



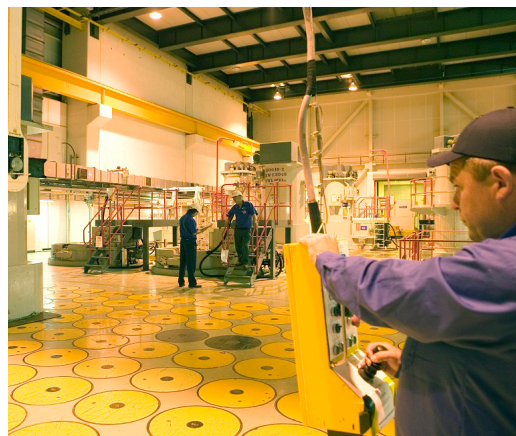
Department for
Business, Energy
& Industrial Strategy



Nuclear
Decommissioning
Authority

Radioactive Wastes in the UK:

A Summary of the 2016 Inventory



The 2016 United Kingdom Radioactive Waste & Materials Inventory (the 2016 Inventory) provides detailed information on radioactive wastes and materials in the United Kingdom (UK). It is produced by the Department for Business, Energy & Industrial Strategy (BEIS) and the Nuclear Decommissioning Authority (NDA).

The 2016 Inventory provides information on radioactive waste stocks (at 1 April 2016) and forecasts of future waste arisings. Information on radioactive materials that may be classed as waste in the future is also presented. The 2016 Inventory aims to provide data in an open and transparent manner for those interested in radioactive wastes and materials.

Information collected for the 2016 Inventory is presented in a suite of five reports:

- Summary Brochure
- Context & Methodology
- UK Radioactive Waste Inventory
- Radioactive Materials Not Reported
- Summary for International Reporting

All documents have been prepared using information supplied to the 2016 Inventory contractors, Pöry Energy and Amec Foster Wheeler. This information was verified in accordance with arrangements established by Pöry Energy and Amec Foster Wheeler.

This high level summary of the 2016 Inventory is written for a broad audience ranging from technical experts to interested members of the public. It outlines the current position of radioactive waste and nuclear materials in the UK, how much there is and how it is being managed.

Conditions of publication

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Feedback

You are invited to provide feedback to the NDA on the content, clarity and presentation of this report and the UK Radioactive Waste Inventory (i.e. the Inventory). Please do not hesitate to contact the NDA if you have any queries on the Inventory and radioactive waste issues. Such feedback and queries should be addressed to:

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ISBN: 978-1-905985-36-4

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AGR

Advanced Gas-cooled Reactor. A term used for the second generation of UK nuclear power plants. The fuel used in the reactor is slightly enriched uranium oxide clad in stainless steel. The coolant is carbon dioxide and the moderator is graphite.

BEIS

The Department for Business, Energy & Industrial Strategy is a ministerial department that brings together responsibilities for business, industrial strategy, science, innovation, energy, and climate change.

Bq

The standard international unit of radioactivity equal to one radioactive decay per second. Multiples of Becquerel used to define radioactivity include the Terabecquerel (TBq) equal to 1,000,000,000,000 Bq.

Conditioning

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

Conversion

In the context of nuclear fuel manufacture, conversion is process that changes the chemical form of uranium for the purposes of isotope enrichment.

Decommissioning

The process whereby a nuclear facility, at the end of its economic life, is taken permanently out of service and its site made available for other purposes.

Dismantling

The disassembly and removal of any structure, system or component during decommissioning. Dismantling may be performed immediately after permanent retirement of a nuclear facility or it may be deferred.

Disposal

The emplacement of waste in a suitable facility without intent to retrieve it. (Retrieval may be possible but, if intended, the appropriate term is storage.)

Enrichment

The process of increasing the U-235 isotope content of uranium.

GDF

Geological Disposal Facility. The specially-engineered facility that will house radioactive waste deep underground.

Geological disposal

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

LLWR

Low Level Waste Repository. The LLWR south of Sellafield in Cumbria has operated as a national disposal facility for LLW since 1959.

Magnox

An alloy of magnesium used for fuel element cladding in the first generation of UK nuclear power plants, and a generic name for this type of reactor. The reactor used natural uranium fuel, carbon dioxide coolant and graphite moderator.

MOX

Mixed Oxide. Refers to nuclear fuel consisting of uranium oxide and plutonium oxide for use in reactors.

NDA

Nuclear Decommissioning Authority. A non-departmental public body responsible for overseeing the decommissioning and cleanup of 17 of the UK's civil public sector nuclear sites.

Nuclear fuel

Fuel used in a nuclear reactor. Most fuel is made of uranium, and produces heat when the uranium atoms split into smaller fragments.

Plutonium

A radioactive element created in nuclear reactors. It can be separated from spent nuclear fuel by reprocessing. Plutonium is used as a nuclear fuel, in nuclear weapons and as a power source for space probes.

PWR

Pressurised Water Reactor. Reactor type using ordinary water under high pressure as coolant and neutron moderator. PWRs are widely used throughout the world for electricity generation. The Sizewell B reactor in Suffolk is of this design.

Radioactivity

A property possessed by some atoms that split spontaneously, with release of energy through emission of a sub-atomic particle and/or radiation. The process of atoms splitting is known as radioactive decay, and rate of decay is determined by the properties of these atoms.

Reprocessing

The chemical extraction of reusable uranium and plutonium from waste materials in spent nuclear fuel.

Spent Fuel

Fuel that has been used (i.e. irradiated) in nuclear reactors and is no longer capable of efficient fission due to loss of fissile material.

Storage

The emplacement of waste in a suitable facility with the intent to retrieve it at a later date.

Supercompaction

A general term that describes the reduction in bulk volume by the application of high external force. It differs from routine compaction methods by using hydraulic equipment capable of exerting forces of 1,000-2,000 tonnes, and the original container (metal drum or box) is supercompacted along with its contents. Waste is often precompacted into steel drums or boxes prior to supercompaction of the drum or box.

tHM

Tonnes of heavy metal. A unit of mass used to quantify uranium, plutonium and thorium including mixtures of these elements.

Introduction

An inventory of radioactive wastes and nuclear materials in the UK is published every three years. The 2016 Inventory provides information on the sources, quantities and properties of radioactive wastes as of 1 April 2016 as well as an estimate of future wastes.

The organisations that produce radioactive wastes, and are responsible for their management, have provided data for over 1,300 individual wastes. The Nuclear Decommissioning Authority (NDA) and the Department for Business, Energy and Industrial Strategy (BEIS) have overseen the process of compiling the Inventory.

Information in the Inventory helps the UK to plan safe and effective radioactive waste management, with high standards of protection for people and the environment. The Inventory informs the development of radioactive waste policy and strategy, and enables the UK to meet its reporting obligations under international treaties.

This brochure provides a summary of the 2016 Inventory and outlines the current position for radioactive waste and nuclear materials in the UK.



Managing Intermediate Level Waste at Winfrith

¹ The Inventory does not include liquid and gaseous wastes containing very low concentrations of radioactivity that are routinely discharged to the environment in accordance with statutory regulations. Discharges are made within authorised limits, usually after some form of treatment. Excluded are small quantities of solid wastes with very low concentrations of radioactivity typically from hospitals, universities and the non-nuclear industry (small users) that can be disposed of with domestic refuse to landfill, either directly or after incineration. Also excluded are naturally occurring radioactive materials (NORM), which accumulate as scale on pipework during the extraction of oil and gas. Because these scales have raised levels of radioactivity they are treated as radioactive waste.

What is radioactive waste?

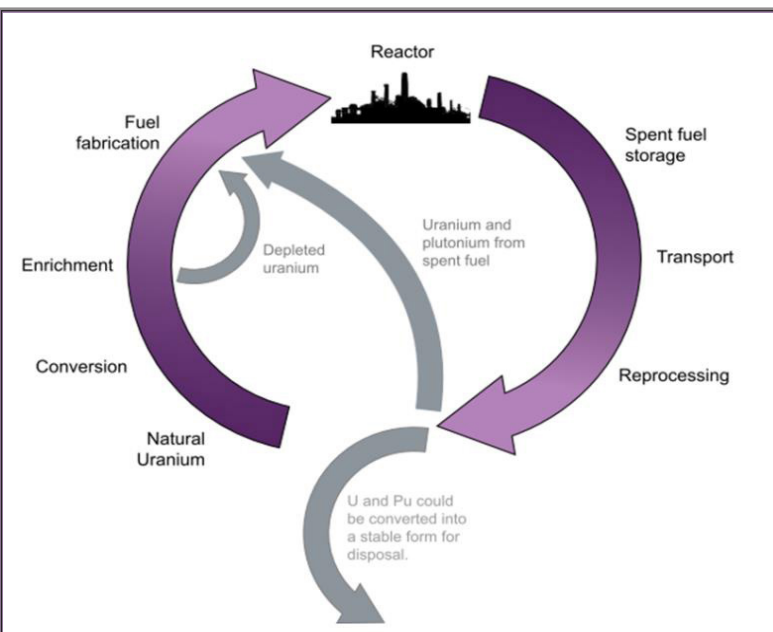
Radioactive waste is any item or substance that has no further use and that contains radioactivity above certain levels defined in legislation. It is a by-product of many industrial, medical, research and defence activities that make use of radioactivity and radiation. The UK was one of the first countries to use nuclear power to generate electricity and has been a pioneer in the development and use of nuclear technology that supports the 'nuclear fuel cycle'.

The UK has eight operating nuclear power stations that generate about 20-25% of the country's electricity supply. Eleven others are no longer producing electricity; they are being progressively dismantled.

Most of the waste from the nuclear electricity generating industry is from decommissioning the older nuclear power stations, historical spent fuel reprocessing and research and development (R&D) facilities.

The nuclear fuel cycle

This is the sequence of activities needed to manufacture nuclear fuel (conversion, enrichment, fuel fabrication) for generating electricity in nuclear reactors and, by reprocessing the spent (i.e. used) fuel, to recycle nuclear materials (uranium, plutonium) for fabricating new fuel.



The UK has a substantial legacy of radioactive waste from various civil and defence programmes. Some of this waste is already in storage, but most of it still forms part of existing facilities and will only become waste over the next century or so as these plants are shut down and dismantled.

Radioactive waste continues to be produced where radioactive materials are used. Most radioactive waste in the UK is from the nuclear electricity generating industry. This includes waste from:

- Manufacture of nuclear fuel;
- Operation of nuclear power reactors;
- Reprocessing of spent nuclear fuel; and
- Dismantling of redundant reactors and nuclear facilities.

Radioactive waste is also produced from spent fuel reprocessing at Sellafield in Cumbria. Spent fuel reprocessing at Sellafield has been undertaken since the 1950's, but is planned to end in 2020.

Defence activities that continue to produce radioactive waste are nuclear weapons production at Aldermaston, and operation and maintenance of the UK's nuclear-powered submarine fleet at Devonport and Clyde. The amount of radioactive waste from defence activities is very small (around 1% of the total volume).

Small amounts of radioactive waste result from the use of radioactivity in medical diagnosis and treatment, and in industrial and research applications.

The nature of radioactive waste is extremely diverse and differs from site to site. Radioactive waste in the UK is classified according to how much radioactivity it contains and the heat this radioactivity produces. The Inventory includes the four main categories of radioactive waste:

- High Level Waste (HLW);
- Intermediate Level Waste (ILW);
- Low Level Waste (LLW); and
- Very Low Level Waste (VLLW).

Materials

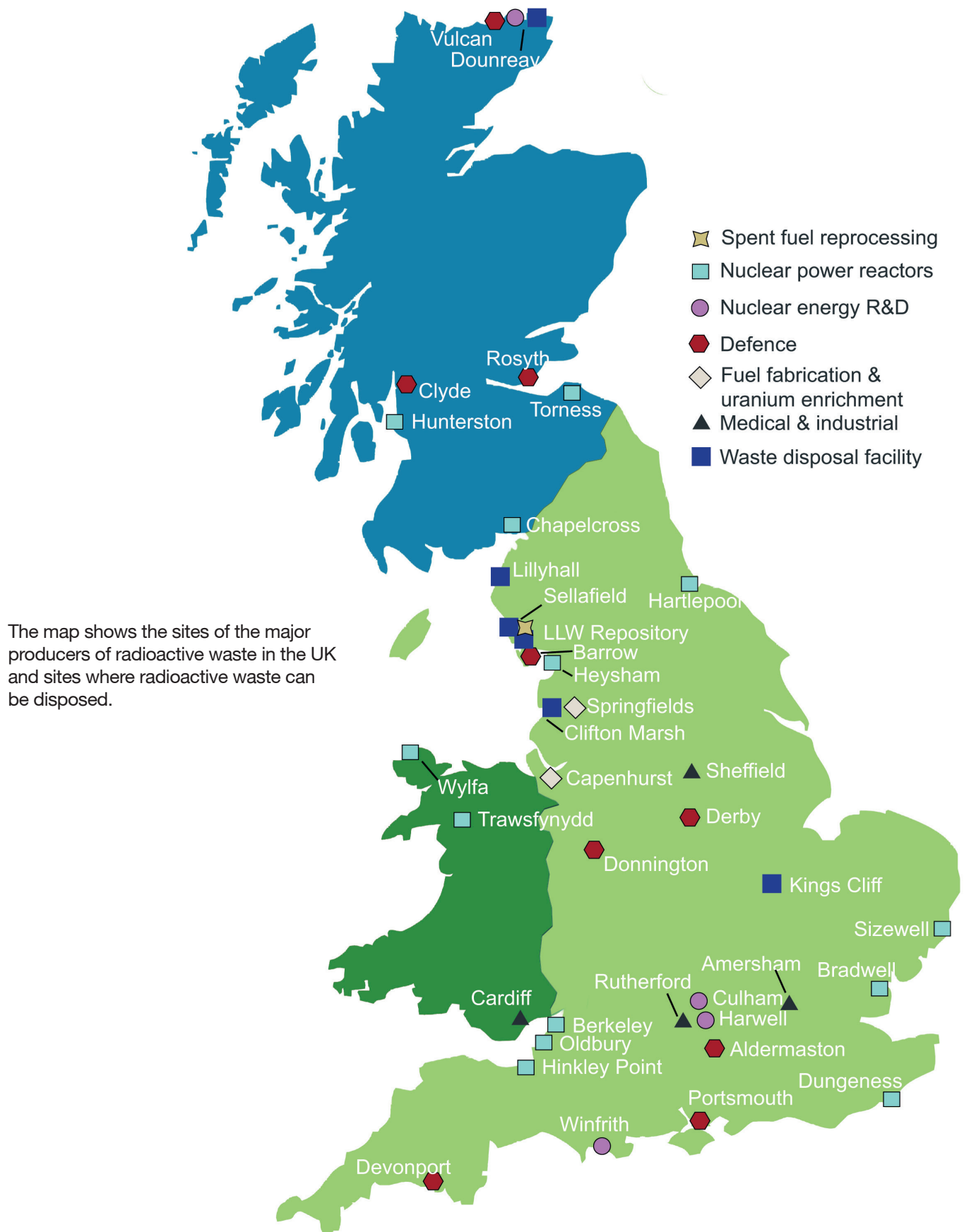
As well as waste, past and existing nuclear programmes have produced an accumulation of radioactive materials such as spent (i.e. used) nuclear fuel, uranium and plutonium that are not currently designated as waste. In most cases this is because they have potential value.

Spent fuel can be reprocessed to separate uranium and plutonium, which in turn can be used to manufacture fresh fuel. If the UK Government decides at some point in the future that these materials have no further use they will be managed as radioactive waste. Any decision will be based on economic, environmental and safety grounds.



The Low Level Waste Repository in Cumbria, with Sellafield in the distance.

Where is radioactive waste produced?



High Level Waste (HLW)

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

Spent fuel is reprocessed at Sellafield to recover uranium and plutonium. HLW is the residue produced during spent fuel reprocessing. The nature of reprocessing means that HLW is produced as an acidic liquid, which is highly radioactive and generates significant heat.

This liquid is converted to a stable solid form for storage. The waste is heated to dryness leaving a fine powder, which is mixed with crushed glass in a furnace to produce a molten product incorporating the waste. The product is then poured into stainless steel canisters, where it cools and solidifies. This process is known as vitrification and it reduces the HLW volume by about one third.

To date nearly 870 cubic metres of vitrified HLW have been produced and 5,780 canisters have been filled. These are held in a modern, engineered air-cooled store known as the Vitrified Product Store. This has thick concrete walls to shield operators from the high radiation.

There is no existing disposal route for HLW. However, current practice is for the canisters to be stored for at least 50 years before disposal. This allows the amount of heat produced by the waste to fall, which makes it easier to transport and dispose.



Vitrified Product Store for HLW canisters

Intermediate Level Waste (ILW)

Wastes exceeding the upper boundaries for LLW, but which do not require heating to be taken into account in the design of storage or disposal facilities.

ILW comprises a wide variety of waste forms. Items contaminated with radioactivity are produced from maintaining, refurbishing and dismantling facilities and plant that process radioactive materials. Such items include redundant plant items, filters, tools and gloveboxes.

The intense radiation in nuclear reactors results in the reactor and its fuel components becoming radioactive. ILW from reactor operation includes redundant nuclear fuel casing and defective reactor components. Reactor dismantling produces graphite blocks and other core components.

The treatment of radioactive liquid effluents at nuclear facilities also produces ILW in the form of sludges, ion exchange resins and flocs.

There is no existing disposal route for ILW so wastes are being stored in tanks, vaults, silos and drums on site. Some wastes are transferred off site to appropriate facilities when there is a clear and compelling strategic case to do so.

Most ILW is initially stored in an untreated or partly treated form, but some wastes are immobilised in cement (known as conditioning) shortly after they are produced.

Some ILW may be treated before it is packaged. The waste treatment techniques used depend upon the type of waste. Example waste treatment techniques include cutting, decontamination, shredding, compacting, drying and solidifying the waste.

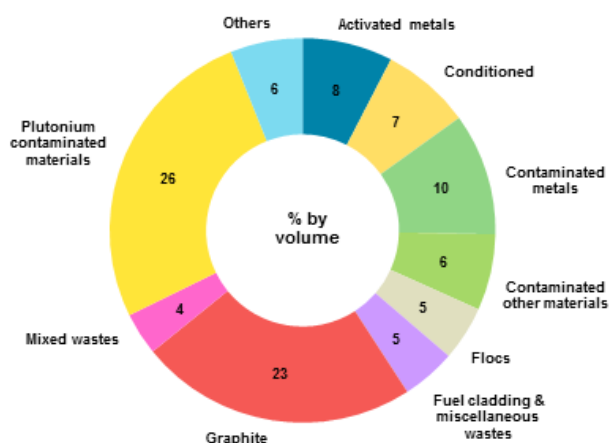


Modern LLW store at Winfrith

For most LLW, packaging involves encapsulating the waste in cement-based materials, and converting it into a solid, stable form. Typical package types include 500 litre stainless steel drums or 3 cubic metre stainless steel boxes. Large items are packaged in higher capacity containers. The packages are placed in specially-engineered stores. Some LLW from nuclear power stations is being packaged in thick-walled cast iron containers without encapsulation of the wastes. These containers do not require a store with significant levels of shielding.

To date over 31,000 cubic metres of LLW have been packaged, resulting in over 60,000 packages.

The different forms of waste that make up LLW



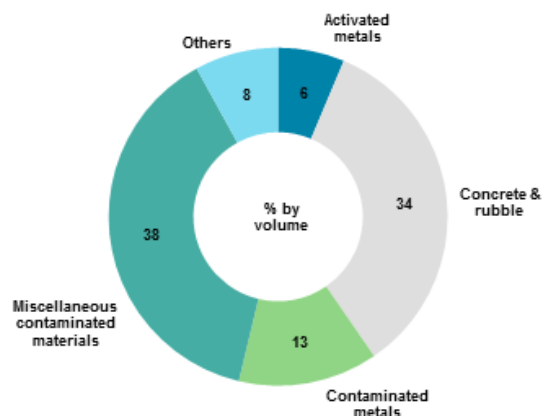
Low Level Waste (LLW)

Wastes having a radioactive content not exceeding 4 GBq (gigabecquerels) per tonne of alpha activity or 12 GBq per tonne of beta/gamma activity.

Most LLW comprises items that are contaminated with low levels of radioactivity. The day-to-day operation and maintenance of nuclear facilities produces a variety of low level contaminated scrap items. These include protective equipment, redundant plant items, filters, and ion exchange resins and sludges from the treatment of liquid effluents.

However, most LLW is generated from the dismantling and demolition of nuclear reactors and other nuclear facilities. This waste is principally structural building materials, such as concrete and reinforcement, brickwork, steelwork, as well as plant equipment and pipework.

The different forms of waste that make up LLW



A LLW National Waste Programme provides the main vehicle for driving sustainable LLW management across the UK. This helps to ensure that there is sufficient future capacity at the national Low Level Waste Repository (LLWR) in Cumbria for waste that cannot be managed using other options. Today over 85% of LLW is diverted away from the LLWR by using more sustainable waste management routes.

Some LLW can be processed in the metals recycling facility at Workington in Cumbria, which uses size reduction and shot-blasting techniques to minimise quantities of LLW metal sent for disposal. The clean material can then be released back into the scrap metals market.

The waste hierarchy



The waste hierarchy encourages new approaches for managing LLW in a more sustainable way. It sets out the priority order for managing waste materials based on their environmental impacts. The preference is to avoid producing waste or minimise the amount of waste that is generated in the first place. Where practicable, waste material is then considered for re-use or recycling following decontamination. If suitable, some waste may be incinerated. Disposal is the least preferred option.

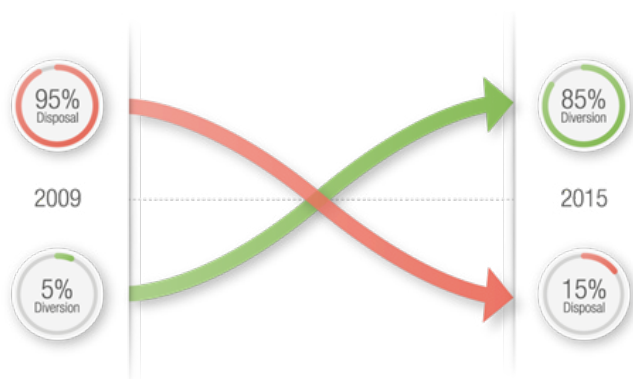
Since 1959 about 1 million cubic metres of LLW from the nuclear power industry, hospitals, research establishments and defence programmes have been consigned to the LLWR. Historically, disposal of LLW at the site was based on landfill practices, with waste being tipped into clay-based trenches and covered with layers of stone and soil. These trenches have now been covered with a water-resistant cap and a soil layer.

Today, suitable waste requiring disposal is supercompacted to minimise its volume before being placed in large metal containers similar to shipping containers. The containers are then filled with cement grout and placed in concrete-lined vaults.

To date over 10,000 containers have been produced.

A new shallow, engineered LLW disposal facility has been constructed next to the Dounreay site in Caithness. The disposal facility is receiving LLW from decommissioning at the Dounreay site, as well as retrieved and repackaged LLW from the historical disposal pits. It will also receive waste from the neighbouring Vulcan nuclear site that cannot be recycled. Waste transfers started in 2015 and about 3,000 cubic metres have been consigned.

Changing approaches to LLW management



Some material, predominantly rubble and soil with relatively low radioactivity can be routed to permitted landfill sites. Most LLW that is unsuitable for re-use, recycling, incineration or landfill disposal is sent to the LLWR disposal facility.



Metal treatment

Very Low Level Waste (VLLW)

A sub-category of LLW, it comprises waste that can be safely disposed of with municipal, commercial or industrial waste, or can be disposed of to specified landfill sites.

VLLW is very lightly contaminated with radioactivity. Small amounts, principally from hospitals and universities, can be safely disposed with municipal, commercial or industrial waste (either directly or after incineration). These wastes are not included in the Inventory.

Larger amounts of VLLW from nuclear sites are produced during facilities demolition and site clean-up operations. These wastes are principally structural building materials and excavated soil. These larger volumes of VLLW can be disposed of at appropriately permitted landfill facilities. Information about these wastes is included in the inventory.

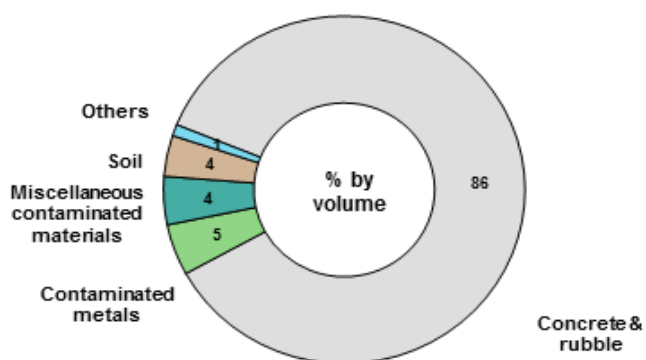
Inventory of all radioactive waste

The total amount of radioactive waste currently held in stores at 1 April 2016 and forecast in the future up to 2125 would occupy a volume of about 4.77 million cubic metres. This is a final volume after all wastes have been packaged. This volume is similar to the volume of Wembley stadium inside its walls and under its roof.

Total packaged volume for all radioactive waste forecast up to 2125 after waste packaging

Type	Total cubic metres
VLLW	2,720,000
LLW	1,600,000
ILW	449,000
HLW	1,500
Total	4,770,000

The different forms of waste that make up VLLW

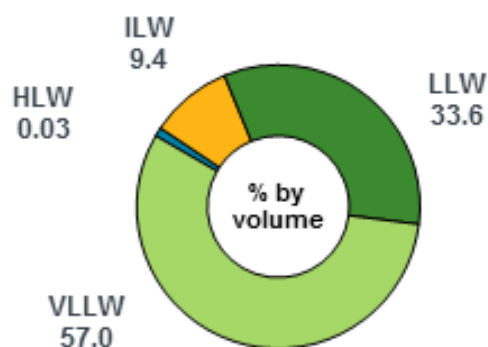


Clearing land contamination at Harwell

A further 1 million cubic metres of radioactive waste has already been disposed in the UK.

In comparison to all other forms of waste that the UK produces, the amount of radioactive waste is very small. The total mass of radioactive waste at 1 April 2016 and forecast in the future up to 2125 is about 4.9 million tonnes. However, the UK currently produces about 200 million tonnes of conventional waste each year. This includes about 4.3 million tonnes of hazardous waste each year.

More than 90% (4.32 million cubic metres) of radioactive waste is low activity waste (LLW and VLLW). Most of this waste is forecast to arise from dismantling existing nuclear facilities and cleaning up nuclear sites. Less than 10% (449 thousand cubic metres) of radioactive waste is ILW and less than 0.03% (1,500 cubic metres) is HLW.



Total packaged volume = 4,770,000 m³

Nearly three quarters of all UK radioactive waste is from Sellafield in Cumbria. Magnox power station sites and Springfields in Lancashire are the next largest producers.

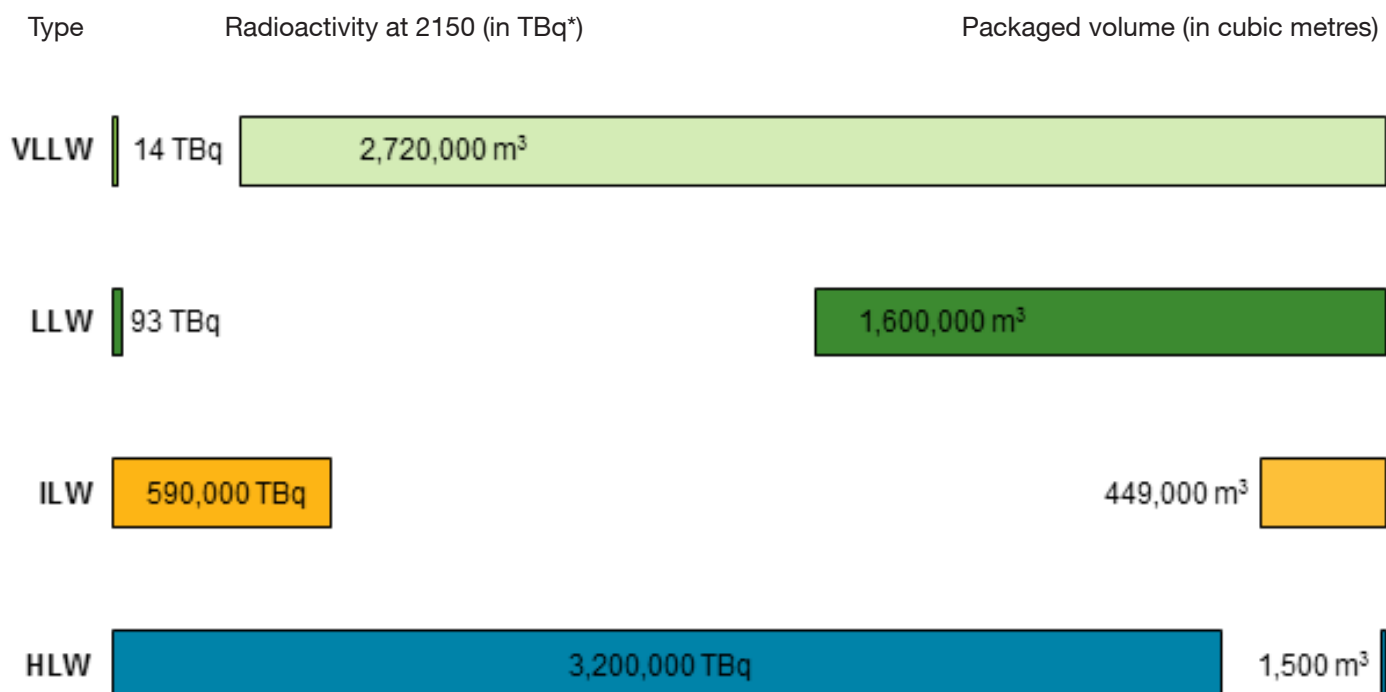
Although the amount of HLW is relatively very small it contains over 95% of the radioactivity in all radioactive wastes. ILW contains less than 5% of the radioactivity, and LLW and VLLW contain less than 0.0001% of the radioactivity. These percentage

values will change gradually over future time as radioactivity decays. The relationship between volume and radioactivity for each waste type is shown below. The relationship between volume and radioactivity for each waste type is shown below.

About 96% (4.6 million cubic metres packaged volume) of all forecast radioactive waste already exists. Most of it is still forms part of current nuclear facilities including nuclear reactors and reprocessing plants, and will only need processing as these facilities reach the end of their operating lifetimes, are shut down, decommissioned and cleaned up over the next approximately 100 years.

About 4% (170 thousand cubic metres packaged volume) of all forecast radioactive waste has yet to be produced. This is waste from future planned operations. The assumptions supporting these forecasts are shown in the box over the page.

*TBq (Terabecquerel) is a measure of radioactivity. It is equal to one million million disintegrations per second. The values given are at 2150; this is after all radioactive wastes in the inventory have been produced. The values include radioactive decay up to this date.



Assumptions supporting future waste forecasts

Nuclear power stations

- Operating power stations shut down over the period 2023 to 2035
- Deferred dismantling of Magnox and AGR reactor buildings for about 70 years before final site clearance
- Wastes from any new nuclear power stations are not included*

Spent fuel reprocessing

- Fuel reprocessing continues until 2020

Nuclear energy R&D

- Joint European Torus fusion experiment shut down in 2020

Defence

- A continuing nuclear defence capability (waste estimated up to 2080)
- A continuing nuclear-powered submarine programme (waste estimated up to 2110)

Medical and industrial sources

- The uses of radioactivity continue as today (waste estimated up to 2080)

*While the UK Government has stated that it supports new nuclear power stations and some operators are planning new stations, the 2016 Inventory does not include any estimates of waste arising from new build reactors as it is not yet clear how many reactors and of what design might be constructed. No final investment decisions had been taken by the 2016 Inventory reference date.



Sellafield is responsible for managing the largest amount of radioactive waste in the UK

When compared with the 2013 Inventory, there are only minor changes in the amounts of radioactive waste in the 2016 Inventory. Overall there is an increase of about 1% (about 50,000 cubic metres).

Estimates of radioactive waste may change in future inventories. These changes can be due to a range of technical, commercial or policy reasons. There are also some uncertainties in the amounts that may be produced, especially from dismantling older nuclear facilities and from site clean-up activities. As decommissioning projects are progressed, and as land contamination surveys are extended and refined, waste amounts can be estimated with greater certainty. Sellafield is responsible for managing the largest amount of radioactive waste in the UK.

Further information on waste volumes and changes from previous inventories can be found in the 2016 Inventory report 'UK Radioactive Waste Inventory'.



AGR spent fuel storage pond at Sellafield

Spent nuclear fuel

Nuclear fuel that is being or has been used to power nuclear reactors is referred to as 'irradiated'. When it has reached the end of its life and is no longer capable of efficient fission, it is known as 'spent fuel'. Spent fuel still contains large amounts of uranium (and some plutonium), which can be separated out by reprocessing and used to make new fuel.

Typically the spent fuel is made up of 96% unreacted uranium, 1% plutonium and 3% waste products, although the precise composition depends on the type of reactor and the amount of power produced by the fuel.

Historically the UK's approach has been to reprocess spent nuclear fuel in order to recover the uranium and plutonium. Plutonium recovery is no longer required for either civil or defence purposes. However, spent fuel from the Magnox reactor programme is reprocessed because it is unsuitable for long-term storage. Spent fuel from Advanced Gas-cooled Reactors (AGRs) will continue to be reprocessed until the Thorp reprocessing plant at Sellafield closes in 2018; thereafter the spent fuel will be stored at Sellafield in a pond. Spent fuel from the Sizewell Pressurised Water Reactor (PWR) is currently stored in a pond at the power station.

Other spent fuels have arisen from research, experimental and prototype reactors that are now shut down and being decommissioned. Most are being reprocessed. Small quantities of low irradiation spent fuel that are not planned to be reprocessed have already been designated as radioactive waste in the Inventory.

The total mass of spent fuel in the UK requiring longer-term storage (i.e. there are no current plans for reprocessing these fuels) is about 7,000 tHM.

In addition there are small amounts of unirradiated fuel in the Inventory that has not yet been used to power nuclear reactors. They include fuel at fabrication plants awaiting shipment and fuel at nuclear power stations awaiting loading into reactors.

Uranium

Uranium is a naturally occurring radioactive element and is used in fuel for nuclear reactors.

In the UK uranium material is produced as a by-product of uranium enrichment and spent fuel reprocessing.

Uranium enrichment produces large quantities of 'depleted' uranium – this is uranium containing a reduced amount of the uranium-235 isotope. This depleted uranium is currently stored as uranium hexafluoride (UF₆) in steel canisters, but will be 'deconverted' to uranium oxide for safer long-term storage.

Depleted uranium is not designated as a waste because it has other possible uses; it can be re-enriched to provide feed stock for new fuel and can be mixed with plutonium to make mixed oxide (MOX) fuel.

Spent fuel reprocessing recovers the unreacted uranium content of used fuel. This material can be re-enriched and reused in new nuclear fuel.

The total mass of UK-owned uranium that has been produced or is forecast to arise in the UK in future is about 200,000 tonnes. This assumes that uranium enrichment at Capenhurst continues for a further 20 years and that all spent fuel reprocessing at Sellafield ends in 2020.



Uranium hexafluoride storage

3 Natural uranium consists largely of two radioactive isotopes, uranium-235 and uranium-238. Energy produced in nuclear reactors is from the 'fission' or splitting of the uranium-235 atoms, a process which releases energy in the form of heat. Natural uranium contains 0.7% uranium-235. The UK's operating nuclear reactors require uranium fuel containing about 3-5% uranium-235. This means that the uranium has to be concentrated ('enriched') before the fuel can be manufactured.

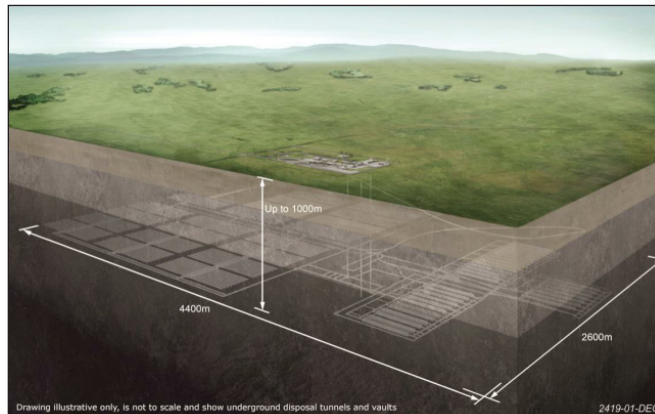
Plutonium

Plutonium is a radioactive element that does not occur in nature. Plutonium is created in nuclear reactors as a result of irradiating the uranium in nuclear fuel. Plutonium is contained within spent nuclear fuel when it is removed from the reactor, but can be extracted by reprocessing the fuel. This separated plutonium is stored as an oxide powder within high integrity containers in purpose-built facilities at Sellafield.

Plutonium is a potentially valuable energy source. The original intention of recovering plutonium was to reuse the material in a future fast breeder reactor programme. Fast breeder reactors make more efficient use of nuclear materials – effectively generating more fuel than they consume. It was believed in the 1950s and 1960s that a closed nuclear fuel cycle was the most desirable option for future energy supply in light of the scarcity of uranium at the time. The UK fast breeder reactor programme was cancelled in the early 1990s as the forecast uranium supply shortage did not occur, therefore closing this option for the use of recovered plutonium.

The total mass of UK-owned plutonium that has been produced or is forecast to arise from spent fuel reprocessing is about 114 tonnes.

Long-term Management of Wastes & Materials



Possible design for a Geological Disposal Facility

HLW and ILW

The UK Government's policy for managing higher activity wastes is 'geological disposal'. This involves placing waste deep underground in a Geological Disposal Facility (repository) with no intention to retrieve the waste once the facility is closed. It is proposed that spent fuel that has also been declared as waste would also be disposed at such a facility.

A GDF is a highly engineered facility with multiple engineered barriers, several hundred metres underground and constructed in a suitable geological environment. The combination of the engineered barriers and the host rock will safely isolate the waste from people for many hundreds of thousands of years.

There is no GDF yet operating but the UK Government is currently developing a site selection process to find a volunteer host community with suitable geology. The geological characteristics of the site are important for the long-term safety of the facility.

The Welsh Government has also decided to adopt a policy of geological disposal for the long term management of higher activity waste and continues to support the policy of voluntary engagement.

The precise layout and design of a GDF will depend on the inventory for disposal and the specific geological characteristics at the site in question. An artist's impression of one potential layout is shown above. All radioactive wastes will be stored in a safe and secure manner until a GDF is available.



Plutonium safe storage

The Scottish Government has a different policy for its higher activity wastes; this is that long-term management should be in near-surface facilities. Facilities should be located as near to the site where the waste is produced as possible and developers will need to demonstrate how the facilities will be monitored and how waste packages, or waste, could be retrieved.

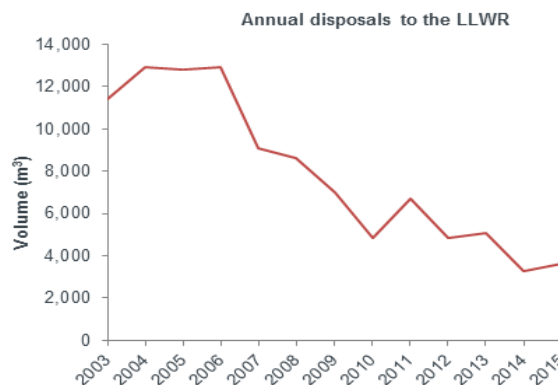
LLW and VLLW

Over the next 100 years large quantities of LLW and VLLW from nuclear plant decommissioning and site environmental restoration will have to be managed. The UK-wide strategy for managing LLW (and VLLW) from the nuclear industry recognises that the UK's radioactive LLW disposal capacity is a precious, finite resource and that waste producers must continue to move away from past reliance on disposal at the LLWR and other disposal sites.

Whilst the LLWR disposal site remains a key strategic asset for the UK's long term management of LLW, in recent years the LLW management environment has changed considerably with the:

- Application of the waste hierarchy by waste producers when making waste management decisions;
- Development and use of alternate treatments (e.g. incineration, metal treatment and re cycling) and disposal routes (e.g. authorised landfill sites);
- Diversion of significant amounts of waste away from disposal at the LLWR, extending its projected operating life to 2130; and
- Identification of opportunities for improvement and sharing of good practices, helping to optimise LLW management and reduce costs.

Improved segregation of waste materials on site is allowing metals to be diverted for recycling and combustible wastes for incineration. The opening up of disposal routes for VLLW together with improved waste characterisation is expected to lead to more LLW being recategorised as VLLW. Similarly, improved characterisation is also resulting in the recategorisation of some waste from ILW to LLW.



Annual disposals to the LLWR have fallen, with most waste diverted to other routes.

Radioactive materials

The strategy for nuclear materials management in the UK is safe and secure storage whilst cost-effective long-term management solutions are developed.

For plutonium the priority is to provide a solution that puts the vast majority of UK-held plutonium beyond reach. This is because of the continuing and extensive safety and security arrangements needed for the storage of these materials alongside international non-proliferation objectives to reduce separated plutonium stocks worldwide. The Government's preferred long-term management option is to reuse the UK's civil plutonium stockpile as mixed oxide (MOX) fuel.

Uranium is also being held in safe and secure storage whilst a long-term management option is developed. These options could include continued storage, recycling or disposal. Given the variety of uranium forms it is unlikely that a single strategic option will be suitable for the entire inventory.

Should plutonium or uranium be designated as radioactive waste in future, it would be contained within appropriate packaging and disposed to a GDF.



Certificate No. 4002929



Certificate No. 4002929/A

As well as this report there are a further four reports for the 2016 UK Radioactive Waste Inventory:

- Summary Brochure
- Context & Methodology
- UK Radioactive Waste Inventory
- Radioactive Materials Not Reported
- Summary for International Reporting

These reports are available in electronic format.

The 2016 Inventory documents can be obtained from the NDA (see contact details below) or via the UK Radioactive Waste Inventory website <http://ukinventory.nda.gov.uk>

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ISBN: 978-1-905985-33-3