy arrangements</p> <p>Description of physical security and safeguard obligations and how these will be fulfilled</p> <p>Close out of Action Points from previous Assessment Report(s)</p>	High	Medium	Low
Production of the waste package	<p>Proposed waste retrieval process and waste treatment processes to be applied prior to waste packaging</p> <p>Waste packaging process including the waste container type and design features and any waste conditioning process and materials</p> <p>Details of the relationship between the submission information and the most recently published UK RWI concerning the waste packaging process</p> <p>Close out of Action Points from previous Assessment Report(s)</p>	Medium	High	Low

Submission topic area	Coverage	Submission stage focus		
		Conceptual	Interim	Final
Waste package properties and expected performance	Package physical, chemical and radionuclide composition and inventories which will arise from the proposed waste and packaging process Compliance with packaging specification requirements (e.g., activity and dose restrictions, heat output, pressurisation, free liquid content, hazardous materials, gas release, etc.) Immobilisation of radionuclides and particulates Radionuclide releases in impact and fire accidents IAEA Transport Regulations criteria Wasteform heterogeneity Close out of Action Points from previous Assessment Report(s)	Medium	High	Low
Waste package evolution and maintenance of integrity	Estimates of the effect of package ageing on the package properties and characteristics Waste package long-term integrity and durability Interim storage facilities and environmental conditions Proposed waste package monitoring system Close out of Action Points from previous Assessment Report(s)	Medium	High	Low
Criticality safety	Criticality safety case and SFM Criticality safety/fissile content restrictions CCAD Close out of Action Points from previous Assessment Report(s)	Medium	High	High
Transport safety	Compliance with CoA and/or Contents Specification Close out of Action Points from previous Assessment Report(s)	Low	Medium	High

Submission topic area	Coverage	Submission stage focus		
		Conceptual	Interim	Final
Management system	<p>The management system established, its implementation and maintenance, covering all safety, quality and data recording aspects for the entire lifetime of the package</p> <p>Compliance with RWM requirements for quality management</p> <p>When objective evidence has been, and will in future be, provided</p> <p>Overview of the plant management system WPrS</p> <p>Close out of Action Points from previous Assessment Report(s)</p>	Low	Medium	High
Package records	<p>Compliance with RWM requirements for data recording</p> <p>Waste package data recording methodology</p> <p>Methods to be applied to derive a waste stream and waste package physical/chemical and radionuclide inventory for recording</p> <p>Close out of Action Points from previous Assessment Report(s)</p>	Low	Medium	High

Glossary of terms used in this document

Assessment of Disposability (AoD)

A statement of the reasoning that allows the case to be made for the disposability of specific waste packages in a geological disposal facility. The AoD is progressively developed as the packaging process matures and the packaging plant is built and operated.

Certificate of Approval (CoA) for a package design

A certificate issued by the Competent Authority, or where this is not required issued by a body responsible for the approval of a package design. The Certificate of Approval for a package design will uniquely identify the package design and all of the instructions, limits and conditions that will apply to that package design.

conditioning

Treatment of a radioactive waste material to create, or assist in the creation of, a wasteform that has passive safety

container

The vessel into which a wasteform is placed to form a waste package suitable for handling, transport, storage and disposal.

Competent Authority

A body or authority designated or otherwise recognised as such for any purpose in connection with the IAEA Transport Regulations. In the UK, the Competent Authority for most aspects of the transport (for civil purposes) of radioactive material is the Secretary of State for Energy and Climate Change (delegated to ONR).

Contents Specification

A detailed description of the permitted contents of a package design. This may be part of the Certificate of Approval or be contained in a separate document. The Contents Specification will define the material that can be carried and the design safety report will demonstrate the safety of the design based on this content.

criticality

A state in which a quantity of fissile material can maintain a self-sustaining neutron chain reaction. Criticality requires that a sufficiently large quantity of fissile material (a critical mass) be assembled into a geometry that can sustain a chain reaction; unless both of these requirements are met, no chain reaction can take place and the system is said to be sub-critical.

criticality safety

A methodology used to define the conditions required to ensure the continued sub-criticality of waste containing fissile material.

Design Authority

A body or authority with the responsibility for, and the requisite knowledge to maintain the design integrity and the overall basis for safety of the package design throughout the full lifecycle of the package.

disposability

The ability of a waste package to satisfy the defined requirements for disposal.

disposal

In the context of solid waste, disposal is the emplacement of waste in a suitable facility without intent to retrieve it at a later date; retrieval may be possible but, if intended, the appropriate term is storage.

disposal facility (for solid radioactive waste)

An engineered facility for the disposal of solid radioactive wastes.

Disposal System Safety Case (DSSC)

The RWM generic DSSC is a suite of reports that will be developed as the disposal system progresses and will eventually form the basis for full, detailed safety cases that will be required in order to seek permission to undertake construction, transport or disposal operations. The underpinning reports provide more detail on the transport, operational safety and environmental safety of a geological disposal system.

enrichment (uranium)

The proportion (usually expressed as a % of the total mass) of uranium-235 in uranium.

fissile material

Fissile material is that which undergoes fission under thermal neutron irradiation. For regulatory purposes material containing any of the following nuclides is considered to be 'fissile': uranium-233, uranium-235, plutonium-239 and plutonium-241.

Generic Specification

The RWM packaging specifications define the bounding features and performance requirements for waste packages that would be compatible with the anticipated needs for transport to and disposal in a GDF. Formed of a hierarchy of three levels, the Generic Specification (Level 2) applies the high-level requirements in the Level 1 Generic Waste Package Specification to packages containing a broad category of waste.

Generic Waste Package Specification (GWPS)

The RWM packaging specifications define the bounding features and performance requirements for waste packages that would be compatible with the anticipated needs for transport to and disposal in a GDF. Formed of a hierarchy of three levels, the top-level GWPS (Level 1) defines the high-level requirements for all waste packages destined for geological disposal.

geological disposal

A long term management option involving the emplacement of radioactive waste in an engineered underground geological disposal facility or repository, where the geology (rock structure) provides a barrier against the escape of radioactivity and there is no intention to retrieve the waste once the facility is closed.

geological disposal facility (GDF)

An engineered underground facility for the disposal of solid radioactive wastes.

geological disposal system

All the aspects of the waste, the disposal facility and its surroundings that affect the radiological impact.

geological environment

The structure, composition and physical and chemical characteristics of the rocks that make up the geosphere.

hazardous materials

Materials that can endanger human health if improperly handled. As defined by the Control of Substances Hazardous to Health Regulations, 2002.

Health and Safety Executive (HSE)

A statutory body whose role is the enforcement of work related health and safety law. HSE is the licensing authority for nuclear installations. HSE exercises this authority through and Executive Agency – the Office for Nuclear Regulation.

higher activity radioactive waste

Generally used to include the following categories of radioactive waste: low level waste not suitable for near surface disposal, intermediate level waste and high level waste.

high level waste (HLW)

Radioactive wastes in which the temperature may rise significantly as a result of their radioactivity, so this factor has to be taken into account in the design of storage or disposal facilities.

immobilisation

A process by which the potential for the migration or dispersion of the radioactivity present in a material is reduced. This is often achieved by converting the material to a monolithic form that confers passive safety to the material.

intermediate level waste (ILW)

Radioactive wastes exceeding the upper activity boundaries for LLW but which do not need heat to be taken into account in the design of storage or disposal facilities.

International Atomic Energy Agency (IAEA)

The IAEA is the world's centre of cooperation in the nuclear field. It was set up as the world's "Atoms for Peace" organization in 1957 within the United Nations family. The Agency works with its Member States and multiple partners worldwide to promote safe, secure and peaceful nuclear technologies.

Letter of Compliance (LoC)

A document, prepared by RWM, that indicates to a waste packager that a proposed waste package is compliant with the relevant packaging criteria and disposal safety assessments, and is therefore deemed to be compatible with the requirements for storage, transport, handling and disposal.

low level waste (LLW)

Defined as "radioactive waste having a radioactive content not exceeding 4 gigabecquerels per tonne (GBq/te) of alpha or 12 GBq/te of beta/gamma activity".

management system

The overall system by which an organisation determines, implements and ensures safety, quality and data recording throughout the lifetime of the waste package.

Nirex (United Kingdom Nirex Limited)

An organisation previously owned jointly by Department for the Environment, Food and Rural Affairs and the Department for Trade and Industry. Its objectives were, in support of Government policy, to develop and advise on safe, environmentally sound and publicly acceptable options for the long-term management of radioactive materials in the United Kingdom. The Government's response to Committee on Radioactive Waste Management in October 2006 initiated the incorporation of Nirex functions into the NDA, a process which was completed in March 2007.

Nuclear Decommissioning Authority (NDA)

A non-departmental public body created through the Energy Act 2004. The NDA is a strategic authority that owns 19 UK sites and the associated civil nuclear liabilities and assets of the public sector, previously under the control of UKAEA and BNFL. It reports to the Department of Energy and Climate Change (DECC); for some aspects of its functions in Scotland, it is responsible to Scottish Ministers.

nuclear licensed site

Any site which is the subject of a license granted by the Office of Nuclear Regulation (part of the HSE) under the Nuclear Installations Act 1965. Nuclear licensed sites include nuclear power stations, nuclear fuel production and reprocessing sites, sites undertaking storage of and/or research into nuclear materials, and major plant producing radioisotopes.

nuclear material

Fissile material or material that can be used to produce fissile material (i.e. source material). This includes all isotopes of uranium, plutonium and thorium, together with certain isotopes of neptunium and americium.

passive safety

The need to provide and maintain a safety function by minimising the need for active safety systems, monitoring or prompt human intervention. Requires radioactive wastes to be immobilised and packaged in a form that is physically and chemically stable. The package should be stored in a manner that is resistant to degradation and hazards, and which minimises the need for control and safety systems, maintenance, monitoring and human intervention.

post-closure period (of a disposal facility)

The period following sealing and closure of a facility and the removal of active institutional controls.

Radioactive Waste Management Ltd (RWM)

A wholly owned subsidiary of the NDA established to design and build an effective delivery organisation to implement a safe, sustainable, publicly acceptable geological disposal programme. Ultimately, RWM will evolve under the NDA into the organisation responsible for the delivery of the GDF. Ownership of this organisation can then be opened up to competition, in due course, in line with other NDA sites.

safeguards

Measures used to verify that nation states comply with their international obligations not to use nuclear materials (plutonium, uranium and thorium) for nuclear explosives purposes. Global recognition of the need for such verification is reflected in the requirements of the Treaty on the Non-Proliferation of Nuclear Weapons (NPT) for the application of safeguards by the International Atomic Energy Agency. Also, the Treaty Establishing the European Atomic Energy Community (the Euratom Treaty) includes requirements for the application of safeguards by the EC.

safety case

A 'safety case' is the written documentation demonstrating that risks associated with a site, a plant, part of a plant or a plant modification are as low as reasonably practicable and that the relevant standards have been met. Safety cases for licensable activities at nuclear sites are required as license conditions under NIA65.

Transport Regulations

The IAEA *Regulations for the Safe Transport of Radioactive Material* and/or those regulations as transposed into an EU Directive, and in turn into regulations that apply within

the UK. The generic term 'Transport Regulations' can refer to any or all of these, since the essential wording is identical in all cases.

UK Radioactive Waste Inventory (UKRWI)

A compilation of data on UK radioactive waste holdings, produced about every three years. The latest version, for a holding date of 1 April 2013, was published in February 2014. It is produced by DECC and the NDA. It is the latest public record of information on the sources, quantities and properties of LLW, ILW and HLW in the UK. It comprises of a number of reports and additional detailed information on the quantities and properties of radioactive wastes in the UK that existed at 1 April 2013 and those that were projected to arise after that date.

waste acceptance criteria (WAC)

Quantitative and/or qualitative criteria, specified by the operator of a disposal facility and approved by the regulator, for solid radioactive waste to be accepted for disposal.

waste container

Any vessel used to contain a wasteform for disposal.

wasteform

The waste in the physical and chemical form in which it will be disposed of, including any conditioning media, capping grout and container furniture (i.e. in-drum mixing devices, dewatering tubes etc.) but not including the waste container itself.

waste package

The product of conditioning that includes the waste form and any container(s) and internal barriers (e.g. absorbing materials and liner), as prepared in accordance with requirements for handling, transport, storage and/ or disposal.

waste packager

An organisation responsible for the packaging of radioactive waste in a form suitable for transport and disposal.

Waste Package Specification (WPS)

The RWM packaging specifications define the bounding features and performance requirements for waste packages that would be compatible with the anticipated needs for transport to and disposal in a GDF. Formed of a hierarchy of three levels, each WPS (at Level 3 they are the most detailed of the specifications) defines the requirements for the transport to and geological disposal of waste packages manufactured using a standardised design of waste container that have been shown to be compatible with RWM's current plans for geological disposal for the packaging of a specific category of waste

Waste Package Specification and Guidance Documentation (WPSGD)

A suite of documents prepared and issued by RWM that are intended to provide a 'user-level' interpretation of the RWM packaging specifications, and other aspects of geological disposal, to assist UK waste packagers in the development of plans for the packaging of higher activity waste in a manner suitable for geological disposal.



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