2013 UK Radioactive Waste Inventory:

Scenario for Future Radioactive Waste and Material Arisings
The 2013 UK Radioactive Waste Inventory

Scenario for Future Radioactive Waste & Material Arisings

Report prepared for the Department of Energy & Climate Change (DECC) and the Nuclear Decommissioning Authority (NDA) by Pöyry Energy Limited and Amec plc.
The 2013 United Kingdom Radioactive Waste & Materials Inventory (hereafter referred to as the 2013 Inventory) will provide comprehensive and up-to-date information on radioactive waste and materials as at 1 April 2013. It is part of an ongoing programme of research jointly conducted by the Department of Energy and Climate Change (DECC) and the Nuclear Decommissioning Authority (NDA).

DECC and NDA have commissioned the 2013 Inventory to provide information on the status of radioactive waste stocks (at 1 April 2013) and forecasts of future arisings in the United Kingdom. Additional information on radioactive materials which may become wastes is collated. Its aim is to provide data in an open and transparent manner for those interested in radioactive waste and material issues.

Information collected for the 2013 Inventory is presented in a series of reports, as listed below:

- High Level Summary
- Summary of Data for International Reporting
- Scope and Conventions
- Scenario for Future Radioactive Waste & Material Arisings
- Waste Quantities from All Sources
- Radioactive Waste Composition
- Radioactivity Content of Wastes

All documents have been prepared on the basis of information supplied to the 2013 Inventory contractors, Pöyry Energy and Amec. This information was verified in accordance with arrangements established by Pöyry Energy and Amec.

This reporting output presents the scenario on which estimates of future radioactive waste and material arisings for the 2013 Inventory are based.

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Nuclear Decommissioning Authority
Information Access Manager
Herdus House
Westlakes Science & Technology Park
Moor Row
Cumbria
CA24 3HU

Tel: 01925 802077
enquiries@nda.gov.uk
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1 INTRODUCTION

The figures given in the 2013 Inventory for future radioactive waste and material arisings are projections made by the organisations that operate sites on the basis of their assumptions as to the nature, scale and timing of future operations and activities. These projections represent their planning positions at 1 April 2013, which have been constructed for the purpose of preparing data for the 2013 Inventory. Projections may need to be amended as plans and arrangements are developed or are changed for commercial, policy or funding reasons, or if improved data become available.

Since the 1 April 2013 there have been developments in the forward plans at a number of sites. This means that certain assumptions used in preparing data for the 2013 Inventory have already been revised or are being reviewed, and there will be or are likely to be some changes to waste estimates. Revisions can affect either or both the quantity and timing of future arisings.

Section 10 describes how certain changes in the assumptions used to prepare 2013 Inventory data could affect projections of future radioactive waste and material arisings.1

2 NUCLEAR DECOMMISSIONING AUTHORITY SITES

2.1 Sellafield

Sellafield is a large complex nuclear facility, which has supported the civil nuclear power programme since the 1940s. It now incorporates the historically separate licensed sites of Windscale and Calder Hall.2

Commercial operations at Sellafield include spent fuel reprocessing and the storage and treatment of nuclear materials and radioactive wastes.

The scenario assumptions described below were constructed for the 2013 Inventory. Actual quantities of fuel to be reprocessed and/or stored are subject to contractual arrangements to be agreed between NDA and its customers.

The Magnox reprocessing plant at Sellafield reprocesses spent fuel from the UK’s Magnox stations. At 1 April 2013, the total quantity of fuel reprocessed was approximately 52,000tU. This includes approximately 3,000tU of spent fuel from the overseas Magnox reactors at Latina in Italy and Tokai Mura in Japan. In addition, 44tU of Dounreay Fast Reactor breeder material will be reprocessed through the Magnox Reprocessing Plant.3 It is anticipated that all spent fuel from the continuing operation of Magnox stations in the UK will be reprocessed, and that the reprocessing plant will continue to operate until 2017. The lifetime throughput of the plant is expected to be approximately 55,000tU.

1 The 2013 Inventory does not include wastes from any new nuclear power stations. While the the UK Government supports new nuclear power stations and some operators are planning new stations, it is not yet clear how many reactors and of what design might be constructed.
2 For convenience Calder Hall is included with the other Magnox stations in Section 3.2.2 below.
3 Shipments of DFR breeder material from Dounreay to Sellafield started in December 2012.
The Thermal Oxide Reprocessing Plant (Thorp) reprocesses spent fuel from the UK’s Advanced Gas-cooled Reactor (AGR) power stations, as well as spent fuel from overseas Light Water Reactor (LWR) power stations. In addition, Thorp will reprocess the smaller quantities of spent fuel from the Windscale AGR (WAGR) and the Winfrith Steam Generating Heavy Water Reactor (SGHWR). At 1 April 2013, the total quantity of fuel reprocessed was over 7,000tU. Reprocessing in Thorp is forecast to continue until the end of 2018, and the lifetime throughput of the plant is expected to be approximately 9,500tU.

The estimate of lifetime waste arisings from Thorp has assumed the reprocessing of approximately 5,000tU AGR fuel. All other spent fuel generated during the lifetimes of the UK’s seven AGR power stations will be held in long-term storage at Sellafield. Measures including the reuse of pond furniture and continuing improvements in pond management practices will result in only small volumes of wastes being generated during fuel storage. Estimated arisings of such wastes are included in the Inventory. It is anticipated that spent fuel would be stored on site until about 2085, pending disposal in a Geological Disposal Facility (GDF).

Waste arisings from overseas LWR spent fuel reprocessing in Thorp are based on a total throughput of approximately 4,400tU.

Waste arisings from Thorp also include those from reprocessing 28tU of WAGR fuel and 120tU of SGHWR fuel, plus a small amount of other Post Irradiation Examination (PIE) type materials.

Mixed Oxide (MOX) fuel fabrication in the Sellafield MOX Plant (SMP) was discontinued in 2011. There will be future waste arisings from Post Operational Clean Out (POCO) and decommissioning activities.

There are routine waste arisings on the Sellafield site from waste packaging plants, effluent treatment plants, plutonium and fuel handling plants, other facilities and site construction activities.

Decommissioning activities for nuclear chemical plants at Sellafield are broken down into the following phases:

- **Initial Decommissioning** which seeks to remove or fix further loose radioactive material with the intention of enabling useful manual access for the interim decommissioning phase. It typically involves decontamination activities to reduce dose rates and removal of ancillary equipment and may include installation of systems to support the surveillance and maintenance phase (if required).

- **Surveillance and Maintenance (S&M)** describes the period of supervision of a plant or facility that may occur after POCO and before the start of the Interim Decommissioning phase. It would typically include operation and maintenance of radiological monitoring and ventilation systems in addition to the more general maintenance of the fabric of the building. This phase only occurs in the event of a requirement to delay decommissioning.

- **Interim Decommissioning** involves the removal of the active plant, equipment and associated systems. In general, the end-point of this phase is a building shell that contains only traces of activity, which are assumed to be localised LLW. It is anticipated that decontamination may not be entirely effective, so it is expected that more remote decommissioning activities may be required.

- **Care and Maintenance (C&M)** describes the period of supervision of a building shell, at minimal cost. This would normally entail minimum maintenance of the fabric of the building with the objective of ensuring that it presents no physical hazard to individuals or adjacent plants, while preventing any significant deterioration of the building. As with the S&M phase, plants and facilities only undergo this phase when there is a requirement to delay the final decommissioning phase.

- **Final Decommissioning** is the final activity associated with bringing a plant or facility to its agreed or assumed end-point (but excluding any contaminated ground or groundwater
remediation). This is assumed to be the demolition/deconstruction to base slab or ground level depending on the principles of ALARP (As Low As Reasonably Practicable). It is assumed that this will be carried out using predominantly conventional techniques.

- **Groundwater Remediation** covers the activities necessary to remediate any contaminated groundwater.
- **Contaminated Land Remediation** covers activities necessary to remediate any contaminated ground.

Decommissioning scheduling is subject to overall site priorities and is driven primarily by hazard and risk management with due consideration of environmental and security requirements.

**Key Dates**

- All reprocessing activities, including POCO (except for the already contracted storage of fuel and POCO of associated plants), will cease by about 2030; decommissioning of the majority of associated facilities will commence shortly thereafter.
- Prior to 2045, contaminated ground and groundwater activities are assumed to be based around monitoring and characterisation.
- Significant contaminated ground remediation activities will commence at 2050.
- Decommissioning activities will be largely complete by 2090.
- All buildings/waste stores (except product stores and supporting ancillary buildings) are assumed to be demolished by 2120.
- It is assumed that institutional control will be maintained after 2120.

There are three shutdown reactors on the historic Windscale site: WAGR, Pile 1 and Pile 2. WAGR, which was operated until 1981, is currently undergoing interim decommissioning. Final decommissioning (Stage 3) of WAGR will be complete by 2045.

The two pile reactors were operated until 1957 when a fire damaged the Pile 1 core, which has created significant additional decommissioning challenges. Stage 2 decommissioning has been completed for Pile 2 and is currently forecast to be complete for Pile 1 in 2031. Following a period of C&M, Stage 3 decommissioning (removal of core and bioshield) is currently planned to be complete by 2041 for Pile 1 and by 2050 for Pile 2.

### 2.2 Magnox stations

Eleven Magnox power stations came into operation over the period 1956 to 1971. At 1 April 2013 only Wylfa was still operating. Ten stations are shut down: Berkeley, Bradwell, Calder Hall, Chapelcross, Dungeness A, Hinkley Point A, Hunterston A, Oldbury, Sizewell A and Trawsfynydd.

A timetable for the operation and decommissioning of all Magnox stations is given in Table 3.1.
Table 3.1: Proposed timetable for Magnox stations

<table>
<thead>
<tr>
<th>Station</th>
<th>Operation</th>
<th>Defuelling and C&amp;M Preparations</th>
<th>Interim C&amp;M</th>
<th>C&amp;M</th>
<th>Final Site Clearance</th>
</tr>
</thead>
</table>

(1) The dates in the table refer to financial years not calendar years. All future dates for operation, defuelling and C&M Preparations are under review and could change. Dates given are those used in preparing waste volumes data for inclusion in the Inventory.

(2) Calder Hall is part of the Sellafield site operated by Sellafield Ltd. All other stations are operated by Magnox Ltd.

(3) The implementation of the Magnox Optimised Decommissioning Programme (MODP) at Chapelcross and Dungeness A has led to the optimisation of the C&M Preparations phase by accelerating the higher hazard reduction activities while deferring much of the low hazard deplanting and demolition activities. It also introduces an Interim C&M period between the higher hazard reduction and the deplant and demolition activities.

(4) Berkeley Site comprises the Magnox station site and that part of what was Berkeley Centre containing the R&D active handling facilities.

(5) Reactor 2 was shut down in April 2012, Reactor 2 is planned to continue generating until September 2014.

The decommissioning strategy for the Magnox sites is "Deferred dismantling of the reactors":

**Defuelling and C&M Preparations:** Removing the fuel from the reactor; removing most plants and structures other than the reactor buildings. This is planned to take between 14 and 37 years.

**C&M:** A period of deferment, planned to extend to between about 50 and 70 years.

**Final Site Clearance:** Dismantling of all remaining structures, clearing and restoring the site. This is assumed to take between 5 and 10 years.

After defuelling, exterior cladding on the reactor containment building would be replaced as necessary with high-integrity materials and un-needed openings would be in-filled to create a low-maintenance structure.

Wastes that arise during the defuelling of Magnox reactors are the same as those that arise during operation. For this reason they are included with operational wastes.

The active handling facilities at Berkeley Site (previously part of Berkeley Centre) used to provide research and development facilities including a post-irradiation examination service. Operations ended in 2005, and the facilities are undergoing decommissioning.

### 2.3 LLWR

The Low Level Waste Repository (LLWR) in Cumbria is the national disposal site for low level wastes. It has operated since 1959, and accepts LLW from a wide variety of sources throughout the UK including nuclear licensed sites, hospitals, research establishments and industrial concerns.
Operations at the site, which cover receipt, storage and disposal of LLW, are forecast to continue until 2080, and will generate small quantities of LLW.

The site has also been used for storing plutonium contaminated materials (PCM), initially in former munitions storage magazines, subsequently in a custom built drum store. All PCM has since been retrieved from the drum store and removed from the site for long-term storage at nearby Sellafield. However, several PCM magazines still require decommissioning. The completion of these decommissioning activities is planned for around 2019-2020.

2.4 Dounreay

The three reactors on the Dounreay site are shut down. The Prototype Fast Reactor (PFR) and Dounreay Fast Reactor (DFR) are undergoing decommissioning. The Dounreay Materials Test Reactor (DMTR) is currently under a C&M regime, Stage 1 decommissioning having been completed.

Both fuel reprocessing plants are shut down. There will be no further arisings of MTR raffinate, DFR raffinate or PFR raffinate. Existing stocks will be conditioned in the Dounreay Cementation Plant (DCP).

The shaft will be emptied of waste, with some decontamination of rock being undertaken. The Silo will be emptied and decontaminated, and the structure will be removed. Separate waste treatment plants will be constructed for the retrieval and conditioning of the wastes from these facilities.

The site Waste Receipt Assay Characterisation and Supercompaction (WRACS) facility treats solid LLW. A LLW disposal facility (for wastes from Dounreay and the adjacent Vulcan site) has been constructed, with disposals starting within the next year subject to regulatory authorisations.

The site plan is that all redundant facilities will be decommissioned by 2025. Published dates for the decommissioning of key facilities may change. Therefore DSRL reports waste arisings up to the 2025 site closure date for the 2013 Inventory.

The proposed timetable for the operation and decommissioning of the major facilities on the Dounreay site is shown in Table 3.2 below.

<table>
<thead>
<tr>
<th>Table 3.2: Proposed decommissioning timetable for major Dounreay facilities</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Facility</strong></td>
</tr>
<tr>
<td>---------------</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>PFR</td>
</tr>
<tr>
<td>DFR</td>
</tr>
<tr>
<td>DMTR</td>
</tr>
<tr>
<td>PFR reprocessing plant</td>
</tr>
<tr>
<td>MTR reprocessing plant</td>
</tr>
<tr>
<td>Development laboratory</td>
</tr>
<tr>
<td>Silo</td>
</tr>
</tbody>
</table>

Note: The dates in the table refer to financial years.
2.5 Harwell

Three redundant reactors remain on the Harwell site since GLEEP decommissioning was completed in 2005. The BEPO reactor and the materials test reactors DIDO and PLUTO were decommissioned to Stage 2 several years ago, and all are currently under a minimum C&M regime.

The reference strategy at 1 April 2013 is to decommission and remediate the site so that by 2027 the only licensed facilities remaining would be stores for packaged operational and decommissioning ILW. Final decommissioning of the reactors is scheduled to start in 2015 for BEPO and 2021 for the MTRs.

The Radiochemical facility ceased operations in 2004, although parts of the building were used subsequently to process certain historic wastes and are currently being used for the interim storage of contact-handled ILW in drums. Stage 1 decommissioning of certain laboratories was undertaken before full shutdown, and under the reference plan the whole of the building should be decommissioned by 2023. RSRL is in the process of establishing similar waste processing operations as part of the wider scope of waste processing in the Solid Waste Complex.

The timetable for the operation and decommissioning of the remaining major facilities on the Harwell site is shown in Table 3.3 below.

<table>
<thead>
<tr>
<th>Facility</th>
<th>Operation</th>
<th>Decommissioning</th>
</tr>
</thead>
<tbody>
<tr>
<td>BEPO</td>
<td>1948 – 1968</td>
<td>Complete</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Complete</td>
</tr>
<tr>
<td>DIDO</td>
<td>1956 – 1990</td>
<td>Complete</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Complete</td>
</tr>
<tr>
<td>PLUTO</td>
<td>1957 – 1990</td>
<td>Complete</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Complete</td>
</tr>
<tr>
<td>facility</td>
<td></td>
<td>2016 – 2025</td>
</tr>
</tbody>
</table>

Decommissioning is divided into three stages:

**Stage 1:** For reactors: remove fuel, coolant and non-fixed items of plant such as process materials and rigs. For other facilities: remove all radioactive sources and readily removable equipment. Prepare facility for a period of C&M if required.

**Stage 2:** Dismantle and remove most of the remaining fixed radioactive material. Prepare facility for a further period of C&M if required.

**Stage 3:** Return facility to a condition where no significant hazard remains.

2.6 Winfrith

There are two remaining shutdown reactors on the Winfrith site: the SGHWR and the Dragon high temperature gas-cooled reactor. Most of the secondary facilities associated with these buildings have been decommissioned, and the reactors have been in a C&M regime for a number of years. In 2011 limited decommissioning activities recommenced on Dragon. Final decommissioning of both reactors is scheduled to commence in 2014 and be completed by 2021.
The timetable for the operation and decommissioning of remaining major facilities on the Winfrith site is shown in Table 3.4 below.

### Table 3.4: Proposed decommissioning timetable for major Winfrith facilities

<table>
<thead>
<tr>
<th>Facility</th>
<th>Operation</th>
<th>Decommissioning (1)</th>
</tr>
</thead>
</table>

(1) For an explanation of the three stages of decommissioning see Chapter 3.2.5.

#### 2.7 Springfields

Operations at Springfields comprise the fabrication of oxide fuels for AGRs and LWRs, intermediate fuel products such as powders, granules and pellets and the production and delivery of natural uranium hexafluoride. In addition, redundant plants and buildings are being demolished, and there is an ongoing programme to recover the site’s historic legacy of uranic residues via residues recovery facilities.

Estimates of future arisings at the site are based on a number of projections. The final recovery of legacy natural and enriched uranium residues is due for completion by approximately 2017/18. Uranium hexafluoride (Hex) production will continue until 2016 at about 5,000tU per year.

Oxide manufacturing will continue until 2023 supplying AGR fuel in line with the current planned closure dates of the AGR power stations, and uranium dioxide products for UK and overseas customers. The annual capacity for AGR fuel manufacture is approximately 260tU, with current demand at 215tU. Intermediate oxide product annual demand is between 200 and 400tU.

The decommissioning of the Magnox and Residue Recovery plant has been delayed due to the need to utilise these facilities for residues storage and processing. Decommissioning of residues facilities is now expected to be completed by 2017, and the Hex Plant and Oxide Fuels Complex have a provisional date of 2045. Final site clean-up and remediation now has a provisional date of ~2100.

### 3 EDF ENERGY SITES

EDF Energy through its licence holder company EDF Energy Nuclear Generation Ltd operates seven AGR power stations and one PWR power station.

The AGR stations came into operation in the UK over the period 1976 to 1988, and the PWR station in early 1995. All eight stations are still operating. Predicted waste arisings from AGR stations assume an operational lifetime of between 35 and 47 years, depending on the station. The PWR station is assumed to operate for 40 years.
A timetable for the operation and decommissioning of the AGR stations is given in Table 3.5.4

### Table 3.5: Proposed timetable for EDF Energy AGR power stations

<table>
<thead>
<tr>
<th>Station</th>
<th>Operation</th>
<th>Defuelling and C&amp;M Preparations</th>
<th>C&amp;M</th>
<th>Reactor Dismantling &amp; Final Site Clearance</th>
</tr>
</thead>
</table>

Note: The dates in the table refer to calendar years and not to financial years.

EDF Energy has proposed an “Early Safestore” strategy for AGR decommissioning, with the start of final reactor dismantling deferred for a period of at least 85 years after the end of generation for AGRs. The decommissioning strategy is divided into three stages as follows:

**Defuelling and C&M Preparations:**

The reactor is defuelled and the fuel transferred for reprocessing or storage. Buildings and plant external to the reactor area are dismantled along with some of the active plant and buildings. Accumulated mobile operational waste is retrieved and packaged. Safestores are constructed to retain all of the active plant and materials on the site in a safe and secure state. These activities are assumed to take between 11 and 14 years.

**C&M:**

There is a period of C&M with inspection and repair as necessary. The duration is assumed to be 71-74 years. It is assumed that during this period packaged ILW will be recovered from stores and disposed of to a GDF.

**Reactor Dismantling & Final Site Clearance:**

Safestore dismantling and final site clearance is envisaged to start about 85 years after reactor shutdown. All activities are assumed to take between 9 and 10 years.

For the Sizewell B PWR the strategy is Early Site Clearance, with reactor dismantling deferred for a period of 10 years after station shutdown. All decommissioning work on the site is planned to be completed 20 years after station shutdown (see Table 3.6). This strategy has been adopted following a review of international best practice for PWR decommissioning.

### Table 3.6: Proposed timetable for EDF Energy PWR power station

<table>
<thead>
<tr>
<th>Station</th>
<th>Operation</th>
<th>Defuelling and C&amp;M Preparations</th>
<th>Reactor Dismantling &amp; Final Site Clearance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sizewell B</td>
<td>1995 – 2035</td>
<td>2035 – 2045</td>
<td>2043 – 2053</td>
</tr>
</tbody>
</table>

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4 Since the 2010 Inventory, EDF Energy has announced operational life extensions for Heysham 1 and Hartlepool of 5 years to 2019, and for Hinkley Point and Hunterston of 7 years to 2023.
EDF Energy has contracts that cover the management of spent fuel generated during the lifetimes of the AGR power stations. The contracts provide for a mixture of long-term storage and reprocessing at Sellafield, and the radioactive wastes generated are included in wastes reported for Sellafield site.

For the Sizewell B PWR, the strategy is to store spent fuel until a disposal route is available, although this does not foreclose potential alternative options.

4 MINISTRY OF DEFENCE SITES

The MoD produces radioactive wastes primarily as a result of the nuclear weapons and nuclear propulsion plant programmes, research and development activities and through the redundancy of assorted equipment that contain radioactive substances. In addition, volumes of waste are produced as a result of the remediation of radioactively contaminated ground on both nuclear and non-nuclear defence sites.

The figures for future waste arisings are projections made by MoD and/or its site operators on the basis of assumptions as to the nature and scale of future operations and activities, and reflect the most likely national defence strategy.

Many of MoD’s sites are operated on its behalf by contractor organisations. For some sites ownership has also been transferred. However the ownership of radioactive wastes at all sites rests with the MoD, which also bears the cost of waste management and decommissioning.

4.1 Atomic Weapons Establishment Aldermaston

The primary purpose of the Atomic Weapons Establishment (AWE) is to support UK nuclear security needs. UK Government policy is to maintain Trident and the nuclear deterrence programme to underpin national security and deter credible threats to the UK. In the Government’s 2010 Strategic Defence and Security Review [1] the warhead system is described as not needing replacement until the late 2030s. Approval has been given for the refurbishment and replacement of some key facilities to enable the option (of replacement) to be available in the next parliament.

AWE has been managed for the MoD through a private sector contract arrangement since 1993. While the sites and facilities remain in government ownership, their management, the day-to-day operations and the maintenance of the nuclear stockpile, is contracted to a private company. This makes AWE a Government Owned Contractor Operated (GOCO) establishment.

AWE’s nuclear facilities are located at Aldermaston and Burghfield, in Berkshire. The Aldermaston site is primarily engaged with research, development, manufacturing and storage of weapon components. Support activities include operations and maintenance of facilities, decommissioning and demolition of redundant facilities, waste processing, waste storage and waste disposal. The activities at Aldermaston include work with radioactive, explosive and toxic materials. Assembly and disassembly of nuclear weapons are the principal nuclear licensed activities that take place at Burghfield.

Wastes from Burghfield are included with those from Aldermaston, as the Aldermaston site is where radioactive waste storage and disposal are co-ordinated. The inventory includes radioactive waste liabilities from:

- Legacy waste stock;
- Waste from production and research facilities; and
- Waste from the decommissioning of existing and future nuclear facilities including final land remediation.
As no viable site end point is currently determinable, a future “end of operations” date has been assumed as the operational lifetime of the current facilities (~2060).

4.2 HMNB Devonport

The Devonport site comprises the Naval Base (owned and operated by the MoD) and its co-located Dockyard (owned and operated by Babcock International Group plc).

Devonport provides maintenance and support services for the operational UK nuclear submarine squadrons. It has the facilities to carry out operations associated with submarine refitting and defuelling. Since 2004 all UK nuclear submarine refitting work has been carried out at Devonport.

Operational waste arisings from Devonport have been derived by extrapolation of historical data and are forecasted up to 2100.

4.3 Rosyth Royal Dockyard

Submarine refitting and refuelling activities at Rosyth ceased in 2003. Progressive site decommissioning has started, and is forecast to continue until 2013/14.

4.4 HMNB Clyde

HMNB Clyde provides maintenance and support services for the operational UK nuclear submarine squadrons. It deals with radioactive wastes arising from weapons handling, and the operation at sea and the maintenance ashore of submarine nuclear propulsion systems.

Operational wastes are at a significantly lower level than those resulting from refitting work at Devonport. The predicted arisings are based on the number of submarines maintained and future development work, and are thus subject to change.

4.5 Decommissioned nuclear powered submarines

When nuclear powered submarines leave Naval service the nuclear fuel is removed, equipment taken off and the vessel prepared for storage afloat. This process is called decommissioning, but in the Naval sense, and is distinct from the decommissioning of nuclear power stations. After Naval decommissioning, radioactivity remains contained within the reactor compartment structures.

To date 17 nuclear-powered submarines have left naval service, and 11 have been defuelled. They are being stored afloat at Rosyth and Devonport dockyards.

Future arisings of submarine decommissioning wastes assume a continuing naval nuclear propulsion programme with a fleet of up to 8 SSNs (nuclear powered, conventionally armed submarines) and 4 SSBNs (nuclear powered submarines with ballistic nuclear weapons). Submarines are assumed to have a hull life of between 25 and 30 years and to be stored afloat for 30 years before being dismantled and the waste processed. Future arisings of submarine decommissioning wastes are forecast up to 2100.

MoD’s Submarine Dismantling Project (SDP) [2] aims to deliver a safe and secure solution for dismantling 27 of the UK’s defuelled nuclear-powered submarines, comprising all 17 currently stored afloat and a further ten yet to leave service (up to and including the Vanguard class). The process for selecting an interim ILW storage site, pending disposal in the planned GDF, may affect the current 30-year afloat storage policy, which in turn may affect the rate at which the waste is processed.

The 2013 Inventory includes wastes for 34 submarines, comprising those under SDP and an assumed 7 Astute class.
4.6 HMNB Portsmouth

HMNB Portsmouth is involved in managing naval stores and de-equipping redundant naval surface vessels that can contain equipment and instrumentation incorporating radioactive materials. The base produces small quantities of radioactive waste from these activities.

4.7 Dounreay (Vulcan)

The Naval Reactor Test Establishment (NRTE) Vulcan at Dounreay is involved in development work, acting as the test bed for prototype submarine nuclear reactors. Operations are forecast to continue to the end of core life in 2014.

This will be followed by a post-operational phase that is estimated to continue until 2020. Decommissioning is assumed to take place during the period 2020 until 2050.

4.8 Rolls Royce Marine Power Operations Ltd Derby

Rolls Royce Marine Power Operations Ltd (RRMPOL) operates two nuclear licensed sites at Raynesway in Derby, where work is carried out in support of the MoD’s nuclear submarine programme. RRMPOL manufactures the reactors for the Navy’s nuclear powered submarines, and operates the low energy Neptune reactor used to develop submarine reactor designs.

The future of the sites is inextricably linked to the future operational requirements of the submarine fleet. It is envisaged that both of the nuclear licensed sites will operate at the current levels of activity for at least the next ten years.

4.9 BAE Systems Marine Ltd Barrow-in-Furness

BAE Systems Marine (BAESM) Ltd builds, tests and commissions nuclear submarines in support of the MoD’s nuclear submarine programme. The site generates only small quantities of radioactive waste associated with the commissioning of submarine nuclear reactors.

4.10 Eskmeals

The Eskmeals site, operated by QinetiQ on behalf of MoD, has been used for proof firing of a wide range of different calibre weapons by the UK’s armed services. This included test firing of projectiles made up in part of depleted uranium, and the use of ‘hard targets’ for testing the effectiveness of armour plating containing depleted uranium.

The firing programme using depleted uranium projectiles is currently suspended, but there are no plans to close the site.

QinetiQ are in the closing stages of the first phase of decommissioning for the MoD, but do not yet have full figures of how much LLW and VLLW this has produced.

4.11 Logistic Services Donnington

Logistics Services Donnington holds redundant equipment containing radioactive materials pending a decision on their future use; and when declared as waste are disposed of as soon as possible in accord with current legislation.

The future needs of MoD will govern waste arisings. It is assumed that waste will continue to arise at current levels.

4.12 Defence Infrastructure Organisation

The Defence Infrastructure Organisation is responsible for managing the MoD Estate.
As part of their work the Defence Infrastructure Organisation manages a major Land Quality Assessment (LQA) programme to assess and manage land contamination, including radioactive land contamination across the MoD Estate. This has the potential to create volumes of low level waste comprising predominantly soil, ash and rubble from the remediation of radioactively contaminated ground. The principal source of the contamination is expected to be radium associated with the historic maintenance and disposal of luminised equipment.

5 UNITED KINGDOM ATOMIC ENERGY AUTHORITY SITE

Small quantities of ILW and LLW will continue to be produced from the operational phase of the JET fusion experiment located at Culham Centre for Fusion Energy (CCFE). The reference decommissioning strategy at 1 April 2013 assumes that operations continue to 2018 and the facility then moves immediately into decommissioning.

However, the length of future operations is uncertain. The UK Atomic Energy Authority’s contract to operate JET is dependent on the experimental requirements, the performance of the JET machine and on EU funding. Operations are also expected to continue for some time in support of ITER. There is some uncertainty over what further experiments will take place, and therefore what will be the final inventory of the plant and of the resultant decommissioning waste quantities. There is, however, an agreed limit on the maximum neutron production from deuterium-tritium operations, which has been used to define a bounding inventory for the wastes, and is likely to be fully utilised.

The UK Atomic Energy Authority has been investigating possible treatment and packaging options for JET ILW streams including options for reduction of the tritium inventory to enable its reuse for fusion research. On the basis of a start date of October 2018 for the decommissioning, removal of the torus facility is programmed for completion in 2024. The Active Gas Handling System needs to remain operational during the dismantling of the JET machine, but should then be fully decommissioned by September 2026, and the JET site completely cleared by the end of 2027.

6 GE HEALTHCARE LTD SITES

Expansion of GE Healthcare Ltd’s activities is expected to be mainly in non-radioactive products. Future radioactive waste arisings are estimated up to 2040. Volumes are based on a continuation of the current rate of arising. Market forces will govern future business and manufacturing activities, so the medium and longer-term estimates of waste volumes and type can only be approximate.

Predictions for decommissioning waste arisings are included in operational wastes, since facilities do not have a fixed operating lifetime but are refurbished as necessary. The rate of arising of refurbishment wastes reflects expected facilities development plans for commercial activities.

7 URENCO SITE

Future arisings at Urenco’s Capenhurst site will be dependent on the commercial contracts won by the group and the installation of new enrichment capacity. The use of either natural uranium or recycled uranium from reprocessing as the enrichment feedstock will be a commercial and regulatory decision. Waste volumes are estimated up to 2030. Uranium recovery routes are in place for some waste materials, and it is assumed that these will remain
open in the short term. In the long term it is envisaged that uranium recovery will be undertaken at Capenhurst.

Government-owned uranium by-product/legacy material from uranium enrichment (uranium tails) will be processed in Urenco’s Tails Management Facility.

8 IMPERIAL COLLEGE SITE

Small quantities of ILW and LLW will be generated from decommissioning the CONSORT research reactor.

The plan is that the reactor will be defuelled and dismantled over a period of ten years 2013-2023. Used reactor fuel, other fissile material and ILW will be transferred off site, and LLW disposed.

9 MINOR WASTE PRODUCERS

Most radioactive waste produced by minor waste producers is not reported in the UK Inventory as it is either low volumes of LLW that can be disposed of by ‘controlled burial’ at landfill sites, or low volume VLLW that can be disposed of with municipal, commercial and industrial wastes at landfill sites.

The rates of arisings from the minor waste producers that are reported in the 2010 Inventory are difficult to predict. In recent years annual arisings of ILW have fallen, and are now at very low levels. Future arisings are expected to be minimal.

Most LLW reported in the 2010 Inventory is consigned to the LLWR. The rate of future arisings of this LLW is assumed to be the same as current arisings, and is estimated up to 2080.

Included in wastes from minor producers is material contaminated when radioactive sources were accidentally smelted at a Sheffield steelworks.

10 DISCUSSION OF SCENARIO

10.1 Fuel manufacturing and uranium enrichment

Springfields manufactures oxide fuels for AGRs and LWRs, and intermediates for export. Uranium hexafluoride continues to be manufactured and exported. Future operations at Springfields will depend on commercial strategies and the outlook for the worldwide nuclear power industry. The 2013 Inventory scenario assumes that oxide fuel and product manufacture and uranium enrichment operations do not continue beyond 2030.

Urenco’s business at Capenhurst supplies enriched uranium for oxide fuel manufacture. Future operations at Capenhurst will depend on the outlook for the worldwide nuclear power industry. The 2013 Inventory scenario assumes that uranium enrichment operations do not continue beyond 2030.

With regard to plutonium, the Government’s preferred long-term management option is to reuse the UK’s civil plutonium stockpile, and the NDA will therefore progress reuse options as: MOX fuel; as fuel in a CANDU reactor; and, as fuel in a PRISM fast reactor. In addition, NDA will also investigate options to immobilise and dispose of the plutonium as a waste [3].

Assumptions could be revised to accommodate an extension of AGR lifetimes as well as firm commitments to build new nuclear generating capacity in the UK and overseas.
10.2 Nuclear power station operation

Power station operating lifetimes are those in operators’ existing corporate plans. However, market conditions or technical and safety issues could result in revisions to lifetimes.

Possible alternatives to current lifetime assumptions for the AGR stations and the PWR station are early closure or extended operation. To illustrate the impact of power station lifetime changes, the authors have estimated waste volumes from one year’s operation of AGR and PWR stations (see Table 3.7). The figures do not include wastes from the reprocessing of one year’s discharged fuel.

Longer or shorter operating lifetimes for power stations would not have a significant effect on overall future waste volumes from the stations, which are dominated by wastes from decommissioning.

Table 3.7: Predicted waste volumes from 1 year’s operation of power station

| Waste type | Station (1) | Volume arising (m³) | When all waste has been packaged | | |
| --- | --- | --- | --- | --- |
| | | | Packaged volume (m³) | Conditioned volume (m³) |
| ILW | AGR (2) | 18 | 32 | 24 |
| | PWR (3) | 4.5 | 17 | 7.1 |
| LLW | AGR (2) | 47 | 29 | 23 |
| | PWR (3) | 68 | 110 | 88 |

(1) Magnox is not included because the one remaining station at Wylfa is scheduled to shut down in 2014 once remaining fuel stocks are utilised.

(2) Average annual arising for period 2013-2018 at AGR stations.

(3) Average annual arising for period 2013-2019 at Sizewell B.

A number of organisations are pursuing plans for new nuclear power stations in the UK. NNB GenCo (a subsidiary of EDF Energy) plans four new reactors; two at Hinkley Point and two at Sizewell. Horizon Nuclear Power (a subsidiary of Hitachi) has plans for new build at Oldbury and Wylfa. NuGeneration Ltd (owned by GDF Suez and Iberdrola) has acquired land for new build in West Cumbria.

Two reactor designs were considered in the Generic Design Assessment (GDA) process: the UK EPR™ developed by AREVA and EDF and the AP1000© reactor developed by Westinghouse Electric Company.

The plans of NNB GenCo to build the EPR are the most advanced. In November 2012 the Office for Nuclear Regulation (ONR) granted the company a nuclear site licence for Hinkley Point C. The Environment Agency has granted permits governing the discharge of liquid effluents and the safe disposal of radioactive waste. In March 2013 the Secretary of State for Energy and Climate Change granted a development consent order to the company to build and operate Hinkley Point C and associated development.

Estimates of radioactive waste that would be generated from operating the EPR at Hinkley Point C are shown in Table 3.8 [4]. This excludes radioactive wastes from reactor decommissioning and from interim spent fuel and waste storage facilities.
Table 3.8: Predicted operating lifetime waste quantities from EPR

<table>
<thead>
<tr>
<th>Waste type</th>
<th>Volume arising (m$^3$)</th>
<th>Packaged volume (m$^3$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ILW</td>
<td>600</td>
<td>3,200$^{(2)}$</td>
</tr>
<tr>
<td>LLW</td>
<td>4,380</td>
<td>6,560$^{(3)}$</td>
</tr>
</tbody>
</table>

(1) Data for Hinkley Point C. For 60 years operating life for a single EPR unit. Excludes wastes from decommissioning and from interim spent fuel and waste stores.

(2) Packaged in C1 and C4 concrete casks.

(3) Based on preferred disposal options.

As well as station lifetime the quantities of spent fuel from a new build reactor would depend on the operating regime. For illustrative purposes an EPR where 1/3$^{rd}$ or 1/4$^{th}$ of the fuel assemblies are removed and replaced every 18 months would produce respectively 3,370 or 2,610 fuel assemblies over a 60-year operating lifetime. This is equivalent to about 1,780tU or 1,380tU [4].

10.3 Reprocessing of spent fuel from nuclear power stations

Waste volumes in the 2013 Inventory are based on a scenario that assumes the reprocessing of all spent Magnox fuel, SGHWR and WAGR fuel, about 5,000tU of AGR fuel and about 4,400tU of overseas LWR fuel. This does not include approximately 4,500tU of AGR fuel that is forecast to arise over UK power station lifetimes. This fuel will be held in long-term storage pending availability of a GDF.

There are no current plans to reprocess fuel from Sizewell B. It is assumed that the fuel will be held in long-term storage pending availability of a GDF.

10.4 Nuclear research and development

Nearly all of the major facilities built in the UK over more than 50 years to undertake research and development in support of nuclear energy generation and fuel cycle operations have been closed down, and have either already been decommissioned or are currently being decommissioned.

The JET fusion facility is assumed to operate until October 2018. However, the extent of future operations is uncertain, and JET could well operate beyond this date for several years in support of ITER. Because annual operational arisings are low, any change to the reference date will not have a significant effect on overall radioactive waste volumes.

10.5 Ministry of Defence activities

Spent fuel from nuclear powered submarines has not been declared as waste. It is held in long-term storage at Sellafield.

While MoD has stated that Eskmeals will be maintained for the foreseeable future, no comment has been made about the future of the battery. There have not yet been any steps taken to estimate the volume of defence wastes likely to arise from decommissioning of the battery.

MoD’s SDP addresses the process for deciding and implementing future policy for managing the hulls, and particularly the reactors, of decommissioned nuclear submarines. Any change in this programme would affect future waste arisings.

The MoD Estate is subject to a rolling programme of prioritised Land Quality Assessment (LQA). This assessment includes the potential for radioactive contamination. In light of the
ongoing LQA programme, the current volume estimate for arisings associated with the remediation of contaminated ground in the UK is subject to potential significant change.

10.6 Radioactive materials and other potential wastes

The quantities of UK civil nuclear materials and other potential wastes including contaminated land are given in a separate reporting output ‘Radioactive Materials’.

10.6.1 Nuclear materials

In addition to commercial spent fuel for which there are no current plans to reprocess (see Section 10.3), the UK has stocks of spent nuclear fuel from research and demonstration reactors with no current reprocessing route. There are also uranic materials, plutonium (from the reprocessing of spent nuclear fuel), Magnox Depleted Uranium (MDU – a by-product of Magnox spent fuel reprocessing), Thorp Product Uranium (TPU – a by-product of oxide spent fuel reprocessing) and “Hex tails” (a by-product of the uranium enrichment process).

Government in consultation with NDA and other stakeholders is considering the most effective management strategies for these materials, including what proportions might be retained as a strategic stock, recycled (e.g. as reactor fuel) and regarded as waste.

10.6.2 Contaminated land

Ground and building foundations at nuclear sites may become contaminated with low concentrations of radioactivity as a result of lifetime site operations. The removal of contaminated foundations and the remediation of contaminated ground will generate radioactive wastes.

There is greater uncertainty in the future arisings of waste from the remediation of contaminated land than in facility dismantling and demolition wastes. This is particularly the case for radioactive wastes at the lower end of the activity range. Estimation of volumes of these wastes can be somewhat speculative due to lack of definition of site decommissioning and clean-up plans, and that much characterisation work might remain to be carried out and that this work may indicate that remediation is not required. Furthermore the benefit of decontamination that might allow waste volume to be below the lower threshold level for radioactive waste must be considered against the cost and dose detriment.

Some contaminated ground is reported as radioactive waste in the 2013 UK Inventory. However because of the uncertainties described above, some waste producers have chosen to report potentially contaminated land with radioactive materials until contamination surveys are extended and refined, and there is more certainty on volumes. This applies to Aldermaston, Sellafield and Springfields. In these cases in-situ volumes of potentially radioactively contaminated ground and foundations are given.

10.6.3 Miscellaneous wastes and materials

There are a limited number of radioactive wastes (so-called ‘orphan’ wastes) from Sellafield and Capenhurst for which no final treatment, packaging or disposal route has yet been identified, and which are not sufficiently well characterised to be reported as wastes in the 2013 Inventory.
11 REFERENCES


### GLOSSARY

The glossary contains a list of specialised terms and abbreviations used in this reporting output.

<table>
<thead>
<tr>
<th>Term</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Activation products</strong></td>
<td>Radionuclides produced in materials as a result of neutron capture by atoms that constitute either the materials or impurities in those materials.</td>
</tr>
<tr>
<td><strong>AGR</strong></td>
<td>Advanced Gas-cooled Reactor.</td>
</tr>
<tr>
<td><strong>ALARP</strong></td>
<td>As Low As Reasonably Practicable.</td>
</tr>
<tr>
<td><strong>AWE</strong></td>
<td>The Atomic Weapons Establishment. A Government owned, contractor-operated company concerned mainly with nuclear weapons technology. Located at Aldermaston, but with a smaller establishment at Burghfield.</td>
</tr>
<tr>
<td><strong>BAESM</strong></td>
<td>BAE Systems Marine Ltd.</td>
</tr>
<tr>
<td><strong>BEPO</strong></td>
<td>British Experimental Pile O. Air-cooled graphite-moderated pile (at Harwell site; shut down in 1968).</td>
</tr>
<tr>
<td><strong>C&amp;M</strong></td>
<td>Care and Maintenance.</td>
</tr>
<tr>
<td><strong>CCFE</strong></td>
<td>Culham Centre for Fusion Energy. The UK's national laboratory for fusion research (formerly known as UKAEA Culham).</td>
</tr>
<tr>
<td><strong>CONSORT</strong></td>
<td>Imperial College research reactor (at Silwood Park, Ascot; shut down).</td>
</tr>
<tr>
<td><strong>DCP</strong></td>
<td>Dounreay Cementation Plant.</td>
</tr>
<tr>
<td><strong>DECC</strong></td>
<td>Department of Energy and Climate Change. The UK Government department responsible for all aspects of UK energy policy and for tackling global climate change on behalf of the UK.</td>
</tr>
<tr>
<td><strong>Decommissioning waste</strong></td>
<td>Wastes arising after the shutdown of a facility associated with the use or handling of radioactive materials. They can consist of plant or equipment, building debris and material from the clean up of surrounding ground.</td>
</tr>
<tr>
<td><strong>Depleted uranium</strong></td>
<td>Uranium where the uranium 235 isotope content is below the naturally occurring 0.72% by mass.</td>
</tr>
<tr>
<td><strong>DFR</strong></td>
<td>Dounreay Fast Reactor (shut down in 1977).</td>
</tr>
<tr>
<td><strong>DIDO</strong></td>
<td>Heavy-water cooled and moderated materials testing reactor (at Harwell site; shut down in 1990).</td>
</tr>
<tr>
<td><strong>Disposal</strong></td>
<td>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.)</td>
</tr>
<tr>
<td><strong>DMTR</strong></td>
<td>Dounreay Materials Test Reactor.</td>
</tr>
<tr>
<td><strong>DRAGON</strong></td>
<td>Experimental high temperature reactor project sited at Winfrith and funded by the Organisation for Economic Cooperation and Development (shut down in 1976).</td>
</tr>
<tr>
<td><strong>EFDA</strong></td>
<td>European Fusion Development Agreement.</td>
</tr>
<tr>
<td><strong>Enriched uranium</strong></td>
<td>Uranium where the uranium 235 isotope content is above the naturally occurring 0.72% by mass.</td>
</tr>
<tr>
<td>----------------------</td>
<td>--------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td><strong>Enrichment</strong></td>
<td>The process of increasing the abundance of fissionable atoms in natural uranium.</td>
</tr>
<tr>
<td><strong>Fission</strong></td>
<td>Spontaneous or induced fragmentation of heavy atoms into two (occasionally three) lighter atoms, accompanied by the release of neutrons and radiation.</td>
</tr>
<tr>
<td><strong>GDA</strong></td>
<td>Generic Design Assessment.</td>
</tr>
<tr>
<td><strong>GDF</strong></td>
<td>Geological Disposal Facility.</td>
</tr>
<tr>
<td><strong>GE Healthcare Ltd</strong></td>
<td>Previously Amersham plc. A company that provides products and services for use in healthcare and life science research. This includes radioisotopes for medical and research users.</td>
</tr>
<tr>
<td><strong>GLEEP</strong></td>
<td>Graphite Low Energy Experimental Pile. Low energy, graphite reactor (at Harwell site; shut down in 1990).</td>
</tr>
<tr>
<td><strong>GOCO</strong></td>
<td>Government Owned Contractor Operated.</td>
</tr>
<tr>
<td><strong>Government</strong></td>
<td>A collective term for the central government bodies responsible for setting radioactive waste management policy within the UK. It comprises the UK Government and the devolved administrations for Scotland, Wales and Northern Ireland.</td>
</tr>
<tr>
<td><strong>Hex</strong></td>
<td>Uranium Hexafluoride.</td>
</tr>
<tr>
<td><strong>HLW</strong></td>
<td>High Level Waste</td>
</tr>
<tr>
<td><strong>HMNB</strong></td>
<td>Her Majesty’s Naval Base.</td>
</tr>
<tr>
<td><strong>ILW</strong></td>
<td>Intermediate Level Waste.</td>
</tr>
<tr>
<td><strong>Irradiated material</strong></td>
<td>Material that has been exposed to radiation. In the nuclear industry this commonly refers to material that has been exposed to and has captured neutrons, and thus contains activation products.</td>
</tr>
<tr>
<td><strong>ISOLUS</strong></td>
<td>Interim Storage of Laid Up Submarines.</td>
</tr>
<tr>
<td><strong>JET</strong></td>
<td>Joint European Torus - the internationally funded fusion project sited at Culham.</td>
</tr>
<tr>
<td><strong>LLW</strong></td>
<td>Low Level Waste</td>
</tr>
<tr>
<td><strong>LLWR</strong></td>
<td>The Low Level Waste Repository south of Sellafield in Cumbria has operated as a national disposal facility for LLW since 1959.</td>
</tr>
<tr>
<td><strong>LQA</strong></td>
<td>Land Quality Assessment.</td>
</tr>
<tr>
<td><strong>LWR</strong></td>
<td>Light Water Reactor.</td>
</tr>
<tr>
<td><strong>m³</strong></td>
<td>Cubic metres – a measure of volume.</td>
</tr>
<tr>
<td><strong>Magnox</strong></td>
<td>An alloy of magnesium used for fuel element cladding in natural uranium fuelled gas-cooled power reactors, and a generic name for this type of reactor.</td>
</tr>
<tr>
<td><strong>MDU</strong></td>
<td>Magnox Depleted Uranium.</td>
</tr>
<tr>
<td><strong>MoD</strong></td>
<td>Ministry of Defence.</td>
</tr>
<tr>
<td><strong>MODEP</strong></td>
<td>Magnox Optimised Decommissioning Programme.</td>
</tr>
<tr>
<td><strong>MOX</strong></td>
<td>Mixed Oxide. Refers to nuclear fuel consisting of uranium oxide and plutonium oxide for use in reactors.</td>
</tr>
</tbody>
</table>
MTR  Materials Testing Reactor.
MWP  Minor Waste Producers
NDA  Nuclear Decommissioning Authority. A public body set up by the Government in April 2005 with responsibility for the UK’s public sector civil nuclear liabilities, and their subsequent management. In October 2006, the Government also gave the NDA the responsibility for developing and ensuring delivery and implementation of the programmes for interim storage and geological disposal of the UK’s higher activity wastes. From March 2007, the NDA was also given responsibility for developing a UK wide strategy for managing the UK nuclear industry’s LLW and for securing disposal capacity for LLW generated by non-nuclear industry users.
NRTE  Naval Reactor Test Establishment (at Vulcan, Dounreay).
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.
Operational waste  Wastes arising from the day-to-day operations of a facility associated with the use or handling of radioactive materials.
Packaged volume  The volume of waste after packaging, consisting of the waste material, any encapsulating matrix, any capping grout and ullage, and the container.
Packaged waste  Radioactive waste that has undergone Packaging.
Packaging  The loading of waste into a container for long-term storage and/or disposal. In most but not all cases this includes conditioning.
PCM  Plutonium Contaminated Material.
PFR  Prototype Fast Reactor (at Dounreay site).
PIE  Post Irradiation Examination, of fuel elements etc.
PLUTO  Heavy-water cooled and moderated materials testing reactor (at Harwell site; shut down in 1990).
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.
POCO  Post Operational Clean Out. Activity after final shutdown that prepares a plant for decommissioning.
PWR  Pressurised Water Reactor.
R&D  Research and Development.
Radioactivity  A property possessed by some atoms that split spontaneously, with release of energy through emission of a sub-atomic particle and/or radiation.
Raffinate  A solution resulting from a solvent extraction process. The term is applied to the aqueous solution of fission products (liquid HLW) remaining after the extraction of uranium and plutonium in the first stage or irradiated fuel reprocessing.
Reprocessing  The chemical extraction of reusable uranium and plutonium from waste materials in spent nuclear fuel.
Remote Handled Intermediate Level Waste.

Rolls-Royce Marine Power Operations Ltd.

Research Sites Restoration Limited.

A strategy for decommissioning gas-cooled power stations that involves the construction of containments around all buildings containing active plant. The purpose is to protect the buildings and their contents from deterioration due to weathering so that complete dismantling can be deferred.

Rolls-Royce Marine Power Operations Ltd.

Submarine Dismantling Project.


Organisations that use radioactive materials and create radioactive wastes that are not part of the nuclear sector licensed under the Nuclear Installations Act 1965 (as amended), including hospitals, universities and industrial undertakings.

Surveillance and Maintenance.

Sellafield MOX Plant.

Ship Submersible Ballistic Nuclear. A nuclear powered submarine armed with ballistic missiles.

Ship Submersible Nuclear. A nuclear powered (hunter-killer) submarine.

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

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.

Tonnes of Heavy Metal – a measure of mass.

Thermal Oxide Reprocessing Plant (at Sellafield site).

Thorp Product Uranium.

A process that changes the state or form of radioactive waste to facilitate its future management. It may or may not serve to put the waste into its finally conditioned form.

An isotope of hydrogen (H-3) having a radioactive half-life of about 12 years.

Tonnes of Uranium – a measure of mass.

A public body that manages the UK fusion research programme and operates the Joint European Torus (JET). Originally formed in 1954 to carry out nuclear research for the UK Government.

A subsidiary of Babcock International Group. Before its sale in 2009, the commercial arm of the United Kingdom Atomic Energy Authority.

A radioactive element that occurs in nature. Uranium is used for...
nuclear fuel and in nuclear weapons.

<table>
<thead>
<tr>
<th>Term</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Vitrification</strong></td>
<td>The process of converting materials into a glass or glass-like form. Vitrification is the process used at Sellafield to convert liquid HLW from spent fuel reprocessing into a borosilicate glass.</td>
</tr>
<tr>
<td><strong>VLLW</strong></td>
<td>Very Low Level Waste.</td>
</tr>
<tr>
<td><strong>Vulcan</strong></td>
<td>The Naval Reactor Test Establishment, located adjacent to UKAEA’s Dounreay site on the north coast of Scotland.</td>
</tr>
<tr>
<td><strong>WAMAC</strong></td>
<td>Waste Monitoring and Compaction facility (at Sellafield site).</td>
</tr>
<tr>
<td><strong>WRACS</strong></td>
<td>Waste Receipt Assay Characterisation and Supercompaction facility (At Dounreay).</td>
</tr>
</tbody>
</table>
Electronic copies of this and other 2013 Inventory documents can be obtained from the NDA (see contact details below) or via the UK Radioactive Waste Inventory website www.nda.gov.uk/ukinventory

Nuclear Decommissioning Authority
Information Access Manager
Herdus House
Westlakes Science & Technology Park
Moor Row
Cumbria
CA24 3HU

T +44 (0) 1925 802077
foi@nda.gov.uk
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Front cover images: left - waste packages at Dounreay, top - LLW vaults, bottom left - deplanting and demolition at Sizewell A, bottom right - demolition, making room for new facilities

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