Basic principles of radioactive waste management

An introduction to the management of higher activity radioactive waste on nuclear licensed sites

Joint guidance from the Office of Nuclear Regulation, the Environment Agency, the Scottish Environment Protection Agency and Natural Resources Wales to nuclear licensees

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Contents

Foreword

In producing guidance to nuclear licensees on the management of higher activity radioactive wastes, the Office for Nuclear Regulation (ONR), the Environment Agency, the Scottish Environment Protection Agency (SEPA) and Natural Resource Wales (NRW) (together referred to as the regulators) received comments that it would be useful to have an introductory document explaining the context of radioactive waste management.

This introductory document aims to fulfil that role by explaining:

- what radioactive waste is;
- what happens to radioactive waste;
- who is involved in radioactive waste management;
- what their roles are; and
- how radioactive waste management is regulated.

Further information on the management of higher activity radioactive waste can be found in the joint guidance produced by the regulators for licensees[1].

Document history

This document updates and replaces the Fundamentals of the Management of Radioactive Waste[2].

Similarly the previously published Joint Guidance (Part 1[3], Part 2[4], and Part 3 (a-d)[5,6,7,8]) is updated and replaced by The management of higher activity radioactive waste on nuclear licensed sites[33]. Bringing the documents together eliminates and is intended to provide a single comprehensive source of information.

What is radioactive waste?

Definition of radioactive waste

Radioactive waste is any material that is either radioactive itself or is contaminated by radioactivity, for which no further use is envisaged. Government policy means that certain nuclear materials such as uranium, plutonium and spent nuclear fuel have not been declared as wastes by their owners.

Categories of radioactive waste

The term ‘radioactive waste’ covers a wide variety of material, ranging from wastes that can be put safely into a dustbin, to items that need remote handling, heavy shielding and cooling to be managed safely. Radioactive waste is considered in different categories, as follows:

High-Level Radioactive Waste (HLW)

High-level radioactive waste is radioactive enough for the decay heat to increase significantly its temperature and the temperature of its surroundings. This means that heat generation has to be taken into account when designing storage and disposal facilities.

This category of waste includes:

- the liquid residue that contains most of the radioactivity from the reprocessing of spent nuclear fuel;
- this residue once it has been solidified; or
- any other waste with similar radiological characteristics.

Intermediate-Level Radioactive Waste (ILW)

Intermediate-level radioactive waste is more radioactive than low-level radioactive waste (see below), but does not generate enough heat to require this to be taken into account of in storage or disposal facilities. However, like other radioactive waste it still needs to be contained to protect people and the environment. ILW arises mainly from the reprocessing of spent fuel and from general operations and maintenance at nuclear sites, and can include metal items such as fuel cladding and reactor components, graphite from reactor cores, and sludge from the treatment of radioactive liquid effluents.

Low-Level Radioactive Waste (LLW)

Low-level radioactive waste has a radioactive content not exceeding four giga-becquerels per tonne (GBq/te) of alpha activity or 12GBq/te beta-gamma activity and is suitable for disposal in near surface engineered facilities. Most LLW from nuclear licensed sites is currently disposed of at the Low Level Waste Repository (LLWR) near Drigg in Cumbria, although other disposal facilities are now permitted to receive such waste.

Most LLW arises from the operation of nuclear power stations and nuclear fuel reprocessing facilities, as well as the decommissioning and clean-up of nuclear licensed sites. Operational LLW is principally lightly contaminated miscellaneous waste arising from maintenance and monitoring, such as plastic, paper and metal. LLW from decommissioning is mainly soil, building materials and metal plant and equipment.

Very Low Level Radioactive Waste (VLLW)

VLLW is a sub-category of LLW, however amendments to legislation in 2011 means that this sub-category is now obsolete.

Exempt waste

Some radioactive waste is considered exempt, because its levels of radioactivity fall below thresholds defined in legislation and disposal of this waste does not require a radioactive substances permit or authorisation from the environmental regulators under the Environmental Permitting Regulations 2010 (EPR10) in England and Wales, or the Radioactive Substances Act 1993 (RSA93) in Scotland. However, disposal of exempt waste may be subject to other environmental regulation because of its non-radiological properties.

Higher Activity Radioactive Waste (HAW)

Higher activity radioactive waste is a broad term, which includes all HLW and ILW, as well as certain wastes categorised as LLW but which are not currently suitable for disposal in existing LLW facilities.

What happens to radioactive waste?

Once created, radioactive waste may undergo some of the following stages depending on the type of waste and the strategy for its management:

Pre-treatment is the initial step that occurs just after waste generation. It may involve collection, segregation, chemical adjustment and decontamination and may also include a period of interim storage. The aim of this step is to segregate waste into streams that will be managed in similar ways, and to isolate non-radioactive wastes or those materials that can be recycled.

Treatment involves changing the characteristics of the waste by volume reduction, radionuclide removal or change of composition. Typical treatment operations include:

- compaction of dry solid waste or incineration of solid or organic liquid wastes (volume reduction);
- filtration or ion exchange of liquid waste (radionuclide removal); and
- precipitation or flocculation of chemical species (change of composition).

Conditioning involves transforming radioactive waste into a form that is suitable for handling, transport, storage and disposal. This might involve immobilisation of radioactive waste, placing waste into containers or providing additional packaging. Common immobilisation methods include solidification of LLW and ILW liquid radioactive waste in cement, and vitrification of HLW in a glass matrix. Immobilised waste may be placed in steel drums or other engineered containers to create a waste package.

Storage of radioactive waste may take place at any stage in the radioactive waste management process and aims to isolate the radioactive waste, help protect the environment and make it easier to control its disposal. Storage may be used to make the next step in the management process more straightforward or to act as a buffer between or within steps. Waste might be stored for many years before it undergoes further processing and disposal. Some storage facilities are located within a nuclear power plant or a licensed disposal facility, others are separate facilities.

Retrieval involves recovering waste packages from storage either for inspection, for disposal or for further storage in new facilities. Some storage facilities are designed so the equipment that deposits waste can be operated in reverse to retrieve waste packages. Others may need retrieval equipment to be installed.

Disposal occurs when packages of radioactive waste are deposited in a disposal facility, with no intention of retrieval. Disposal may also include discharging radioactive wastes such as liquid and gaseous effluent into the environment and transfer of wastes from one site to another.

These basic steps in radioactive waste management are illustrated in Figure 1.

Which steps are employed in a particular situation depends on the types of radioactive waste and the methods of radioactive waste management that are to be used. In some cases individual steps may be closely linked or carried out together. The whole process needs to take place in such a way that the wastes are managed at each step, and it is compatible with the subsequent steps.

On most nuclear licensed sites there are a number of radioactive wastes to manage, particularly if nuclear facilities are being decommissioned. In all cases, an integrated approach to managing radioactive wastes and non-radioactive wastes is required.

Basic principles of radioactive waste management

Objective of radioactive waste management

The objective of radioactive waste management is to control and account for radioactive waste to protect human health and the environment now, but also to make sure we do not leave unnecessary burdens for future generations.

The preferred way to do this, where reasonably practicable, is to concentrate and contain the waste and to isolate it from the environment. This allows any releases to the environment to be restricted and subject to regulatory control.

Waste hierarchy

The waste hierarchy is a stepwise approach to achieving waste minimisation to promote sustainability that considers the lifecycles of both the processes that create waste and the waste that is produced from them. The hierarchy, as set out in the European Directive 2008/ 98/ EC on Waste (the Waste Framework Directive)[9] encourages the adoption of options for managing waste in the following order of priority:

- **Prevention**: Creation of waste should be prevented, or reduced at source (i.e. minimised), as far as possible to secure the conservation of nature and resources, in particular waste that cannot be managed using current techniques, or techniques under current development;
- **Preparing for reuse**: Where waste cannot be prevented, waste materials or products should, where appropriate, be reused directly or refurbished then reused;
- **Recycling**: Waste materials should be recycled or processed into a form that allows them to be reclaimed as a secondary raw material, where appropriate; and
- **Disposal**: Only if waste cannot be prevented, reused, recycled or recovered should it be disposed of into the environment and this should only be undertaken in a controlled and authorised manner.

These principles have been adopted in the UK government policy on LLW management[15]. The regulators consider that, so far as is reasonably practicable, they should be applied during the planning, design, construction, manufacture, commissioning, operational and decommissioning stages of a facility.

Policy and regulatory objectives

Government policy

The last full statement of government policy on radioactive waste management was in Cm2919[10]. This has been amended or elaborated as follows:

- The Decommissioning of the UK Nuclear Industry Facilities September 2004[11] replaces paragraphs 120–131 of Cm2919;
- Intermediate Level Radioactive Waste Substitution December 2004[12] replaces paragraphs 140–141 and 186 of Cm2919;
- Implementing Geological Disposal, A Framework for the Long-Term management of Higher Activity Waste 2014[13] which superseded the Managing Radioactive Waste, Safely A Framework for the Long-Term management of Higher Activity Waste 2008.[14]
- UK government policy on LLW management[15]
- The Scottish Government Policy[16] defines the policy for the long-term management of ILW and certain LLW in Scotland.

The regulators will take account of any future revision to this policy and amend this guidance as appropriate.

As stated in Cm2919 paragraph 52(2), The Government requires that the regulators ensure that the policy and regulatory framework is properly implemented in accordance with their statutory powers. Within the framework, the producers and owners of radioactive waste are responsible for developing their own waste management strategies, consulting the Government, regulatory bodies and disposal organisations as appropriate.

The Government maintains and continues to develop a policy and regulatory framework which ensures that:

- radioactive wastes are not unnecessarily created;
- such wastes as are created are safely and appropriately managed and treated; and
- they are then safely disposed of at appropriate times and in appropriate ways.

The fundamental aim is to ensure that radioactive waste is managed in a way that protects the public, workforce and environment and safeguards the interest of existing and future generations and the wider environment in a manner that commands public confidence and takes due account of costs.

The policy for the disposal of higher activity wastes in England is to manage higher activity waste in the long-term through geological disposal, with safe and secure interim storage.

Current Welsh Government policy is neither to support nor to oppose the United Kingdom government policy of geological disposal for Higher Activity Waste (HAW) and spent fuel classed as waste. Nor does the Welsh Government currently support any other disposal option for these wastes. Following a consultation[17], the Welsh Government is currently reviewing the responses received and will publish its findings and clarify its policy decision in the near future. Once clarity on Welsh Government policy on HAW disposal and the regulatory expectations from Natural Resources Wales is identified, this will be included in future revisions of this strategy.

The Scottish Government Policy[18] is that the long-term management of higher activity radioactive waste should be in ‘near surface, near site’ storage and/ or disposal facilities where the waste can be monitored, retrieved (if required) and the need for transportation over long distances is minimised.

Principles of radioactive waste management

The ONR Safety Assessment Principles (SAPs)[19] set out the basic principles of radioactive waste management:

- **RW.1**: A strategy should be produced and implemented for managing radioactive waste on a site. (This should be consistent with government policy, including the government's overall policy aims on sustainable development.)
- **RW.2**: The generation of radioactive waste should be prevented, or where this is not reasonably practicable, minimised in terms of quantity and activity.
- **RW.3**: The total quantity of radioactive waste accumulated on site should be minimised so far as is reasonably practicable.
- **RW.4:** Radioactive waste should be characterisation and segregated to facilitate subsequent safe and effective management.
- **RW.5**: Radioactive waste should be stored in accordance with good engineering practice and in a passively safe condition.
- **RW.6:** Radiological hazards should be reduced systemically and progressively. The waste should be processed into a passively safe state as soon as is reasonably practicable.
- **RW.7** Information that might be needed for the current now and future safe management of radioactive waste should be recorded and preserved.

For England and Wales the principles for the regulation of radioactive substances as detailed in Radioactive Substances Regulation: Environmental Principles[20,21]. Relevant principles include:

- **Principle RSMDP3 - Use of BAT to minimise waste**, states "The best available techniques should be used to ensure that production of radioactive waste is prevented and where that is not practicable minimised with regard to activity and quantity";
- **Principle RSMDP8 - Segregation of wastes**, states "The best available techniques should be used to prevent the mixing of radioactive substances with other materials, including other radioactive substances, where such mixing might compromise subsequent effective management or increase environmental impacts or risks."; and
- **Principle RSMDP9 - Characterisation**, states "Radioactive substances should be characterised using the best available techniques so as to facilitate their subsequent management, including waste disposal."

The EA principles do not apply in Scotland; guidance in this area can be found on the SEPA website[22].

Regulatory objectives

The regulators look to licensees to demonstrate strategic planning for managing all radioactive material and radioactive waste. This includes developing programmes for disposing of waste and the long-term management of material that may become waste at some time in the future. Strategies should be integrated within a single site and nationally where appropriate, to make sure the overall safety is maintained, while the environmental impact is minimised.

The regulators will be looking to see the Waste Framework Directive[9], is applied in the strategies (see sub-section 'Waste hierarchy'). This involves:

- avoiding producing radioactive waste where reasonably practicable;
- where waste does need to be produced, reducing this as much as reasonably practicable (in terms of both volume and activity);
- reusing or recycling material that forms radioactive waste where reasonably practicable;
- only disposing of radioactive waste that cannot otherwise be dealt with.

In terms of practical radioactive waste management, the regulators will be looking to see that, where reasonably practicable, licensees characterise and segregate their radioactive waste on the basis of physical and chemical properties and then store the waste in accordance with the principles of passive safety. The regulators will also be looking to see that licensees manage radioactive material and radioactive waste in a manner that is compatible with future potential disposal requirements.

More details on the regulatory objectives are provided in guidance to inspectors[23] and in the joint guidance on the management of higher activity radioactive waste produced by the regulators[1].

Who is responsible?

Licensees

Licensees bear the prime responsibility for safety and environmental protection.

Licensees bear the prime responsibility for safety and environmental protection relating to activities carried out on their sites. ONR requires that the licensee has an adequate management structure, capability and resources to do this before granting a nuclear site licence[24]. Licensees must produce safety cases for all operations, including radioactive waste conditioning operations, which consider safety, radioactive waste management and environmental protection.

In some cases, the licensee's own requirements or the site licence might mean that radioactive waste conditioning operations cannot continue without the permission of ONR.

The cost of regulation is met by licensees through charges made by ONR under section 24A of the Nuclear Installations Act 1965 (NIA65). These costs include the cost of advice given to ONR by the Environment Agency, SEPA or NRW.

NDA

The Nuclear Decommissioning Authority (NDA) is responsible for the decommissioning and clean-up of all civil public-sector nuclear sites in the UK, including the management of radioactive wastes. NDA establishes waste management plans with its Site Licensee Companies (SLCs), and consults on these plans with the regulators, as described in the Energy Act 2004 (TEA04).

In accordance with the Government announcement of 25 October 2006[14], NDA is also responsible for implementing the UK's geological disposal programme

(Potential) disposal site operators

Operators of radioactive waste disposal sites in the UK are responsible for operating their sites according to the terms of permits or authorisations granted by the relevant environment agency. As part of this, they must set out waste acceptance criteria (WAC) which can be used by nuclear site licensees to demonstrate in their conditioning proposals that wastes are disposable.

The government has announced[14] moves towards disposing of a range of higher activity radioactive wastes (HLW, ILW and some LLW) in deep geological repositories. Radioactive Waste Management Ltd is the body that will advise licensees, through the Letter of Compliance (LoC) process, on the packaging and conditioning of radioactive wastes until a repository operating company is set up. Radioactive Waste Management Ltd (RWM) is a wholly owned subsidiary of NDA.

A different policy applies in Scotland, where the preference is for long-term, near-surface, near-site management of higher activity waste[16]. The regulators consider that wastes packaged and conditioned in anticipation of deep geological disposal are also suitable for long-term management, as required by the government policy in Scotland.

How is radioactive waste management regulated?

ONR

ONR regulates radioactive waste management through conditions attached to the nuclear site licence.

ONR makes sure that the public and workers are protected from radiation by securing effective control of health, safety, radioactive waste management and security at nuclear sites. It enforces the Health and Safety at Work etc. Act 1974 (HASW74), the Energy Act 2013 (TEA13), and their relevant statutory provisions in Great Britain, including NIA65 and Ionising Radiations Regulations 1999 (IRR99).

There are 36 standard Licence Conditions[25] (LCs) attached to all nuclear site licences (see nuclear site licence conditions). All the licence conditions apply and are relevant to activities involving management of radioactive waste. However, a number of licence conditions are particularly relevant:

- **Licence Condition 4** requires that no nuclear matter is stored on the site except in accordance with adequate arrangements made by the licensee for this purpose;
- **Licence Condition 25** requires that adequate records are kept of the amount and location of radioactive waste used, stored or accumulated on site at any time.
- **Licence Condition 32** requires adequate arrangements for minimising so far as is reasonably practicable the rate of production and total quantity of radioactive waste accumulated on the site at any time and for recording the waste so accumulated;
- **Licence Condition 33** requires that radioactive waste is disposed of in accordance with an environmental permit.
- **Licence Condition 34** requires the licensee to ensure, so far as is reasonably practicable, that radioactive material and radioactive waste on the site is at all times adequately controlled or contained so that it cannot leak or otherwise escape from such control or containment; and
- **Licence Condition 35** requires the licensee to make and implement adequate arrangements for the decommissioning of any plant or process that may affect safety. Insofar as decommissioning and radioactive waste management are interlinked activities, this is a relevant licence condition to this guidance.

A series of Memoranda of Understanding (MoU)[a,] ensure that ONR consults the Environment Agency[26], SEPA[27] and NRW[28] on radioactive waste management activities and means that they will not give permission without taking full and meaningful account of any environmental issues raised.

The Environment Agencies

The Environment Agency, Scottish Environment Protection Agency and Natural Resources Wales regulate any disposal, discharge or off-site transfer of radioactive waste through authorisations issued under EPR10/ RSA93.

[a] ONR is in the process of developing and updating its MoUs with other government departments and agencies. Until such time as these are updated, MoUs with HSE and other bodies will apply equally to ONR.

The primary role of the environment agencies in the regulatory process covered by this guidance is to advise ONR on the long-term protection of the public and the environment. This includes providing advice on the disposability of conditioned waste in the long term, and ensuring waste is managed in a sustainable way, taking into account long-term environmental considerations. The agencies carry out this duty under section 37(3) of the Environment Act 1995[29] and charge for this advice under section 37(1).

The Environment Agency takes a leading role in protecting and improving the environment in England, while the Scottish Environment Protection Agency (SEPA) and Natural Resources Wales (NRW) have similar responsibilities in Scotland and in Wales. The environment agencies regulate radioactive disposals (including the discharge of gaseous and aqueous radioactive wastes) and the transfer of radioactive wastes between nuclear sites.

The legislation under which the environment agencies regulate is different. In England and Wales, the Environment Agency and NRW regulate the disposal of radioactive waste from nuclear licence sites under the environmental permitting (England and Wales) regulations 2010 (EPR10). In Scotland, the SEPA administers the Radioactive Substances Act 1993 (RSA93) which has similar requirements to EPR10. Before granting or significantly varying an authorisation granted the appropriate environment agency will wish to ensure that a systematic and proportionate examination has been made of the options for waste management (having regard to the waste hierarchy) and that the waste management strategy chosen represents the optimum to provide proper protection for people and the environment. Waste management strategies should be determined by application of the principles of best practicable means (BPM)[30] or best available techniques (BAT)[31] as appropriate to the legislative regime.

Under the terms of the MoU[26,27,28] the environment agencies consult ONR and will not authorise the disposal of radioactive waste without taking full and meaningful account of any health and safety issues raised.

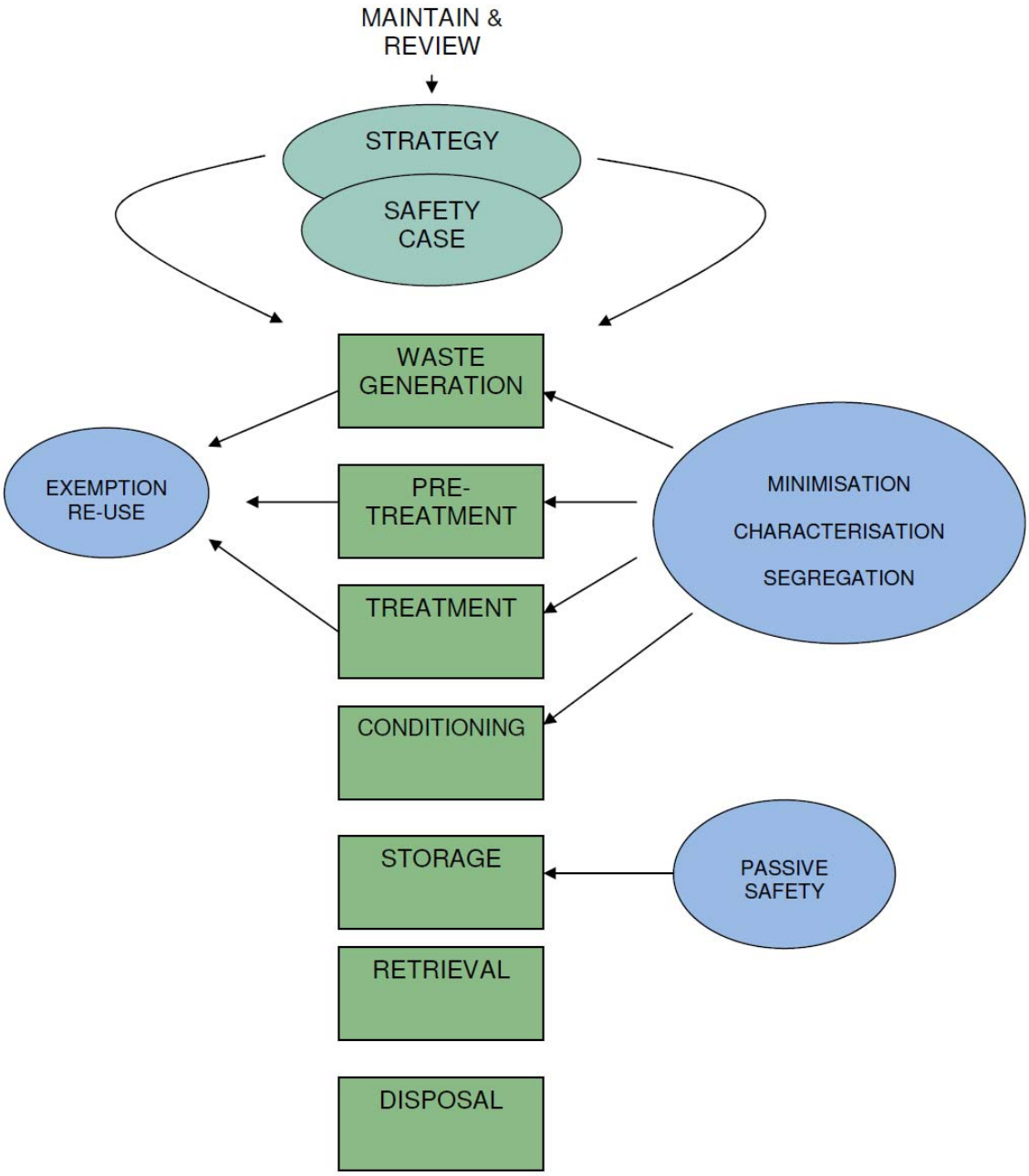

Figure 1: The basic steps of radioactive waste management

Abbreviations and Glossary

Characterisation - characterisation of radioactive waste involves determining its physical, chemical and radiological properties. It may be carried out in association with several of the other basic steps, such as during segregation. It may be required for record keeping, moving waste between steps and also to determine the best method for managing waste.

Clearance - clearance is where radioactive materials and their management are removed from within a process of regulatory control. It is particularly relevant to the management of wastes produced in decommissioning. The Euratom Basic Safety Standards BSS[32] provides guidance on exemption and clearance criteria.

Conditioning - conditioning involves transforming radioactive waste into a form suitable for handling, transportation, storage and disposal. This may include immobilisation of radioactive waste, placing waste into containers and providing additional packaging. Common immobilisation methods include solidification of LLW and ILW liquid radioactive waste, for example in cement, and vitrification of HLW in a glass matrix. Immobilised waste may be placed in steel drums or other engineered containers to create a waste package.

Disposal - disposal is the authorised emplacement of waste in a disposal facility without the primary intention of retrieval; retrieval may be possible but, if intended, the appropriate term is storage. Disposal may also include discharging radioactive wastes such as liquid and gaseous effluent into the environment and transfer from one site to another.

Exempt waste - radioactive waste can be exempted from specific regulatory control if its activity does not exceed thresholds of quantity and concentration laid down in the current regulations. In England and Wales the levels are described in Environmental Permitting Regulations (England and Wales) Amendment 2011. In Scotland, the requirements are set within the Radioactive Substances Exemption (Scotland) Order 2011.

HLW (High-level radioactive or heat generating waste) - Waste that is sufficiently radioactive that the decay heat significantly increases its temperature and the temperature of its surroundings. Typical characteristics of high level waste are thermal power above about 2kW/ m^3.

ILW (Intermediate-level radioactive waste) - waste with radioactivity levels exceeding the upper boundaries for low-level wastes, but which does not require heating to be taken into account in the design of storage or disposal facilities. IAEA guidance[Error! Bookmark not defined.] is that ILW thermal power is below about 2 kW/m^3.

LLW (Low-level radioactive waste) - waste having a radioactive content not exceeding four gigabecquerels per tonne (GBq/te) of alpha or 12 GBq/te of beta/gamma activity[b].

LoC (Letter of Compliance) - documentation provided by Radioactive Waste Management Ltd to a licensee (or anyone producing conditioned waste packages) indicating how well the proposed waste package would fit in the anticipated safety case for a repository. This information can be used by licensees to demonstrate to the regulators that the proposed packages should be disposable.

Minimisation - the process of reducing the amount and activity of radioactive waste to a level as low as reasonably practicable (ALARP) at all stages, from the design of a facility or activity to decommissioning. Waste generated can by reduced by means such as recycling, reuse and treatment, and requires due consideration for secondary as well as primary waste. Minimisation of waste is fundamental good practise in radioactive waste management. Effective methods of minimising the accumulation of radioactive waste include the clearance of waste that is exempt from regulatory control and the reuse or recycling of radioactive material

NDA (Nuclear Decommissioning Authority) - a non-departmental public body set up, under the Energy Act 2004, by the government in 2005 with a vision to ensure the safe, accelerated and affordable clean-up of the UK's civil nuclear legacy.

[b] Policy for the Long Term Management of Solid Low Level Radioactive Waste in the United Kingdom Defra, DTI and Devolved Administrations 26 March 2007

Nuclear matter - includes radioactive materials and radioactive waste, as defined in section 26 of NIA65:

(a) any fissile material in the form of uranium metal, alloy or chemical compound (including natural uranium), or of plutonium metal, alloy or chemical compound, and any other fissile material which may be prescribed; and
(b) any radioactive material produced in, or made radioactive by exposure to the radiation incidental to, the process of producing or utilising any such fissile material as aforesaid.
(c) any substance which meets the definition of radioactive waste in the Radioactive Substances Act.

Passive safety - providing and maintaining a safety function by minimising the need for active safety systems, monitoring or prompt human intervention.

Pre-treatment - Any or all of the operations prior to waste treatment, such as collection, segregation, chemical adjustment and decontamination. This step provides the best opportunity for segregating waste streams according to how they will be managed and to isolate those non-radioactive or recyclable wastes.

Radioactive material - defined in Environmental Permitting Regulations 2010, schedule 23, part 2, paragraph 2 as a substance, not being waste, falling within either or both of the following descriptions:

(a) a naturally occurring substance containing an element specified in Schedule 1 of the Act which is present at specific activity levels greater than those given in that Schedule;
(b) any substances which are not naturally occurring, whose radioactivity is wholly or partly due to nuclear fission, neutron or ionising radiation.

Radioactive waste - defined in Environmental Permitting Regulations 2010, schedule 23, part 2, paragraph 4 as waste which consists wholly or partly of:

(a) a substance or article which, if it were not waste, would be radioactive material, or
(b) a substance or article which has been contaminated in the course of the production, keeping or use of radioactive material, or by contact with or proximity to other waste falling within paragraph (a) or this paragraph.

RWM (Radioactive Waste Management Ltd) - a wholly owned subsidiary of the NDA. It is responsible for implementing geological disposal of higher activity radioactive waste, development of the geological disposal concept, defining waste package specifications, conducting disposability assessments and the issue of Letters of Compliance.

Segregation - An activity where types of waste or material (radioactive or exempt) are separated or are kept separate on the basis of radiological, chemical and/ or physical properties, to facilitate waste management. Mixing together radioactive wastes that have different properties and different methods of future management is avoided. It is most effectively carried out during the early steps of radioactive waste management.

Storage – the holding of radioactive sources, spent fuel or radioactive waste in a facility that provides for their/ its containment with the intention of retrieval. Storage of radioactive waste may take place at any stage in the radioactive waste management process and aims to isolate the radioactive waste and protect people and the environment from the hazards presented by the waste, while keeping the waste in a controlled state that will ultimately make it amenable to safe disposal. Storage may be used to make the next step in the management process more straightforward, or to act as a buffer between or within steps. Waste might be stored for many years before it undergoes further processing and disposal. Some storage facilities are located with a nuclear power plant or a licensed disposal facility, others are separate facilities

Treatment - treatment involves changing the characteristics of the waste. Basic treatment concepts are volume reduction, radionuclide removal and change of composition. Typical treatment operations include incineration or compaction of dry solid waste or organic liquid wastes (volume reduction),

filtration or ion exchange of liquid waste (radionuclide removal) and precipitation or flocculation of chemical species (change of composition).

VLLW (Very low-level radioactive waste) - a sub-category of LLW that, because of amendments to legislation, is now obsolete.

WAC (waste acceptance criteria) - Quantitative or qualitative criteria specified by the regulatory body, or specified by an operator and approved by the regulatory body, for radioactive waste to be accepted by the operator of a repository for disposal, or by the operator of a storage facility for storage.

Waste generation (waste creation) - occurs during the operation and decommissioning of nuclear facilities. Waste generation can give rise to solid, liquid and/or gaseous wastes.

Further reading

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- Basic Safety Standards Directive (BSSD) (Council 2013/59/EURATOM) - which lays down basic safety standards for the protection of the health of workers and the general public against the dangers arising from ionising radiation.
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