LLW Repository Ltd

Nuclear Decommissioning Authority

UK Management of Solid Low Level Radioactive Waste from the Nuclear Industry

Guidance for the Segregation and Management of Low Level Waste from the Nuclear and Associated Industries

October 2011

Document History

Rev.	Issue Date	Description	Prepared by	Checked by	Approved by
Rev A0	December 2010	Draft Issue for comment	K Dodd	A Laker	D. Rossiter
Rev A1	October 2011	Issue 1 for comment	K Dodd	L Eden	D. Rossiter

Executive Summary

This document provides guidance on effective Low Level Waste (LLW) Segregation Best Practice with specific reference to proposals to establish a common approach to segregation supported by a coding system based on the Low Level Waste Repository service provision. This guide recognises the importance of the Waste Hierarchy (WH) to the management of LLW.

This Guidance has been designed to be deployed as an electronic sign post document for waste managers and others who may be required to contribute to establishing arrangements to manage LLW. It is the intention of Low Level Waste Repository (LLWR) to modify this document as practices change and evolve.

The document details the importance of effective Waste Segregation for the effective implementation of the waste hierarchy as well as providing the means to minimise waste management costs.

The document provides a definition of segregation and guidance on segregation best practice, appropriate management arrangements, and regulatory policy and framework. In addition the guidance details proposals for a National Coding system to support the segregation of LLW. Whilst this system is not mandatory, a coding approach is considered critical to effective segregation practice. Such systems are utilised throughout conventional industry to ensure effective implementation of the waste management hierarchy. The guidance also discusses segregation facility design and practice.

The document has been submitted as Revision 1 as a milestone in the delivery of initiative WAM1; a requirement of the UK Nuclear Industry LLW Strategy and Management Plan [1]. It is the intention that the next iteration will incorporate stakeholder comments.

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Contents

1 Introduction

Waste Segregation is key to effective LLW Prevention, Minimisation and subsequent management

1 Introduction

1.1 What does the purpose of this guidance?

The purpose of this guidance is to promote effective LLW segregation. The segregation of LLW is considered essential to the implementation of the waste hierarchy, and UK LLW policy and compliance with regulatory requirements.

This guidance also proposes a coding scheme to promote effective waste segregation at or as close to the point of generation as possible. This scheme, whilst not mandatory, supports the LLWR service offering and aligns with waste management practices in conventional industries. At the very least this provides an example of best practice.

The document has been submitted as Revision 1 as a milestone in the delivery of initiative SC 1 and 3; a requirement of the UK Nuclear Industry LLW Strategy [2] and Management Plan. It is the intention that the next iteration will incorporate stakeholder comments.

1.2 What does this guidance cover?

This Guidance:

- Describes and emphasises the importance of the appropriate segregation of Low Level Waste and its fundamental role in implementing the waste hierarchy;
- Describes the policy and regulatory requirements supporting application of segregation and the waste hierarchy;
- Proposes a national coding scheme to facilitate LLW segregation at or as close to the point of generation as possible, aligned to current and future LLWR services;
- Provides information on segregation facility design and practice;
- Provides advice on appropriate management arrangements;
- Provides advice on subsequent waste transport requirements in so far as it impacts on segregation practice.

1.3 Who is this guidance for?

The guidance has been written for all sites that generate or have the potential to generate LLW and consign this to the LLWR. In particular the guidance is aimed at waste managers, facilities managers, and others who may contribute to waste management procedure and practice development and implementation.

The guidance has also been produced for those organisations supporting the nuclear industry in, for example, a design or decommissioning capacity. It outlines the requirements that may be placed on them to ensure effective LLW segregation.

2 What is Segregation?

Segregation ensures the effective implementation of the Waste Hierarchy

2 What is Segregation

2.1 The Waste Hierarchy

The Waste Hierarchy establishes a hierarchy of management options in the context of increasing environmental impact, and is based on the simple premise that it is better to avoid waste generation than to treat or dispose of waste. For LLW management, this concept is very important as the liabilities associated with the management of LLW can be significant.

The principles established in the Waste Hierarchy underpin good LLW management practices. Avoiding waste generation is considered a priority, whilst disposal should only be considered as a last resort. By moving up the Waste Hierarchy, sites will save money, minimise raw material consumption, and reduce overall environmental impact. Capacity at the LLWR will also be preserved.

Figure 1 provides an overview of the waste hierarchy as it applies to LLW.

Joint regulatory guidance has confirmed that Waste Minimisation is a fundamental principle of radioactive waste management and that the Waste Management Hierarchy is a stepwise approach to achieving this [3].

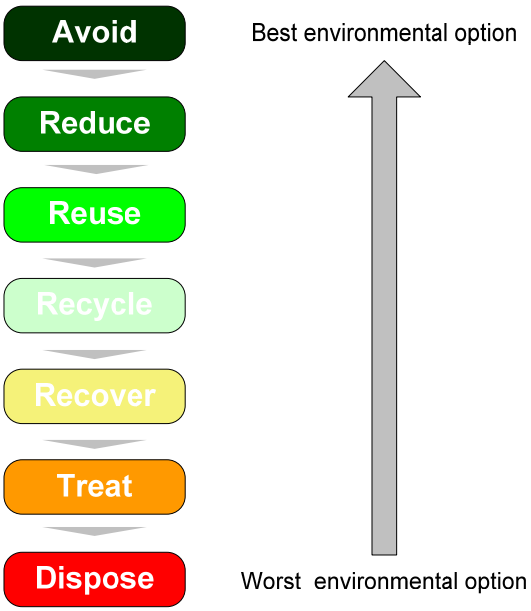


Figure 1 The Waste Hierarchy

Segregation of wastes is a fundamental prerequisite for the effective implementation of the Waste Hierarchy. Without the effective segregation of wastes, materials are mixed and opportunities to utilise alternative waste options to disposal are lost.

Segregation practices can also help to prevent contamination of conventional wastes with radioactivity.

2.2 Segregation

Segregation is a simple concept; waste is separated to facilitate application of the waste hierarchy into waste suitable for recycling, recovery, reuse, or treatment of waste instead of disposal. Segregation is often termed a pre-treatment process.

The IAEA [4] defines segregation as '*an activity where waste or materials (radioactive or exempt) are separated or kept separate according to radiological, chemical and / or physical properties which will facilitate waste handling and / or processing*'

The EA advises [5] that segregation:

- Should be based on the type of waste and classification and the most appropriate treatment and disposal option;
- Into suitable colour-coded containers is good waste management.

This guidance adopts this approach. In the context of LLW, classification through accurate characterisation is essential. This, together with a number of additional considerations, (such as the requirement to keep exposure to radiation As Low As Reasonably Practicable (ALARP) during activities such as waste handling, decommissioning practices etc.) will determine the most appropriate waste route.

The Low Level Waste Repository waste services are aligned to the waste hierarchy; specifically recycle, recover, treat and dispose. This forms the basis of classification by type and activity. This is discussed further in Section 4.

A proposal to establish a common system for colour coding, based on the LLWR service offering, is presented in Section 5.

2.3 Principles

This guidance promotes the following principles / standards to support effective waste management and segregation:

1. Segregation is fundamental to the implementation of the waste hierarchy;
2. Waste should be segregated at or as close to the point of generation as possible;
3. Segregation practice should ensure employee and environmental safety;
4. Segregation systems should be as simple and easy as possible to understand ensuring implementation.

2.4 Benefits of Segregation

Effective segregation offers a number of important benefits:

- Enables the implementation and operation of the waste management hierarchy and realises opportunities for recycling, reuse and disposal;
- Realises cost savings on waste disposal; specifically for conventional wastes and VLLW disposal to suitable facilities other than LLWR;
- Opportunities to release valuable commodity to the market place (e.g. metal);
- Potential for waste reuse on site (e.g. soils and rubble) thus saving disposal and transport costs.

Priorities for successful segregation are provided (in the form of a checklist) in Section 11 of this document.

3 Policy and Regulatory Framework

Effective waste management and segregation is a requisite of UK LLW policy and supporting legislation.

3 Policy and Regulatory Framework

3.1 Introduction

UK LLW policy and regulation requires effective waste management and segregation practices to be carried out.

Waste segregation, underpins the waste management hierarchy and is an implicit and explicit requirement in three areas of legislation and supporting guidance as shown in Figure 2.

Figure 2 Regulatory Drivers for waste management and segregation

3.2 Policy for the Long Term Management of Solid LLW in the UK

The UK policy for the management of Solid Low Level Waste [6] emphasises the importance of the waste hierarchy and states that:

'*LLW managers should plan to manage their wastes in accordance with the Waste Management Hierarchy principles established in the UK Waste Strategy documents'.*

The policy states that for LLW, implementation of the waste hierarchy means:

- Reducing waste arisings by activity and mass to a minimum through the appropriate design and operation of processes and equipment and making effective use of techniques such as waste characterisation, sorting and segregation, volume reduction and surface contamination removal;
- Minimising quantities of LLW requiring disposal through decay storage, re-use and / or recycling, and incineration;
- Disposal.

In addition the UK Policy supports and encourages new developments in the field of appropriate segregation of LLW at source.

It is clear therefore that the requirement to segregate is a fundamental element of the waste hierarchy, essential to the selection of an appropriate waste management option and embedded in UK National Policy.

3.3 UK Nuclear Industry LLW Strategy for the Management of Solid Low Level Radioactive Waste

The UK strategy for the management of Solid Low Level Waste has been published [2]. This document clearly articulates a vision for the management of LLW through application of the waste hierarchy:

'The UK strategy for the management of solid low level radioactive waste from the nuclear industry will facilitate continued hazard reduction and decommissioning through application of the waste management hierarchy'.

In addition, the strategy provides, through a number of key principles, a framework by which the strategy should be implemented. These principles reference segregation.

'Effective characterisation and segregation of waste and material that will become waste is critical to flexible management of LLW'.

In addition the strategy also notes the following:

- Waste being appropriately characterised at source, segregated and sentenced so as to not foreclose a range of appropriate waste management options is fundamental to waste avoidance;
- Sorting and segregation is essential to utilising the different approaches to the management of waste;
- In addition to the current practice of segregating into compactable and non-compactable wastes, segregation into different types and categories, preferably at source (where practicable and recognising the requirement to keep exposure to radiation ALARP; Section 5) is critical to success;
- Development of LLW services to encourage greater segregation (Section 4).

3.4 HSE Guidance

The HSE utilises the Safety Assessment Principles (SAPs) [7] to assess safety cases and relates specifically to nuclear safety and radioactive waste management. The aim of the SAPs is to provide NII inspectors with a framework for consistency during the evaluation of safety cases. The SAPs are thus one of the principal regulatory tools utilised to enforce regulation and in the context of radioactive waste management require segregation practices to be implemented:

- ENM 5 Characterisation and Segregation; Nuclear matter should be characterised and segregated to facilitate its safe management;
- RW 4 Characterisation and Segregation; radioactive waste should be characterised and segregated to facilitate subsequent safe and effective management.

Effective systems for LLW segregation will assist sites to meet these Safety Assessment Principles.

The Technical Assessment Guides (TAG) produced by the HSE [8] detail the approach taken by the NII in regulating radioactive material and waste on nuclear licensed sites. The TAG on the management of radioactive materials and radioactive waste on nuclear licensed sites [10] states that:

> *'NII requires that, so far as is reasonably practicable, radioactive material and radioactive waste should be characterised and segregated in order to facilitate safe and effective management and disposal*

The TAG further states that segregation:

- Is most appropriately completed during operations as close to the point of generation as possible and;
- Early and appropriate segregation can contribute significantly to the effective and safe management of radioactive materials and radioactive waste if completed early and if appropriate.

3.5 Nuclear site Licence Conditions

The HSE has developed 36 standard nuclear site licence conditions to attach to all nuclear licences[9]. Whilst they do not specifically detail segregation requirements, two conditions specifically relate to radioactive waste:

- LC 32 Accumulation of Radioactive Waste;
- LC 33 Disposal of Radioactive Waste.

3.6 Environmental Permitting Regulations 2010

Radioactive Substance Regulation (RSR) has been incorporated into the Environmental Permitting

Programme [10],[11],[1] The principle change is the replacement of Best Practicable Environmental Option (BPEO) / Best Practicable Means (BPM) with Best Available Technique (BAT). Scotland retains the Radioactive Substances Regulations 1993 and BPM. Permit conditions include reference to employing BPM / BAT to minimise the activity of radioactive waste produced on a site.

An example [12] of an authorisation clause related to the management of waste is provided below

> 'The operator shall use Best Practical Means to:
>
> (a) Minimise the volume of radioactive waste disposed of by transfer to other premises;
>
> (b) Dispose of radioactive waste at times, in a form and in a manner so as to minimise the radiological effects on the environment and members of the public.

Whilst not explicit, it is evident that an effective segregation system can assist in meeting these objectives particularly if it helps avoid waste disposal.

3.7 Nuclear Sector Plan

The second issue of the Nuclear Sector Plan [13] was published in July 2009. This document details the environmental objectives against which the nuclear sector will be measured. It reflects the issues that are considered important to both the regulator and the nuclear industry.

[1] Scotland will retain RSA 1993

The objective established for LLW emphasises the importance of the waste hierarchy in the management of waste arisings:

Objective - LLW Management: operator will use the waste management hierarchy as much as possible and minimise use of LLWR as a national asset.

In this context operators are required to report the percentage of LLW sent for:

- Reuse or recycling;
- Disposal via routes other than LLWR (e.g. incineration, HV VLLW to landfill);
- Disposal to LLWR.

Compliance with this objective will require sites to adopt appropriate systems for waste segregation. Subsequent iterations will report on progress and may in fact require more detailed information on application of the waste hierarchy to be supplied.

3.8 Joint Regulatory Guidance

The HSE, EA and SEPA have developed joint regulatory guidance. This guidance is focussed on the management of higher activity waste and provides a useful insight into regulatory priorities and the central role of the waste hierarchy and segregation in regulation. Guidance is available in the following areas:

- The Regulatory process [14];
- An introduction to the management of higher-level radioactive waste on nuclear licensed sites [15];
- Managing information relating to radioactive waste in the United Kingdom [16];
- Waste minimisation, characterisation and segregation [17];
- Radioactive Waste Management Cases [18].

The guidance recognises the importance of segregation; '*Segregation of waste materials at source provides an efficient means of managing waste in relation to their hazard*'.

3.9 Other Relevant Guidance

The following guidance further reinforces the importance of segregation to any waste management system:

- IAEA-TECDOC-1537 Strategy and methodology for radioactive waste characterisation [19];
- Clearance and exemption Principles, Processes and Practices for Use by the unclear Industry; a Code of Practice [20];
- LLWR Waste Acceptance Criteria [21].

> *'Waste should not be consigned for disposal if reasonably practicable measures could be adopted to segregate its constituent parts such that alternative waste treatment and / disposal services could be used to reduce the final volume requiring disposal at the Low Level Waste Repository or to avoid disposal at the Low Level Waste Repository'*

Section L1.1 of the LLWR Low Level Waste Disposal Waste Acceptance Criteria states [22]:

4 Definitions, Characterisation, Classification

The accurate characterisation of waste is essential to ensure appropriate classification to support segregation.

4 Definitions, Classification, Characterisation

4.1 Introduction

This Section outlines:

- The definitions and classification applied to the waste hierarchy and LLW in the UK and alignment with current LLW waste services;
- The role of characterisation in appropriate segregation;
- The approach adopted by the Clearance and Exemption Working Group.

4.2 Segregate or Sort?

The terms **Segregate** and **Sort** are often used together or interchangeably. Clearly their meanings are slightly different.

Segregate is defined by IAEA as: '*An activity where waste or materials (radioactive or exempt) are separated or kept separate according to radiological, chemical and / or physical properties which will facilitate waste handling and / or processing*'

In contrast Sort has no formal definition in the nuclear industry but details the task where waste types are identified prior to segregation. The sorting operation determines whether waste is to be segregated by treatment or type. In practical terms there is little difference and this guide suggests that Segregate is used in preference to Sort.

4.3 Low Level Radioactive Waste

Low Level Radioactive waste is defined as [6]:

'*radioactive waste having a radioactive content not exceeding 4 gigabecquerels per tonne (GBq/te) of alpha or 12 GBq/te of beta/gamma radioactivity*'

In addition there are two other waste classifications that are pertinent to this guidance:

- Very Low Level Waste (VLLW) - sub-classified as:
  - Low volume very low level waste
  - High volume very low level waste
- Exempt waste – determined by compliance with exemption orders.

Figure 3 shows the UK waste classifications.

LLW and VLLW includes metals, soil, building rubble and organic materials. Metals principally arise as lightly contaminated miscellaneous scrap including redundant equipment. Organic or other combustible materials are mainly in the form of paper towels, clothing and laboratory equipment that have been used in areas where radioactive materials may have been used – such as hospitals, research establishments and industry. LLW contains radioactive materials other than those acceptable for disposal with municipal and general commercial or industrial waste. Soils arise from land contaminated by radioactivity.

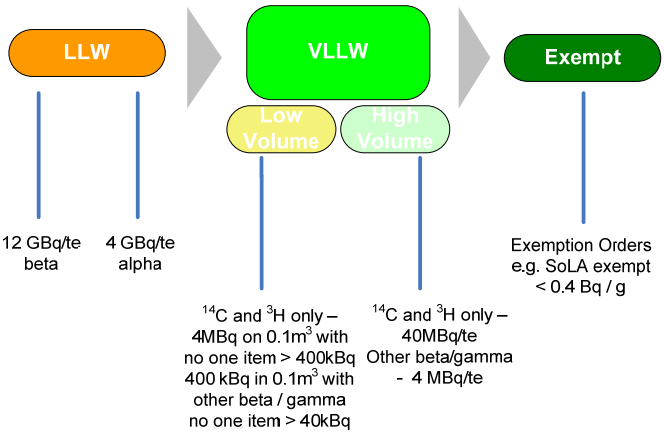


Figure 3 UK Waste Classifications

4.4 Low Level Waste Repository Services Area Definitions

The LLWR has established a number of services focused on disposal and treatment routes for LLW or VLLW:

- Waste Packaging;
- Metallic Waste Treatment;
- Combustible Waste Treatment;
- Supercompactable Waste Treatment;
- Very Low Level Disposal;
- Low Level Waste Disposal.

In support of this service provision LLWR has designed a series of colour coded labels and simple definitions [23]; Table 1

Recycling Option

Waste treated by decontamination, blasting or melting to remove radiological content.

Secondary waste may be returned to LLWR for disposal.

Treatment Option

Waste treated by incineration. Secondary waste may be returned to LLWR for disposal.

Volume Reduction Option

Waste treated by shredding and/or high force compaction to reduce volume.

Waste may be transferred to LLWR for final disposal.

Waste consigned to landfill for Disposal

Waste selected as being suitable for disposal at appropriately registered VLLW landfill.

Waste consigned to LLWR for disposal

Waste not suitable or selected for treatment, or waste that has already been treated or any secondary waste from a treatment process.

Table 1 LLW Service Provision and Definitions

Effective segregation is a precursor to sites being able to access these services.

These services are aligned to the waste management hierarchy as shown in Figure 4.

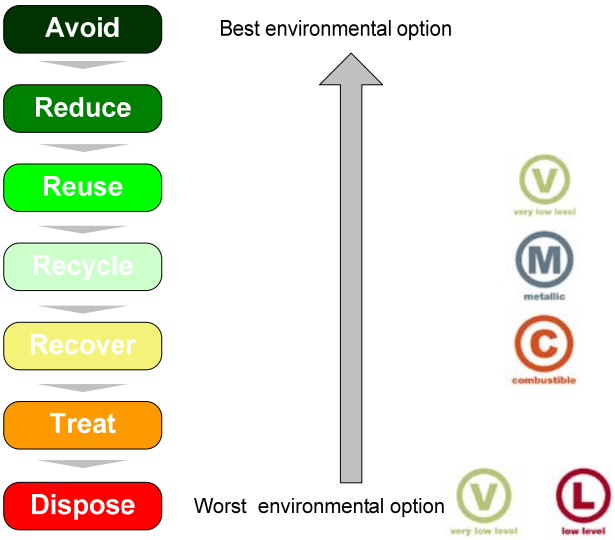


Figure 4 Alignment of LLW Service Provision with Waste Hierarchy

4.5 Radioactive Waste and Transport

The transport of radioactive waste on road is subject to regulatory control by:

- The Carriage of Dangerous Goods and Use of Transportable Pressure Equipment Regulations 2009 (CDG 2009), and the

- Accord européen relatif au transport international des marchandises dangereuses par route, ADR

Guidance on sea and air transport is provided by:

- Sea – International Maritime Dangerous Goods Code 2008 Edition Inc Am 34-08
- Air – International Aviation Transport Association (IATA) Technical Instruction for the Safe Transport of Dangerous Goods by Air

Transport requirements should be considered during the planning of a segregation system. Further guidance is provided in Section 8.

4.6 Characterisation and Waste Assessment Framework

The nuclear industry, as a whole, is in transition from operations to decommissioning and site remediation. The challenges presented by decommissioning and site remediation and the associated radioactive waste management issues cannot be under-estimated. The preferred hierarchy for wastes: avoid, minimise, re-use, recycle, dispose, as stated in Government Policy should be the principal objective for the management of all materials and wastes, including those containing radioactivity.

Radiological characterisation is the technique of determining the radiological properties of a material using a combination of studying the material's provenance, in-situ measurements and intrusive sampling.

Characterisation is defined by the IAEA [4] as:

'*the determination of the physical chemical and radiological properties of the waste to establish the need for further adjustment, treatment or conditioning, or its suitability for further handling, storage or disposal*'

Effective characterisation is an essential precursor to segregation. It is only through understanding the radiological properties of the waste that it can be appropriately segregated. Whilst radiological properties take precedence, an understanding of other hazardous properties may also be required before identifying a waste route.

The UK Nuclear Industry clearance and exemption working group has established comprehensive guidance to support clearance and exemption [24].

What comes first; Segregation or Characterisation?

It depends! It may be appropriate to complete preliminary characterisation; perhaps a review of historical data to identify initial segregation requirements. In contrast it may be that preliminary in-situ measurement is sufficient to identify segregation requirements, prior to comprehensive characterisation.

For facilities receiving Low Level Waste it is fair to assume that characterisation has already been completed and segregation can begin. Knowing the radiological conditions makes segregation easier.

5 Waste Segregation and Identification– a standard approach

Segregation of LLW into appropriately identified packaging is essential to effective waste minimisation and practical waste management; a simple coding system will facilitate this

5. Waste Segregation and Identification – a Standard Approach

5.1 Introduction

The key to practical waste management is segregation at the point or as close to the point of production as possible. Successful segregation is based on knowing the radiological characteristics as well as the treatment and disposal routes. Once these options have been identified, the application of a simple coding system for waste will ensure that waste can be effectively segregated in an operational situation. This is considered best practice (see Appendix 4) and is common place in conventional waste management. However, the development of UK LLW Policy and a supporting strategy could be ably supported by a National Coding system based on the LLWR's LLW service offering. This section of the guidance proposes such a system. Whilst not mandatory, it may provide an operator with an example of a best practice approach.

5.2 LLWR LLW Services

Within each waste category (e.g. LLW), the NDA groups waste either by the method available to treat the waste or the destination of the material [25].

The LLWR has adopted this approach to describe their segregated waste service offering. To promote and improve communication, the LLWR has visually represented their services by a logo for each; distinguished by colour and a letter as shown in Figure 5 below.

Figure 5 Visual Representation of LLWR Segregated Waste Services

Waste is identified for one of the treatment or disposal options and optimum packaging can be identified through the packaging services available.

Appropriate segregation of radioactive waste is not only critical to the safe management of LLW but also assists in meeting the requirements of the waste hierarchy. Cost management is also important and effective segregation will assist sites in consigning waste to the most cost effective waste management route. For example failure to segregate metallic LLW for disposal will result in increased disposal costs as well as the loss of a potential asset. Figure 6 presents further information on the coding system for LLW indicating the treatment technique, the applicable waste types and content and the secondary designation for the waste.

			Example Symbols and Colour Code
M metallic	Indicative Treatment/ Disposal Option	Treatment: Shot blasting and/or melting	M STAINLESS STEEL
	Waste Type	Metal: surface contaminated with radioactivity Classified as VLLW or LLW	M CARBON STEEL
	Example Contents	Tanks, plates, cables, white goods, scaffold pipes May be subject to secondary packaging	
	Secondary Designation	Stainless steel, lead, copper, ferrous, alloy, aluminium, mixed	M COPPER
C combustible	Indicative Treatment/ Disposal	Treatment: incineration Disposal of secondary waste to LLWR	C PLASTIC
	Waste Type	Solid or liquid combustible waste contaminated with radioactivity Classified as VLLW or LLW	C PPE
	Example Contents	PPE, plastic, wood, paper, cardboard, oil	C MIXED
	Secondary Designation	PPE, plastic, wood, paper, cardboard, mixed, oil	C OIL
S supercompactable	Indicative Treatment/ Disposal	Treatment: Supercompaction Disposal of compacted waste at LLWR	S PPE
	Waste Type	Compactable waste Classified as VLLW or LLW	S MIXED
	Example Contents	PPE, plastic, wood, paper, cardboard	S PLASTIC
	Secondary Designation	PPE, plastic, wood, paper, cardboard, mixed, oil	
V very low level	Indicative Treatment/ Disposal	Disposal	V RUBBLE
	Waste Type	Waste destined for disposal at approved landfill sites	V SOIL
	Example Contents	Rubble, soil	V MIXED
	Secondary Designation	Rubble, soil, mixed	
L low level	Indicative Treatment/ Disposal	Disposal	
	Waste Type	Waste destined for disposal at the LLWR	
	Example Contents	NORM, Mixed	
	Secondary Designation	NORM, mixed	

Figure 6 Example of a Coding System for LLW

The secondary designation will provide additional detail to the primary symbol and recognises that there will be occasions when further segregation is beneficial.

Such a sign could be used to label segregation areas or individual waste packages.

The proposed system is not mandatory However, it is considered best practice that this or a similar system is embraced and implemented at sites. A National system is preferable as it ensures continuity across the industry and would facility effective LLW management.

The RGB colours used in the LLWR system are presented in Table 2 below:

	RGB Value
M metallic	R:107 G:121 B:130
C combustible	R:184 G:80 B:39
S supercompactable	R:130 G:162 B:190
V very low level	R:138 G:103 B:69
L low level	R:181 G:9 B:55

Table 2 RGB Values for LLWR Coding System

6 Segregation Facility Design

The appropriate design of the waste segregation facility will ensure that operations are safe and can support effective waste minimisation and management.

6. Segregation Facility Design

6.1 Introduction

The design of a segregation facility is not prescriptive, as the physical and radiochemical properties of the waste will have an important impact on the design. Where practicable, this guidance seeks to consider both operational and project specific waste campaigns and the requirements for each may be different. However, certain common themes can be identified and these are discussed in this section.

Health Physics is also of critical importance in the design of a segregation facility and provision may be required for a separate work and storage area. This is also considered in this section.

This Section should be read in conjunction with Section 7.

6.2 Common Themes

Location of Segregation Facilities and Work Area

Guidance on the location of facilities for the segregation of waste can never be prescriptive as it must consider the nature of the wastestream and type of activities leading to generation of the waste. However, it is advised that segregation facilities should be located as close to the point of waste generation as possible. Such facilities must be adequately equipped to handle the waste as well as to manage the radiological conditions.

Understanding the potential waste streams is requisite prior to designing segregation facilities, for example, understanding the space requirement is a priority. Depending on the type of waste and waste volumes the containers required may take up significant space. This information will also determine the requirement for plant, tools and equipment.

Ideally an area will have sufficient space to manage all the wastes identified at the planning stage with additional capacity for perhaps forklift truck movement, waste handling and administration area (particularly important for the final sentencing area) etc..

At its simplest, the facility may be just an area for transferring segregated waste into storage containers. At its most complex, the facility will incorporate plant (conveyors, cranes etc.) tools (e.g. cutting equipment for size reduction at the work face) and equipment (e.g. FLT, monitoring equipment, lifting equipment).

Segregation at the Point of Generation

As previously noted, best practice is to establish segregation facilities as close to the point of generation as possible. Such practice encourages employees to comply with segregation requirements. In addition, particularly in the context of managing a radioactive hazard, this practice limits:

- Exposure (keeping it ALARP), and,
- Opportunity to cross contaminate waste streams.

Segregation at source also ensures non-compliant wastes are eliminated from the bulk material. However, it should be noted that the 'segregation at source and as generated' approach may not be appropriate for decommissioning operations where waste may have variable levels of contamination, differing material types or where cross contamination is likely. For decommissioning operations, planning is essential and segregation facility design (whether permanent or temporary) should be carefully planned to identify and mitigate potential obstacles.

Segregation may be as simple as providing an employees with an individual package for a small quantity of waste that is known to be generated by a particular operation e.g. a rag used to wipe contaminated oil from a mechanical part and known to be suitable for a particular treatment route.

If segregation at the point of generation is not possible the logistics and discipline associated with transferring waste to storage areas becomes more important and consideration should be given to how to complete this whilst still encouraging segregation.

Working Environment

In designing a segregation facility the work environment should be considered. Areas should be reviewed for potential hazards and the practicalities of handling waste should be assessed. The following aspects of any area set aside for segregation should be considered:

- The presence of non-waste high dose rate items that may elevate background radiation and impact on operator safety;
- Space restrictions, particularly related to the ability to handle waste effectively;
- Lifting capabilities and ability to move waste items;
- Repetitive measurements particularly related to operator comfort;
- Restricted access including temporary scaffold, vehicle / pedestrian traffic routes, doorways etc;;
- Other non radiological hazards (asbestos air quality, temperature, noise etc.);
- Presence of a liquid or liquid waste.

Such considerations apply to operational and decommissioning environments alike.

Waste containers

In order for there to be prompt handling and removal of waste, suitable containers must be readily available. For an operational facility such containers are likely to be standard. For decommissioning or similar activities where waste campaigns are completed there may be a requirement for a range of containers or package types.

The requirement for all containers should have been addressed at the planning stage in order to ensure timely delivery. Transport and measurement requirements associated with containers should also be considered.

Ideally packages for segregation should be suitable for subsequent transport (whether as internal containers or external containers). If the containers are intended as internal containers, they should fit easily into transport packages to minimise handling.

Where waste is a liquid, appropriate arrangements for bunding should be considered.

Lifting equipment/fork lift

Adequate lifting equipment should be available for loaded waste containers and for moving non-packaged items.

Scale and measurement

Suitable weighing scales and dimension measurement equipment should be available and if permitted photographic equipment to support further waste management activities; including sentencing etc.

Administration Areas

A suitable administration / computer area should be provided away from the main processing area to ensure operator doses are kept to a minimum. Facilities should be provided for record keeping and storage of electronic records via a computer link.

Instrument storage

Instruments identified for waste assessment may not be identical to those used routinely for area or special surveys. For this reason it may be necessary to have a dedicated pool of instruments purely for the segregation facility with associated equipment such as storage and function check sources.

Manned Receipt Bay

Where waste is produced frequently it may be appropriate to establish manned receipt bays for segregation. Personnel can complete assurance monitoring and appropriately locate waste items these bays.

The provision of a health physics resource at such locations would ensure the correct segregation of all waste. This may be particularly important where waste is being generated at more than one location.

6.3 Segregation Systems

Segregation systems should be established so that waste flows to the point at which it is ready for transport for treatment or disposal (whether on-site or off-site). Figure 8 illustrates a cascade approach to segregation where wastes from different activities in an operational facility are aggregated and collated in a form suitable for transport (very similar in approach to waste stream mapping). This is by no means the only system but illustrates the most likely approach. In its simplest form it is not unlike collecting waste for disposal only.

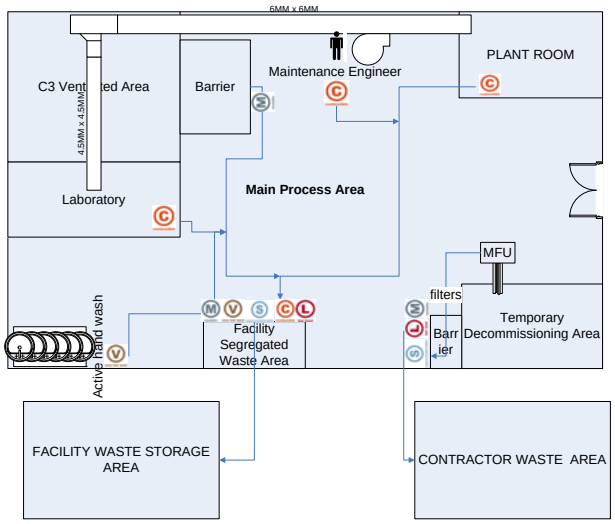


Figure 8 Cascade System for Waste Segregation

The key to segregation is to ensure that waste and activities generating the waste are understood, the packages are accessible and the system is communicated.

The thrust of this guidance has been in clearly defining waste streams and their point of storage prior to either disposal or treatment. This can be completed at the waste generation stage but must be completed prior to sentencing. It is particularly important that exempt wastes are isolated from radioactive wastes to prevent contamination.

Whilst best practice is to standardise the arrangements for segregation as far as possible, the way in which such systems are deployed at a site or facility may vary depending on the predicted waste streams.

6.4 Waste Processing in Preparation for Segregation

It may be appropriate to consider the need to size reduce or decontaminate waste prior to formal segregation of wastes. A waste processing facility may also be used to decontaminate tools and to change vacuum bags. Size reduction should be carried out where practicable during decommissioning at the work face to avoid double handling of waste.

An area designated for size reduction or decontamination would require ventilation and containment. Temporary enclosures may be considered.

7 Segregation Practice

Waste segregation must be completed to minimise risk to employees, regulatory compliance and the environment. Segregation is fundamental to the implementation of the waste hierarchy and should be completed at or as close to the point of generation as possible.

7. Segregation Practice

7.1 Introduction and Overview

Planning segregation practice is essential and may vary between sites and facilities on sites. However alignment with standard treatment and disposal routes at some point is vital. LLWR provides these routes. The following Section addresses the principle aspects of segregation practice.

Sections 4 and 5 discussed the LLWR proposals for coding. Section 7 emphasises the importance of characterisation. Section 8 discusses transport requirements. These are fundamental to effective segregation practice and should be considered in the planning phases prior to the implementation of a system. Planning should consider characterisation as well as transport requirements.

Figure 9 provides a simple outline methodology for developing a segregation system; based on the waste hierarchy and aligned to the LLW treatment and disposal services. Clearly this is a high level representation and there may be further delineation of waste types (e.g. oil, soils, concrete, tools, metal type). This may be site or project specific.

In establishing Segregation Systems, site requirements, procedures and processes need to be fully understood and acknowledged.

For example, the site system may need to recognise the requirement to segregate waste for further intermediate treatment e.g. stabilisation prior to final waste route selection.

This Section should be read in conjunction with Section 6 since the design of the segregation facility impacts segregation practice.

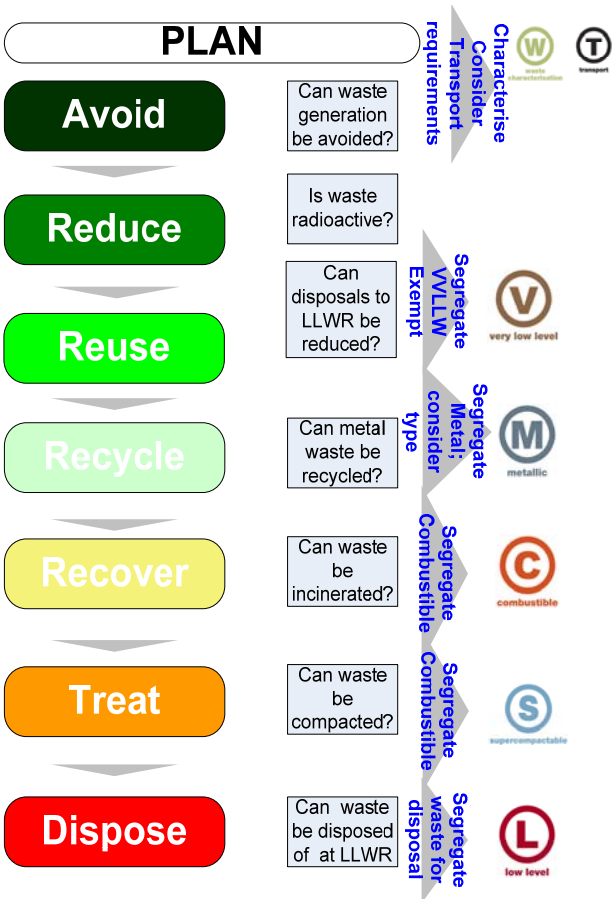


Figure 9 Simple Example Methodology for Identifying Segregation Categories

7.2 Segregation

For operational areas where waste generation is continuous good practice includes:

- Activities that minimise double handling of wastes;
- Provision of individual waste packages suitable for the expected waste volumes;
- Routine waste collation and collection ;
- Appropriate operator and contractor training and awareness;

- Robust monitoring protocols and activity assessment;
- Comprehensive arrangements for determining on-going requirements of supporting infrastructure and consumables (e.g. waste containers);
- Robust management arrangements as well as appropriate layers of defence to prevent non-conformance;
- Appropriate procedures for identifying non-conforming waste.

Segregation practice need not be complex, but should be documented.

Arrangements for record keeping should be developed. In particular, details of where and when waste will be monitored, logged and recorded should be set out to enable the origin of waste to be tracked and understood. This is particularly important if waste is to be moved to a dedicated area for further characterisation.

7.3 Planning

Waste Minimisation

Minimising the production of waste is a priority in any operational facility or project. This may be considered at the earliest stage of project planning or during operational reviews, waste audits etc. Figure 10 details the priorities of such activities.

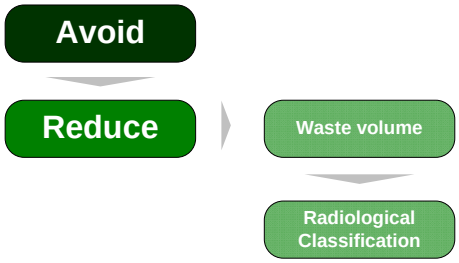


Figure 10 Planning Priorities

The history of the expected waste should be considered during planning. This will influence the nature and extent of the segregation system, required facilities, packaging and other practices.

Provenance

Provenance (sometimes termed history) is knowledge of the use, including location, and controls which have been applied to an article or substance to determine its potential to have become activated and/or contaminated by radioactivity, and the nature of any potential activation or contamination.

An investigation into past use and historical records may be sufficient to understand waste streams. However, if such information is not available a robust sampling and analysis scheme should ensure sufficient information to establish an appropriate waste plan incorporating the requirements for segregation.

This should be less of an issue for an operational facility where waste generation may be routine, and radiological characteristics understood.

It is worth noting that it is the specific guidance of the Clearance and Exemption working group that items or materials with the potential to become radioactive should be identifiable, with ownership defined to ensure segregation is maintained [24].

7.4 Characterisation Practice

Accurate radiological characterisation is one of the many technical challenges of this phase of the nuclear cycle and a potential precursor to segregation.

A very wide range of contaminated or activated material may require monitoring, in-situ non-destructive assay and intrusive sampling.

Effective waste segregation forms a key part of any programme of radiological characterisation.

Robustly segregating the waste at source will often simplify the characterisation approach taken and greatly reduce the cost and potential for waste to be characterised incorrectly. Segregation and characterisation are thus intrinsically linked; each supports the other and the correct approach is

often facility or project dependant, but often iterative.

Characterisation can be a complex task. There is a requirement to know:

- plant history;
- processes;
- neutron activation;
- liquor flows;
- quantities;
- chemical and physical composition;
- leaks and spillages.

Broadly waste characterisation techniques can be split into two types:

- Intrusive sampling, and,
- Direct measurement.

Effective waste segregation can aid both techniques.

Intrusive sampling is used when the predominant radionuclides within the material may be hard or impossible to detect directly e.g. tritium.

When planning a campaign of sampling a fundamental principle is that of zoning the waste into groups of similar contamination. The zoning decision is normally based on some historical data or earlier characterisation data. By segregating the waste, bearing in mind the zoning decisions taken, the sampling activities may be greatly simplified.

Segregation can also simplify the methods of direct measurements. By correctly segregating waste it may be possible to measure large packages of waste e.g. 200 litre drums as opposed to having to measure each individual piece of waste. This is only possible when there is a high degree of confidence that all of the waste material within the large container can be characterised with a single radionuclide fingerprint and the waste has come from a single source. Effective waste segregation can provide this confidence.

7.5 Barrier Procedures

The barrier provides a physical obstruction that prevents or inhibits the movement of people or radionuclides

In the context of segregation, barriers may be required to support decommissioning activities or areas of high / low contamination.

It is recommended Segregated waste should be monitored across the barrier and stored in a clean radiological designated area away from the work face.

7.6 ALARP considerations

In establishing a system for segregation, risks associated with the management of waste should be As Low as Reasonably Practicable (ALARP).

Clearly segregation practice will be dominated by the requirement to manage and minimise operator dose. Operational and decommissioning practice should be considered in this context and as such may impact segregation practices.

Prompt removal of waste is a key consideration. Such action will minimise operator dose, background dose (and hence improve the accuracy of measurement), but principally limit the potential for cross contamination (particularly important if waste has been sentenced).

7.7 Area Classification, Notices, Signage and labels

Regulation 16 of the Ionising Radiation Regulations 1999 requires employers to designate controlled or supervised areas to prevent or restrict routine and potential exposure [26].

The design of facilities for segregated waste should also consider the requirement for area designation. Figure 11 provides an example of signage for such an area.

Figure 11 Example Sign

Other signage, barriers (or similar) may be appropriate depending on the nature and extent of the waste involved.

Waste coding systems and other miscellaneous safety requirement signage may also be utilised. It is however important to note that stations should not be overburdened with signage.

In addition, where intermediate waste storage or where individual work parties have their own waste collection requirements, labelling may also be appropriate. Figure 12 below provides an example of a cable tie to be utilised on a plastic bag designed for combustible waste. Other innovation such as labelled Perspex drum covers may be considered to facilitate segregation practice.

Figure 12 Example of 'Cable Tie' to label waste bag with National Code Identification

7.8 Transport and Waste Movement

Transport is discussed in detail in Section 8. However, any segregation system must consider how waste is to be moved to the various intermediate storage locations.

At some point following segregation, waste will require movement to either interim or final storage areas. Consideration should be given to the safe and effective means of transport.

7.9 Contamination Control and Housekeeping

Effective contamination control at the point of waste generation, storage and in between is essential.

Good housekeeping is essential:

- During segregation activities;
- At segregation stations.

It is particularly important that exempt waste is prevented from being contaminated.

7.10 Tool Management

Tool management is a consideration for decommissioning activities. Typically tools are discarded following the completion of the works.

However segregation systems should consider the following interventions:

- Can tools be retained and utilised for further to alternative works?;
- Can a portion of the tools be recycled e.g. metal?;
- Can the tool cleaning regime limit secondary waste generation?.

Facilities may be required in which to undertake these activities.

7.11 Inspection

The areas established to support the segregation of wastes should be subject to routine inspection to ensure continued safety and effectiveness. Practices established for segregation should be also subject to routine inspection. Appropriate training, in particular outlining the aims and requirement of the system for segregation should be provided.

7.12 Waste Stream Mapping

Waste stream mapping should be considered in the planning stage to understand waste arisings and volumes. Reference to existing Integrated Waste Strategies should be considered.

7.13 Sentencing

Dedicated sentencing areas for waste may be considered as such areas have advantages over monitoring waste at the workface, specifically related to the accuracy associated with elevated background dose rate. Clearly dedicated areas may be required for large waste volumes and such waste items may by more appropriately addressed in their final disposal containers at the point of generation. In such circumstances drums assay, informed activity assessment or sampling will help to ensure correct sentencing.

As indicated the requirement for dedicated sentencing areas is dependant on the waste type and waste generating activities and is most appropriately addressed during planning phase.

7.14 Waste Activity Types

Introduction

The radiological properties of waste should be considered prior to developing and implementing a system for segregating and managing waste.

Gamma Contaminated Wastes

Waste dominated by gamma emitting radionuclides can be easily measured using hand held Health Physics instrumentation and applying the established fingerprint. Such waste is readily segregated in-situ.

The nature of the activity (whether surface or activated) will determine the most suitable method of monitoring and measurements to be completed to support a segregation system.

For waste of high surface to volume ratios i.e., soft waste (paper, clothing etc.) and relatively high contamination levels, the activity assessment may be determined by taking dose rate measurements and applying mathematical modelling to the fingerprint to calculate the total activity of a fixed volume of waste. This is most practically applied by loading a waste drum with such items and assaying it as a total volume. These items may also be compacted providing a higher quantity of activity per drum hence better assay statistics. This method of inferred activity is more problematic if the dose rate measurements are taken in an area of high background or are close to environmental levels. In these cases the elevation in background dose rate may not be practically detectable and is often taken as the item dose rate, hence overestimating the activity.

For larger items with a greater volume to surface area ratio such as metals not suitable for decontamination, wood, plastics etc. measurements of surface activity using hand held probes will provide adequate results. This is providing they are surface contaminated only, or their bulk activity is known from representative sampling.

Where waste items are distinct and of uniform material the most accurate method of activity assessment will be by sampling and analysis similar to statistical sampling required for waste exemption. The results from this sampling can either be assessed solely for gamma emitting radionuclides to which the fingerprint is applied or submitted for a full radiochemical analysis. It should be noted that any individual item may not agree exactly with the established project or area fingerprint. The evaluation of any specific results

requires an informed review to ensure a correct and consistent assessment of the total activity in the consignment.

Beta Contaminated Wastes

Waste containing significant quantities of beta emitting radionuclides may also include gamma emitters, and an activity assessment based on these radionuclides is often the most practicable.

The exception to this will be waste streams of a single radionuclide. In this case the choice of suitable instrumentation able to detect the activity is of most importance and large area scintillation type contamination monitors are probably the most appropriate. However this method of activity assessment will be inappropriate for items where the activity is distributed throughout the material body. For this type of waste only sampling will provide accurate assessments to inform a segregation / waste management plan.

Waste streams containing beta emitters alone are likely to have been generated from the laboratory/ hospital environment and a system of sentencing which involves an activity balance assessment may provide an appropriate method.

Problems can arise when a fingerprint is dominated by a soft beta such as tritium. Traditional hand held instrument will not be able to make suitable measurements for segregating such waste; elaborate sampling and analysis may be required prior to understanding segregation and waste management options.

Consideration must also be given to the storage of tritium contaminated waste; packages must be able to contain the activity, otherwise operators may be subject to increased doses.

Alpha Contaminated Wastes

An appropriate segregation and waste management system for purely alpha contaminated material must account for the limitations of hand held instrumentation in assessing the total activity; only surface activity will be detected and even then only if it is grease free and dry.

The potential for contamination to have penetrated the surface layers of a material and not be readily detectable must be considered. In such cases sampling supported by statistical analysis to evaluate the average bulk activity should support segregation decisions.

For soft/ drummed wastes a reasonable estimate of activity can be made by averaging the activity based on routine and area surveying and the knowledge of the workplace. Providing the surface area of the waste can be assessed, the total activity can be inferred from the results of representative surface alpha monitoring and the fingerprint.

Once waste has been packaged there will be no means of assessing the activity. Accurate logs of the package must therefore be made during the loading process. In the absence of such logs it may be necessary to reopen the drums and in such circumstances these radiological impacts from activities must be kept ALARP.

8 Waste Storage and Transport

Waste must be stored safely and securely prior to treatment and disposal. Considering the subsequent transport requirements prior to establishing a segregation system will reduce risk to workers.

8. Waste Storage and Transport

8.1 Introduction

Waste may not be treated or disposed in the vicinity of its generation. At some point waste may be transported to interim storage or to a final treatment or disposal facility. Consideration of waste transport requirements is therefore essential to prevent excessive handling and ensure radiological impacts are kept ALARP.

8.2 Waste Transport Legal Requirements

The United Nations produce a model set of Dangerous Goods Transport regulations which are commonly know as the Orange Book. Transport relates to Road, Rail, Inland Waterway, Sea and Air. These are then transcribed into European Legislation as Directives such as ADR (Road), RID (Rail), and IMDG (Sea). These model regulations cover all classes of dangerous goods and include radioactive material which is assigned to Class 7. Table 3 provides an overview of UK Legislation.

Transport also includes in transit storage and handling. Transport should not be confused with the movement of radioactive material which takes place on a private premises and does not use public roads. These movements are governed by the requirements of the Ionising Radiations Regulations 1999.

European Legislation has been adopted by the members of the EU community. In the UK, the Carriage of Dangerous Goods and Use of Transportable Pressure Equipment Regulations 2009 (CDG 2009)[27], adopt ADR and RID and the Merchant Shipping Regulations 1997 adopt the IMDG code for Sea shipments.

For Radioactive Material (Class 7 Dangerous Goods), The IAEA produce Requirements which are adopted by the UN Model Regulations and are transcribed into the European and Domestic Legislation as stated above. The Requirements are known as TS-R-1 and the current edition is 2009.

In general the transport regulations lay down a framework for:

- Classification and Radioactivity Limits;
- Packaging and Test Procedures;
- Identification;
- Marking, Labelling and Placarding;
- Transport Preparation and Documentation;
- Emergency Systems;
- Placing Requirements on consignor's:
  - Consignees;
  - Carriers;
  - Loaders;
  - Packers;
  - Fillers;
- Quality Assurance requirements;
- Training requirements.

For Radioactive Material, the system is based on the nature of the risk; the higher the risk, the more requirements that need to be met to ensure the safety of the load during normal or accidental conditions of transport.

Mode	UK Regulations	Comment
Road	The Carriage of Dangerous Goods and Use of Transportable Pressure Equipment Regulations 2007	Transport through another EU member state is subject to ADR
Air	The Air Navigation (Dangerous Goods) Regulations 2002 The Air Navigation (Dangerous Goods) Amendment Regulations 2007 and subsequent amendments	Technical Instructions referred to in the Regulations are the ICAO Technical Instructions for the Safe transport of Dangerous Goods
Rail	The Carriage of Dangerous Goods and Use of Transportable Pressure Equipment Regulations 2007 (CDG2007) The Packaging, Labeling and Carriage of Radioactive Material by Rail Regulations 2002	International is subject to the International Carriage of Dangerous Goods by Rail 2001 (known as RID).
Sea	The Merchant Shipping (Dangerous Goods & Marine Pollutants) Regulations 1997. The Merchant Shipping (Carriage of Packaged Irradiated Nuclear Fuel etc) (INF CODE) Regulations 2000	The International Maritime Organisation has produced the International Maritime Dangerous Goods Code 2006. (IMDG)
Inland Waterways	The Carriage of Dangerous Goods and use of transportable Pressure Equipment Regulations 2007 (CDG2007)	British Waterways Board Terms & Conditions: Dangerous Goods BWB 1981. Schedule of Dangerous Goods (Green Book) BWB 1981 (Class 7).
Postal System		IAEA regulations specifies activity limits up to which radioactive materials may be accepted but Royal Mail decided that no radioactive material will be accepted for national or international destinations.

Table 3 – Domestic Transport Legislation List

8.3 Waste Transport Practical Consideration – Interim Storage Containers

Appendix 5 provides a summary of the LLWR transport packages. These are designed for the transport of LLW and some may be considered as appropriate containers for direct or intermediate storage of segregated waste. The decision to utilise transport packages in such a way requires planning but offers advantages including reduced handling (and hence operator dose) and perhaps more efficient waste processing. Particular consideration is required as to how waste stored in such away can be sentenced. Figure 13 illustrates a Berglof box being monitored prior to transport.

Figure 13 Berglof Box Undergoing Sentencing

In line with UK LLW management policy and the emphasis on the importance of applying the waste hierarchy, reuse of transport packages is preferred to single use followed by disposal.

A suitable storage container will either:

- Meet the requirement of a re-useable class 7 transport package in its own right e.g. IP-2, or,
- Have the capability to be loaded in multiple numbers into a larger approved class 7 transport packages that can be used to transport the smaller interim storage packages. In either case, the storage container and indeed the larger transport package if appropriate needs to also fulfil the requirements of the consignee who will be treating or disposing of the waste.

Guidance on Package Types is provided in Appendix 6. The IAEA has established regulations supporting the safe transport of radioactive materials[28].

Currently the Half Height ISO (HHISO) is a storage, transport and disposal container but may only be used once for transport (although a concession has recently been issued by the design and approval authority allowing it to be transported up to three times as an approved Class 7 transport package providing it is filled only to a fraction of its maximum allowable gross weight). The current HHISO is approved as an Industrial Package Type IP-2 and has been designed and manufactured to meet the IP-2 criteria specified in TS-R-1[28].

The HHISO has been designed to meet IP-2 criteria as the predominant nature of the LLW from the nuclear industry meets Low Specific Activity Criteria (or specifically LSA-II criteria which bounds most LLW). In the majority of situations the LLW requiring transport has been loaded at the consigning site and transported using the HHISO for direct disposal into the LLWR.

Figure 14 presents the package types identified in TS-R-1 [28].

A decision on the most appropriate package type must consider the material to be transported and flexibility of design:

- Excepted, Type A and Type B packages are used for transport of Class 7 material based upon the total activity;
- Industrial Package (IP) use is based on the specific or surface activity of the consignment.

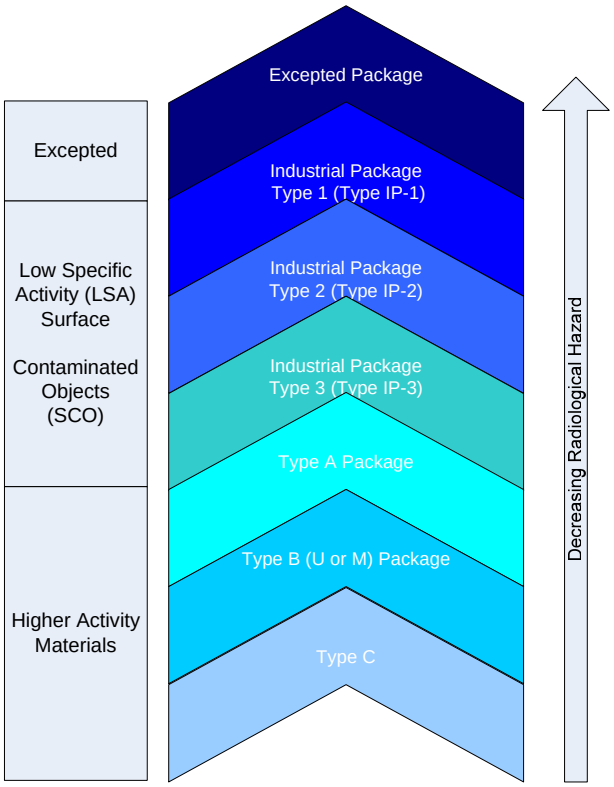


Figure 14 IAEA Package Types

For LLW, Industrial Packages are more appropriate if the can be considered as homogenously contaminated, irradiated or surface contaminated (i.e. Low Specific Activity (LSA) or Surface contaminated Object (SCO).

In addition, because the packaging decision is based upon specific activity or surface activity for IP packaging, there is effectively no upper limit on the total activity. As a consequence more material can be transported provided that it meets the LSA or SCO criteria.

That is not to say that EXCEPTED, TYPE A and TYPE B packages are not suitable as storage and/or transport containers for LLW.

However, in general:

- *EXCEPTED* packages will not meet the demands of LLW storage / transport due to the radiological characteristics;
- *TYPE A and B* are very expensive and designed for higher activities that in most cases will exceed LLW.

TRANSPORT SUMMARY

The storage container should consider:

- Activity;
- Physical properties;
- Transport requirements.

IP packages are probably the most suitable to meet these demands; they are available in many different forms and can be approved for Class 7 use.

8.4 Waste Containers and Storage

During the segregation planning stage, the type of intermediate and perhaps final waste package should be identified. Clearly this will depend on the volume and activity of the waste.

Whilst a range of packages may be required for operational facilities decisions on the utilisation of packages may not be reviewed.

However, for specific waste campaigns or decommissioning projects, waste packaging requirements should be considered at the planning stage and subject to review as required.

In both cases packages should be readily available and lead time should be fully understood.

The radiological conditions of the container should be understood particularly if re-usable packages are being used. This should be checked prior to use and status confirmed.

9 Competence Development

Suitably trained and competent personnel, with arrangements and requirements effectively communicated will ensure segregation practice supports the implementation of the waste hierarchy

9. Competence Development

9.1 Introduction

Any system that is established for effective waste management and segregation is only as effective as the competence of staff. Such systems cannot operate appropriately unless they are applied consistently throughout the organisation.

This requires all staff involved in waste management to be aware of the procedures and systems established to ensure LLW segregation.

9.2 Training and Competence Development

Without effective training and competence development, the successful implementation of a system for LLW segregation will be difficult.

The following should be considered:

- Training needs will vary depending on job function and responsibilities;
- Delivery of training should be completed by personnel familiar with LLW management;
- Training materials should reflect job function and specific project requirements;
- Formal arrangements (e.g. audit) should check adequacy of delivered training;
- Training records should be retained.

CONTENTS OF A TYPICAL TRAINING COURSE

- Waste Management Hierarchy
- Definitions – what is segregation
- Benefits of Segregation
- Context – UK policy etc.
- System employed at site, facilities
- Roles and Responsibilities
- Reporting

9.3 Raising awareness – Waste Champion

Awareness amongst staff is an important contributor to the success of a segregation system. A means of promoting effective waste management and segregation in an organisation may be through the establishment of waste champions; given the task of promoting and embedding good practice in an organisation. Such arrangements are commonplace for conventional waste management.

A typical profile of a suitable individual may include:

- Enthusiasm and commitment to effective waste management
- Understanding of the organisation's waste management arrangements
- Understanding of the importance of the waste management hierarchy
- Credibility at all levels in the organisation
- Exceptional communication skills and ability to communicate with employees at all levels of the organisation
- Ability to enthuse all staff

There are a number of barriers to effective waste management and segregation and the appointment of a waste champion may seek to address these:

- Lack of understanding and awareness, particularly of system but also benefits;
- Poor staff motivation;
- Absence of buy in.

Examples of a tool box talk and poster to promote competence development is provided in Appendix 2.

10 Management Approach; Audit and Review

Segregation systems should be supported by management arrangements and subject to audit and review to ensure effectiveness. Waste audits support duty of care compliance

10 Management Approach; waste audit and review

10.1 Introduction - Principles of LLW Management

The overriding principles of LLW management are established in UK Policy and Strategy[2] and include:

- High standards of health, safety and security, environmental protection and public acceptability are central to the development of appropriate waste management plans and their implementation;
- Waste prevention should be implemented by all producers of LLW wherever practicable;
- Effective characterisation and segregation of waste and material that will become waste is critical to the flexible management of LLW.

These principles and the UK Nuclear Industry Strategy (Figure 15) should be considered prior to the establishment of any segregation system for Low Level Waste.

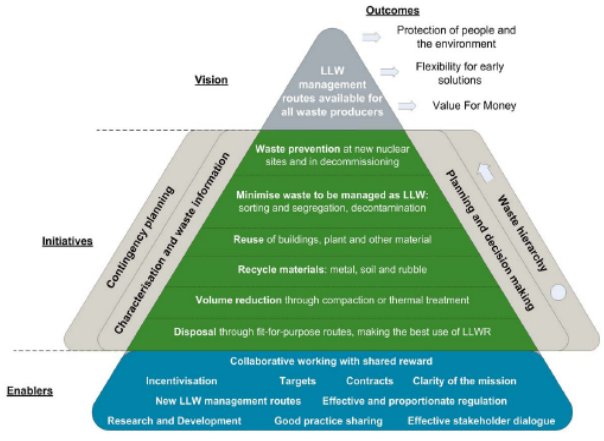


Figure 15 UK Nuclear Industry LLW Strategy[2]

Sites should adopt a management approach, with all aspects of LLW management, including arrangements for segregation detailed within a documented system, integrated where appropriate with wider waste management arrangements.

Systems for segregation should apply to a facility lifecycle. Sites should consider the strategy for segregation as central to any waste strategy development e.g. Integrated Waste Strategy.

10.2 Commitment

The introduction of any new or revised system requires commitment for all stakeholders / partners.

This should be obtained at the earliest possible opportunity but requires consideration throughout a facility lifetime:

- Design;
- Construction;
- Operation;
- Maintenance;
- Decommissioning.

To avoid confusion and where practicable a standard system should be utilised at all times, which is flexible enough to address all eventualities.

10.3 Identify Waste Steams

Systems to identify site / facility waste streams are an important precursor to the establishment of a segregation system for LLW.

Without an understanding of the waste stream, a suitable disposal or treatment route cannot be identified.

10.4 Determine Strategy/Approach

A strategy or approach to segregation within the wider waste management arrangements should be developed.

Direction to the site and individual facility should be provided to ensure a consistent approach to segregation practice

Where appropriate segregation strategies should be integrated into wider site waste strategy.

10.5 Management Structure and Responsibilities

Waste management initiatives should have a defined management structure with responsibilities that are clearly specified and understood. Such a requirement extends to designating responsibility for waste segregation practice, and should apply to both operational and project (e.g. decommissioning) waste management, or indeed waste campaigns.

All employees and contractors (whether permanent or temporary) who have responsibility for segregation or who have an impact on the effectiveness of a segregation system should understand their roles and responsibilities; this is applicable to sites, facilities and projects.

Competency (Suitably Qualified and Experienced Personnel (SQEP)) should cover all requirements of the segregation system

10.6 Management Arrangements

General

Documented procedures for waste management should include arrangements for segregation. Such arrangements should as a minimum consider the following:

- Roles and responsibilities;
- A description of segregation facilities including their location;
- General safety (e.g. risk assessment, ALARP) and environmental requirements;
- Details of the system in place for LLW segregation;
- Documentation requirements.

A common system that is integrated into the existing site system is recommended. This should address both operational facilities and project specific facilities.

Other considerations

Management arrangements should consider the following:

- Contractors – contractors should be aware of the requirements to segregate LLW appropriately; this information should be provided in any ITT. Where contractors propose their own system this should be assessed against the overall aims of the site and the requirement to meet LLW policy and strategy (and other applicable site documents e.g. BAT studies);
- Waste Management Plan – site or project specific waste plans may offer an opportunity to detail specific arrangements for waste management and segregation. In particular where there is a deviation from the site system specific arrangements can be communicated;
- Site / Facility / Project Documentation - should reflect the requisites of waste segregation and perhaps consider integration with other documentation requirements, e.g. ALARP reports, designated areas, Hazard studies, local rules;
- Integrated Waste Strategies (IWS) – NDA sites are required to complete IWS documents. These documents may provide the means to communicate segregation objectives, requirements and outcomes.

10.7 Record Keeping

Within the strategy and arrangements established for waste management and segregation the requirements for record keeping should be clearly detailed.

An important strength of adopting a systematic management based approach to waste management, including segregation practice, is that it will provide the basis for appropriate management of records.

Record keeping is an important consideration in radioactive waste management and an essential element of a number of the tools and techniques supporting waste management activities. Record keeping is often a legal requirement. For example the SAPs specifically require that information that might be required now and in the future for the safe management of radioactive waste should be recorded and preserved[29]. Records are essential to comply with Duty of Care [30] requirements and should certainly be retained, including those supporting characterisation, transport, consignment, and exemption (in the case of recycled materials).

Record keeping should be proportionate but may include:

- Documented arrangements with appropriate revision history;
- Waste audits and inspection;
- Consignee audits;
- Consignment paperwork;
- Training records;
- Waste Management Plans;
- Container inspection / maintenance;
- Characterisation and sentencing studies;
- Monitoring results;
- Routine Health Physics routines of segregation area;
- Photographic record of segregation areas and waste containers;
- Instrument calibration;
- Minutes of meetings.

It is also considered essential to monitor waste management performance. An understanding of programmes of work is essential and records may then provide information to support reporting.

10.8 Quality Assurance (QA)

The Quality Management System should be applied to arrangements established for waste management and segregation.

The development of formal documented procedures to support the implementation of a segregation system is recommended. These procedures could incorporate:

- Waste management objectives;
- Arrangements for waste management planning;
- Segregation arrangements and procedures;
- Communication;
- Competence; Training and awareness;
- Data validation and verification supporting segregation;
- Document control procedures;
- Arrangement for package movement and transport planning;
- Arrangements for internal audit.

10.9 Use of Contractors

Contractors who generate waste or have been employed to manage waste streams should be familiar with the site waste management practices including the arrangements for segregation.

Formal training of sub-contractors should be considered, with appropriate supervision and waste audits completed to ensure compliance with specific site segregation arrangements.

10.10 Design

Consideration should be given at the design stage for waste streams and segregation systems. Indeed the TAG on the management of radioactive materials and radioactive waste on nuclear licensed sites[8] suggests that segregation systems should be addressed at the design stage.

10.11 Implementation

In implementing a segregation system the following should be considered:

- Requirements for the implementation; identified opportunities may require significant resource ;
- Documentation of segregation systems and procedures / plans;
- Systems required to monitor progress including the need for performance indicators;
- Opportunities to integrate into existing site programmes;
- The requirement for pilot studies.

10.12 Monitor - Waste Audits

Waste audits form an essential component of a system for managing LLW. Indeed waste audits are required to ensure compliance with Duty of Care. Further guidance is provided in Appendix 3.

The approach to waste sentencing should be fully documented. This should include, in particular, all records related to calibration as well as decision making.

10.13 Evaluation - Management Review

Project / programme review should be considered throughout the project lifecycle. It is customary and good practice to complete reviews post project but the following should also be considered:

- Prior to implementation of significant initiatives the validity of supporting data should be tested;
- Assessment of progress in support of milestones.

10.14 Reporting and Communication

Within the arrangements established for waste management and segregation, reporting and communication requirements should be clearly established.

Appendix 2 and 3 provides examples of a tool box talk and a poster respectively.

Consideration should be given to an appropriate communication strategy, and in particular, the method of provision of information to stakeholders and how to publicise successes. Communicating success should be seen as an excellent opportunity to encourage and engage others in site waste management and segregation programmes.

11 Segregation Best Practice - checklist

Effective segregation is considered best practice and is fundamental to the implementation of the waste hierarchy

11. Segregation best practice – checklist

Table 4 – Priorities for Successful Waste Segregation

❶	**Gain commitment**	**The development and implementation of a segregation system requires the commitment of all involved, including senior management. Segregation is an essential component of implementing the waste hierarchy and meeting permit requirements.**
❷	**Establish Leadership**	**Leadership at each level of a segregation and waste management system is a pre-requisite for the successful implementation of the system.**
❹	**Develop segregation system**	**A formal system for ensuring effective segregation of waste, reflecting expected arisings, available waste routes and characterisation practices should be established. Such a system should be simple and easy to understand.**
❸	**Determine priorities**	**The priorities for a segregation system should be understood; these may change depending on facility and project, but any system should be flexible enough to address all circumstances.**
❺	**Standardise and Ensure Flexibility**	**The system should be standardised through an organisation, site, and facility. However, it should be flexible enough to address all eventualities.**
❻	**Establish segregation facilities**	**The facilities required for segregation should be established in specific areas. Such areas should be identified through signage. The system should recognise that temporary segregation facilities may be required depending on activities.**
❼	**Establish and integrate management arrangements**	**Development and implementation of formal documented arrangements for segregation including, where appropriate, integration with existing systems**
❽	**Deploy and Embed**	**Established arrangements should be embedded into custom and practice.**
❾	**Review performance**	**Performance of permanent and temporary segregation arrangements should be subject to regular review**
❿	**Report progress and success**	**The results of segregation should be reported; where appropriate by company and/or site facility. Invariably the success is compliance with the waste hierarchy**

Appendix 1 - Glossary

As Low As Reasonably Practicable (ALARP)

To satisfy the ALARP principle, measures necessary to reduce risk must be taken unless the cost of those measures, whether in money, time or trouble is disproportionate to the reduction in risk.

Contamination

Radioactive substances on surfaces or within solids, liquids or gases (including the human body), where their presence is unintended or undesirable or the process giving rise to their presence in such places.

Characterisation

Determination of the physical chemical and radiological properties of the waste to establish the need for further adjustment, treatment or conditioning, or its suitability for further handling, storage or disposal.

Decontamination

The complete or partial removal of contamination by a deliberate physical, chemical or biological process.

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 may also refer to the release of airborne or liquid wastes to the environment (i.e. emissions and discharges).

Environment Agency (or EA)

The environmental regulator for England and Wales. The Environment Agency's role is the enforcement of specified laws and regulations aimed at protecting the environment, in the context of sustainable development, predominantly by authorising and controlling radioactive discharges and waste disposal to air, water (surface water, groundwater) and land. In addition to authorisations issued under the Environmental Permitting Regulations 2010 for radioactive substances, the EA also regulates conventional discharges at nuclear sites under the same regulations.

Exemption Order (EO)

The Radioactive Substances Act 1993 (RSA93) makes provision for certain low activity wastes, when used for certain purposes and when managed in particular ways, to be excluded from particular regulatory provisions made under the Act. Exemption Orders are currently under review.

Health and Safety Executive (HSE)

A statutory body whose role is the enforcement of work related health and safety law under the general direction of the Health and Safety Commission established by the Health and Safety at Work Act 1974. HSE is the licensing authority for nuclear installations. The Nuclear Safety Directorate of HSE exercises this delegated authority through the Nuclear Installations Inspectorate (NII) who are responsible for regulating the nuclear, radiological and industrial safety of nuclear installations UK wide.

Low Level Waste (LLW)

Includes metals, soil, building rubble and organic materials, which arise principally as lightly contaminated miscellaneous scrap. Metals are mostly in the form of redundant equipment. Organic materials are mainly in the form of paper towels, clothing and laboratory equipment that have been used in areas where radioactive materials are used – such as hospitals, research establishments and industry. LLW contains radioactive materials other than those acceptable for disposal with municipal and general commercial or industrial waste. It is now defined as "radioactive waste having a radioactive content not exceeding four gigabecquerels per tonne (GBq/te) of alpha or 12 GBq/te of beta/gamma radioactivity"

Low Level Waste Repository (LLWR) near Drigg

The LLWR is in Cumbria and has operated as a national LLW disposal facility since 1959. Wastes are compacted and placed in containers before being transferred to the facility. Following a major upgrade of disposal operations in 1995, all LLW is now disposed of in engineered concrete vaults. The LLWR near Drigg is owned by the NDA and currently operated by a consortium of companies called UKNWM.

Pre-treatment

Any or all operations prior to waste treatment, such as collection, segregation, chemical adjustment and decontamination.

Provenance

A knowledge of the use (including location) and controls which have been applied to an article or substance to determine its potential to have become activated and / or contaminated by radioactivity, and the nature of any potential activation or contamination (sometimes called 'history').

Radioactive waste

Any material contaminated by or incorporating radioactivity above certain thresholds defined in legislation, and for which no further use is envisaged, is known as radioactive waste. (See RSA93 and NIA65).

Radioactive Substances Act 1993 (RSA93)

UK legislation which provides for regulation of the disposal of radioactive wastes, including liquid and gaseous discharges to the environment. It also provides for regulation of the accumulation of radioactive wastes on non-nuclear sites: this function for licensed nuclear sites being provided by the NIA65. This Regulation has been replaced by EPR 2010 in England and Wales but exemption orders remain. Scotland retains RSA 1993.

Segregation

An activity where waste or materials (radioactive or exempt) are separated or kept separate according to radiological, chemical and /

or physical properties which will facilitate waste handling and / or processing.

Sentence / Sentencing

That part of the clearance process at which the decision is made that an article or substance is clean and excluded, exempt or radioactive.

Treatment

Operations intended to benefit safety and/or economy by changing the characteristics of the waste. Three basic treatment objectives are:

- Volume reduction;
- Removal of radionuclide from the waste;
- Change of composition

.

Waste Hierarchy

Establishes the hierarchy of management options in the context of environmental harm; avoiding waste generation is the preferred option, with disposal the least.

Waste producer

The organisation that produced radioactive waste in the first instance. The waste producer may or may not equate to the current waste manager, as responsibility for the waste may have been passed to another organisation in the interim.

Appendix 2 – Sample Toolbox Talk

This is an example of a tool box talk used to communicate and reinforce a site segregation system. It is provided as an example only.

TOOLBOX TALK

LOW LEVEL WASTE SEGREGATION

1.0 INTRODUCTION

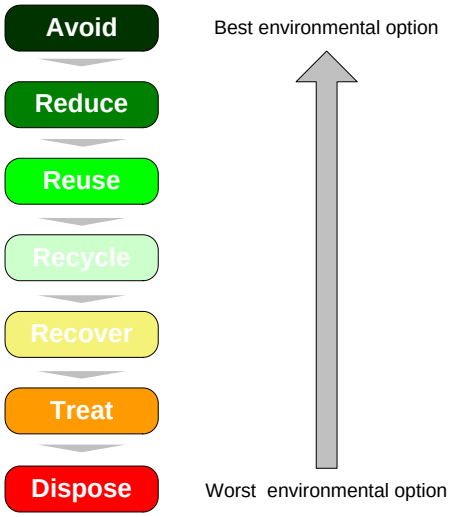
TITLE: Segregation of Low Level Waste

Reason	To understand the site segregation coding system
Why	Segregation is fundamental to the implementation of the waste hierarchy and effective LLW management
Outline	Provide overview of waste hierarchy, segregation and the coding system adopted by the site. Simple Dos and Don'ts are provided.

2.0 BRIEFING

What is Waste Hierarchy (opposite)?

- The Waste Management Hierarchy establishes a hierarchy of management options in context of increasing environmental impact
- Based on the simple premise that it is better to avoid waste generation than to treat or dispose of waste.
- The principles established in the hierarchy underpin good LLW management practices - avoiding waste generation is considered a priority, whilst disposal should only be considered as a last resort.



What is Segregation?

Segregation is the separation of waste in accordance with radiological properties or where radiological properties are similar, separation on the basis of identified treatment routes.

Segregation helps sites to apply the waste hierarchy. Waste can be separated into waste suitable for recycling, recover, reuse, or treatment instead of disposal.

What are the benefits of Segregation?

SEGREGATION IS FUNDAMENTAL TO:

- **Apply the waste hierarchy - by clearly identifying recycling, reuse, treatment options**
- **Avoid environmental harm**
- **Avoid prosecution – by clearly labelling waste with type and route**
- **Reduce costs – avoiding costly disposal options**

How do we segregate waste?

The following signage is used on this site to describe the Segregation System. Waste containers will be labelled with these.

Symbol	Indicative Treatment/ Disposal Option	Waste Type	Example Contents	Secondary Designation	Example Symbols and Colour Code
M metallic	Treatment: Shot blasting and/or melting	Metal: surface contaminated with radioactivity Classified as VLLW or LLW	Tanks, plates, cables, white goods, scaffold pipes May be subject to secondary packaging	Stainless steel, lead, copper, ferrous, alloy, aluminium, mixed	
C combustible	Treatment: incineration Disposal of secondary waste to LLWR	Solid or liquid combustible waste contaminated with radioactivity Classified as VLLW or LLW	PPE, plastic, wood, paper, cardboard, oil	PPE, plastic, wood, paper, cardboard, mixed, oil	
S supercompactable	Treatment: Supercompaction Disposal of compacted waste at LLWR	Compactable waste Classified as VLLW or LLW	PPE, plastic, wood, paper, cardboard	PPE, plastic, wood, paper, cardboard, mixed, oil	
V very low level	Disposal	Waste destined for disposal at approved landfill sites	Rubble, soil	Rubble, soil, mixed	
L low level	Disposal	Waste destined for disposal at the LLWR	NORM, Mixed	NORM, mixed	

Do

- ✓ ***Look out for the standard signs and segregate waste***
- ✓ ***Use waste containers and skips provided***
- ✓ ***Understand the segregation system and the containers that should be used***
- ✓ ***Seek advice if unsure about the segregation system in place***

Don't

- × ***Overfill waste containers and skips***
- × ***Mix different types of waste***
- × ***Guess waste type – always ask if unsure***

Appendix 3 – Waste Audit Guidance

Purpose

The Purpose of a waste audit in the context of LLW management and segregation is to:

- Assess compliance with established waste management procedures and the segregation system;
- Demonstrate compliance with regulatory requirements;
- Assess accuracy of characterisation information supporting the segregation system;
- Assess the success of training and development programmes ;
- Monitor waste segregation, handling, transport and disposal arrangements;
- Assess composition of waste stream – ensure actual composition meets expected composition (as detailed in waste management plans for example);
- Provide accurate and appropriate information to support a (management) review of waste management and segregation practice.

Who should complete a waste audit?

Waste audits should be completed by suitable experienced and competent personnel. For large audits requiring specialist knowledge e.g. characterisation, instrumentation (including calibration) a team approach may be required.

Arrangements for waste audit

Procedures for a waste audit should be established and should include:

- Management arrangements;
- Roles and Responsibilities;
- Tools and techniques to be utilised;
- Reporting arrangements;
- Requirements for competency;
- Action planning;
- Intervals between audits.

Duty of Care

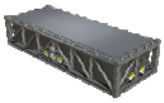
An important benefit of a waste audit is to demonstrate compliance with duty of care requirements. In the context of the segregation of LLW this means:

- Ensuring waste is segregated in accordance with treatment / disposal facility ;
- Ensuring associate documentation (characterisation, transport) represents the radiological conditions of the waste;
- Providing the opportunity to review and inspect receiving facility licences;
- Providing the opportunity to review employee SQEP;
- Ensuring waste is consigned to a site authorised by the Environment Agency.

Appendix 4 – National Coding System for Conventional Waste

A National Colour Coding System for construction waste is in operation; below [31]

Appendix 5 – LLW Transport Packages

Transport package	Size	Drawing/Picture	Specific Usage Classification	Compatability	How they can be moved
TC02 - Reusuable HHI	6.048m long x 2.591m high x 2.410m wide		IP-2 container for metals in Berglofs/DOLAV boxes, Drums and large components	Specially designed stillages	FLT, crane
TC05 - ISO Skip	3.4m long x 1.95m wide x 1.739m high		IP-2 container for combustables and compactable waste	Requires special trailer unit	FLT, crane
Berglof Box 1/8	2.2m long x 1.4m wide x 0.875 high		internal storage box for metals and conbustibles	TC02 stillage	FLT, Pallet truck
Berglof Box 1/16	1.4m long x 1.1m wide x 0.875 high	see above picture	internal storage box for metals and conbustibles	TC02 stillage	FLT, Pallet truck
Dolav box	1.2m long x 1m wide x 0.74m high		internal storage box for metals and conbustibles	TC02 stillage	FLT, Pallet truck
TC11- Soft side packa	1.8m long x 1.2m wide x 1.2m wide		IP1/IP2 package for VLLW soil, decommisioning debris	TC11 transport frame - same size as TC02	Crane/FLT with lifting frame
TC-12 Compactabel D	620mm diameter x 880mm high		IP-2 for compactable waste	TC02 drum stillage, FHISO container	FLT, Pallet truck
TC-13 Incinerable drur	620mm diameter x 880mm high		IP-2 for inicinerable waste	TC02 drum stillage, FHISO container	FLT, Pallet truck
TC-14 Oil Drum	620mm diameter x 880mm high		IP-2 for oil waste	TC02 drum stillage, FHISO container	FLT, Pallet truck

Appendix 6 – IAEA System of Classification, Packaging and Labelling

The IAEA system for the classification, packaging and labelling of radioactive material [28] relies on categorisation in accordance with the risk that it poses to the public during normal and accidental conditions of transport.

The system for radioactive material is based upon each nuclide having a specified risk depending on the activity levels being carried. For each nuclide in Table 1 of IAEA TS-R-1[28], an A1 and A2 value, Activity concentration for exempt material and activity limit for an exempt consignment is assigned. The table from paragraphs 401 -406 of TS-R-1 is reproduced below.

TABLE 1. BASIC RADIONUCLIDE VALUES

Radionuclide (atomic number)	A_1 (TBq)	A_2 (TBq)	Activity concentration for exempt material (Bq/g)	Activity limit for an exempt consignment (Bq)
Actinium (89)				
Ac-225 (a)	8×10^{-1}	6×10^{-3}	1×10^{1}	1×10^{4}
Ac-227 (a)	9×10^{-1}	9×10^{-5}	1×10^{-1}	1×10^{3}
Ac-228	6×10^{-1}	5×10^{-1}	1×10^{1}	1×10^{6}
Silver (47)				
Ag-105	2×10^{0}	2×10^{0}	1×10^{2}	1×10^{6}
Ag-108m (a)	7×10^{-1}	7×10^{-1}	1×10^{1} (b)	1×10^{6} (b)
Ag-110m (a)	4×10^{-1}	4×10^{-1}	1×10^{1}	1×10^{6}
Ag-111	2×10^{0}	6×10^{-1}	1×10^{3}	1×10^{6}

The type of package depends on the radionuclides, the activity, the form it takes and whether the material is incorporated into instruments or articles. The decision making process relies on the determination of material classification using the activity limits, radionuclides present and the A_1 and A_2 values.

Material may be classified as either:

- EXEMPT
- EXCEPTED
- Low Specific Activity as LSA-I, LSA-II or LSA-III
- Surface Contaminated as SCO-I, SCO-II
- TYPE A
- TYPE B
- Fissile

Depending on the classification of the material, the appropriate package can then be selected. Packages are divided into seven types dependent on the quantity and nature of the radioactive contents; Excepted, IP1, IP2, IP3, Types A, B and C. The Table below shows the categorisation and package type.

Classification	Description	Package Type	Description of Package
Exempt	If the material is classed as EXEMPT, the transport regulations then do not apply and the material should then be transported in a suitable package appropriate to the material. However, this does NOT mean that the material is not Radioactive and therefore, the requirements of the Ionising Radiation Regulations still apply	**EXEMPT**	
Excepted	Where the activity of the material is less than specified limits. No special external labelling; activity such that whole radioactive content if released would not cause a significant hazard.	**Excepted**	Excepted material may be shipped in **Excepted Packages**. The maximum activity that may be transported depends on the radionuclide, the form the material takes and whether it is incorporated in for example an instrument. Empty packaging which has previously been used to transport radioactive material may also be categorised as excepted packages. Excepted Packages do not require competent authority approval and can be deemed suitable by the consignor or packer of the material. In general terms, the package must meet the requirements as laid down in TS-R-1 and must be suitable for normal conditions of Transport. Some main points are: • The radiation level on the external of the package must not exceed 5 μSv/h and • the contamination levels must be less than 4 Bq/cm^2 (beta/gamma) and 0.4 Bq/cm^2 (alpha). The package must be suitable for routine conditions of transport
Low Specific Activity	LSA is radioactive material where the activity is distributed homogeneously throughout the material and does not exceed the values specified in TS-R-1 for LSA-I, LSA-II or LSA-III material. LSA material may be ores such as Uranium or Thorium or other solid or liquid Radioactive material. The activity is subject to a maximum dose rate of 10 mSv/h at 3 m from the unshielded material(s). The category of LSA material is determined using derivatives of the A2 values, as described in the IAEA Requirements TS-R-1. LSA material depending on the specific class may be shipped either unpackaged for LSA-I under certain conditions or packaged within Industrial Packages (IP packages), IP-1, IP-2 or IP-3. These are normally ISO containers but maybe drums etc.	**IP1** **IP2** **IP3**	**IP-1** conforms to general design requirements; used for low specific activity materials like uranium and thorium ores, unirradiated fuel elements and waste. Material, if released, would not be particularly hazardous since large amounts would need to be ingested or inhaled to case a hazard. **IP-2 and IP-3**, in addition to meeting general design requirements, must satisfy specified performance standards; used for low-level radioactive materials such as consolidated wastes and contamination. These performance criteria are laid down as test procedures in the IAEA Requirements. Industrial packages have to withstand certain tests specified in TS-R-1 or have to demonstrate that they meet equivalent ISO standards as applied to freight containers.

Classification	Description	Package Type	Description of Package
Surface Contaminated Objects	SCO object which itself is not radioactive but has radioactive material which is fixed or non-fixed contamination on its accessible and non-accessible surfaces. SCO objects maybe classed as SCO-I or SCO-II depending on the level or fixed and no-fixed contamination. Depending on the classification as SCO-I or SCO-II, the material may be transported either unpackaged (as for LSA-I) under specified conditions or be transported in Industrial Packages, either IP-1, IP-2 or IP-3 depending on the category.		
Type A	For Special Form material the maximum activity is given by the A_1 value and for material that is not Special Form the A_2 value. The significant differences between the values mainly derive from the radiotoxicity. Where more than one radionuclide is packed or transported in a single package the Regulations provide a formula to calculate the A_1 and A_2 values (paragraph 404 TS-R-1)	**Type A**	Type A packages are more stringently designed than Industrial Packages, have to withstand certain performance tests (water spray, free drop, stacking and penetration tests) but need not withstand severe accidents. The "package" will consist of a number of constituent parts e.g. glass vile + polystyrene block + metal can + cardboard box. Responsibility for design and ability to withstand the specified tests rests with the **consignor**. The consignor must be able to demonstrate that the packages used are suitable to be TYPE A packages and have passed all the necessary test criteria. If the packages are hired or rented from another supplier, the consignor must ensure that he is confident that the package meets TYPE A criteria and have the relevant documentation regarding the package.
Type B	If the activity is greater than that which can be transported in a Type A package then a Type B must be used. The approval certificate will detail the radionuclides and maximum activity.	**Type B(U)** **Type B(M)**	There are two forms of Type B package: • **Type B(U)** – Unilateral: a package which meets all design requirements for worldwide movement; design only requires approval of Competent Authority of country of origin of design; no shipment certificate required. • **Type B(M)** – Multilateral: a package which does not meet all of the design requirements for worldwide movement; the package design must be approval by the Competent Authority of the country of origin and of each country through which the package is to be transported. Shipment approval may also be required. The approval certificate will specify the nuclides and maximum activities and will include an expiry date after which the individual container will be re-certified by the competent authority.

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