Defence Nuclear Organisation

Nuclear Liabilities Management Strategy

May 2022

Foreword

The Integrated Review of Security, Defence, Development and Foreign Policy, published by the Prime Minister, in March 2021, reaffirmed the UK's commitment to having a nuclear deterrent to preserve peace, prevent coercion and deter aggression. Part of the Defence Nuclear Organisation's (DNO) role in maintaining that deterrent is the responsible management of our nuclear liabilities arising from our nuclear propulsion and weapons capabilities.

Since the previous Nuclear Liabilities Management Strategy was produced in 2016 the DNO has been established. The DNO is responsible for procurement and disposal of submarines, nuclear warheads, nuclear fuel, skills, related infrastructure, and day-to-day nuclear policy. Our mission is to lead the Defence Nuclear Enterprise, keep safe and capable submarines at sea, maintain our nuclear warheads and provide the nuclear deterrent to protect national and global security.

We take our responsibilities in managing the nuclear programme and associated liabilities seriously. We are proud of our excellent nuclear safety record and strive to improve even further.

This Strategy clearly sets out how we will continue to manage our nuclear liabilities in a safe and responsible manner. It also re-affirms our commitment to the safe, secure and cost-effective management of those liabilities, and to the protection of people and the environment.

Since the first strategy was published in 2011, we have developed ever closer and more effective working relationships with the Department for Business, Energy and Industrial Strategy and the Nuclear Decommissioning Authority, demonstrating strong and effective collaboration within the public sector in the interests of UK taxpayer. We have made good progress in several areas taking a strategic perspective across government departments and public bodies, challenging barriers to collaboration and delivering effective nuclear liabilities management outcomes. We will continue to build on this work, which we see as fundamental to our role as a responsible owner of nuclear liabilities.

Vanessa Nicholls
Director General, Nuclear
Defence Nuclear Organisation

May 2022

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Executive summary

The UK's independent nuclear deterrent has existed for over 60 years to deter the most extreme threats to our national security and way of life, helping to guarantee our security and that of our Allies. Our nuclear liabilities have arisen from building and operating nuclear submarines, and from the manufacture and management of nuclear weapons in support of that deterrent. We are committed to being a responsible owner of those liabilities.

This strategy is one of the ways we can both communicate our intentions and demonstrate our continued commitment to managing our nuclear liabilities as a responsible nuclear operator. It provides an update on each of the five strategic themes: Submarines, Irradiated Fuel, Nuclear Materials, Sites, Facilities and Radioactive Waste. A sixth theme also describes the key strategic enablers that are essential to delivery of the strategy. The safety and security of our nuclear liabilities is paramount when delivering the strategy. They are managed on nuclear licensed and authorised sites, regulated by the Office for Nuclear Regulation, the Defence Nuclear Safety Regulator, and the environment agencies.

We are making good progress despite the global challenges we face. Since the last strategy we have funded an increase in the capacity of national facilities to prepare some of our Intermediate Level Waste for long term storage, pending geological disposal. We are working across government, at the highest levels, to collaborate effectively and have signed agreements with other departments to enable us to work together more effectively managing nuclear liabilities within the UK.

We continue to progress the Submarine Dismantling Programme. The fourth boat has entered dismantling and is currently docked at Rosyth for the removal of its Low-Level Radioactive Waste. We are committed to delivering our programme to be able to re-start defueling submarines in Devonport by 2023, and Swiftsure sent off-site to undergo recycling by 2026, once all the Low-Level and Intermediate Level Waste has been removed. We continue to drive the implementation and further development of this strategy, working together with our nuclear liability project delivery teams, with the Nuclear Decommissioning Authority and with wider government.

This strategy re-affirms our commitment to the safe, secure and cost-effective management of our liabilities, and to the protection of people and the environment.

Defence Nuclear Organisation
Ministry of Defence

Introduction

The Submarine Delivery Agency supports the Royal Navy's Continuous At-Sea Deterrent. At least one of four nuclear-armed submarines, supported by smaller attack submarines, is always patrolling at sea, providing the ultimate guarantee of our national security. Fundamental to sustaining this capability is ensuring that the associated nuclear liabilities are managed appropriately.

After our submarines have left service with the Royal Navy and have been defueled, we are adopting an approach to completely dismantle them, recycling around 90% of the submarine. This approach is unique to the UK and minimises the liabilities left for our future generations.

We put safety, security, sustainability, and environmental protection at the heart of our business; these aspects are particularly important for the management of all our legacy and future nuclear liabilities.

We work closely with the Nuclear Decommissioning Authority as we develop and implement coherent strategies for managing our legacy and future nuclear liabilities in a way that is consistent with the UK decommissioning mission. We coordinate the management of nuclear liabilities across all parts of the defence nuclear programme providing leadership and direction and a link to the UK nuclear sector, including government departments, agencies, the supply chain, and regulators.

This is the third Nuclear Liabilities Management Strategy and over the last ten years we have progressed our organisational culture heightening the priority and focus on the effective management of nuclear liabilities and developing strong collaboration across government.

The publication is intended to provide clarity and transparency into our nuclear liabilities and how we manage them. The report provides a brief overview followed by six main 'themes' addressing the key aspects of our nuclear liabilities and the broader business enablers. Additional background information, and descriptions of each of our sites is provided at the end.

Keith Beckett CBE
Technical Director
Submarine Delivery Agency

Overview of our Nuclear Liabilities

Introduction

Our nuclear liabilities fall broadly into five themes. Each of them, along with our key strategic enablers, is described in more detail within the main body of this strategy, and an overview of the five themes is given below.

Submarines

The most visible of all our nuclear liabilities are the submarines that are no longer in service. There are currently 21 submarines that have left service and are awaiting dismantling, this process has started at Rosyth Royal Dockyard where low-level radioactive waste has been removed from Swiftsure, Resolution, and Revenge. Repulse has now entered dismantling as of February 22.

At Rosyth Royal Dockyard there are seven submarines stored afloat, all of which are defueled.

At Her Majesty's Naval Base Devonport, there are 14 laid up submarines; four defueled, with plans to defuel the remainder.

Irradiated fuel

Irradiated fuel comprises submarine reactor fuel that has fulfilled its purpose for submarine propulsion and is either in a reactor awaiting defuel or is stored underwater in a purpose-built storage facility. Irradiated fuel includes prototype and research fuel.

Nuclear materials

This theme covers uranium and plutonium that is no longer required for defence purposes.

Most of our nuclear material liabilities are voluntarily placed into safeguards, all our nuclear material liabilities are managed alongside similar NDA nuclear liabilities materials.

Sites and facilities

We use several sites across the UK to support the defence nuclear programme. These sites and the defence nuclear facilities on them are covered in this theme. Each site manages nuclear liabilities and radioactive waste, but unlike the legacy civil nuclear sites, we have an ongoing requirement to keep most of our sites operational.

Radioactive waste

This theme covers the management of radioactive wastes that are produced from operations and decommissioning. Our radioactive waste is predominantly Very Low-Level Waste and Low-Level Waste. We have Intermediate Level Waste but no High-Level Waste. The theme is focussed on implementing applicable waste policy and safe and secure management.

Theme One: Submarines

Safe and secure storage, defuel, and dismantle

Description

Our most visible nuclear liabilities are the submarines in Rosyth and Devonport that have left service with the Royal Navy. Once out of service, our nuclear submarines are stored afloat and are regularly maintained by the site operator, however they remain under our ownership.

Once the irradiated fuel is removed, submarines are managed by the SDP.

All seven of the submarines at Rosyth are defueled, four submarines at Devonport are defueled, and the remainder will be within scope of SDP once they have been defueled.

Scope

We established the SDP to deliver a safe, environmentally responsible, and cost-effective solution for dismantling the UK's defueled nuclear-powered submarines after they have left service with the Royal Navy.

To date, 21 nuclear powered submarines of past and current classes have left naval service, there are seven decommissioned submarines at Rosyth and 14 at Devonport, these are listed below:

- Dreadnought
- Valiant
- Warspite
- Resolution
- Repulse
- Renown
- Revenge
- Churchill
- Conqueror
- Courageous
- Swiftsure
- Sovereign
- Superb
- Sceptre
- Spartan
- Splendid
- Trafalgar
- Tireless
- Turbulent
- Torbay
- Trenchant

Some of the submarines that are managed by SDP are still in service with the Royal Navy, these are:

- HMS Talent
- HMS Triumph
- HMS Vanguard
- HMS Vengeance
- HMS Vigilant
- HMS Victorious

The approved scope of SDP currently excludes the Astute and Dreadnought classes, as they will not be ready for decommissioning for decades, by which time our approach and techniques used to dismantle submarines will have evolved, and new infrastructure and facilities may be required. We are considering the credible options for the management of current and future submarines outside the SDP scope, including the management of irradiated fuel, berthing capacity and supporting infrastructure.

Strategy

The Submarine Delivery Agency is taking a staged approach to dismantling, consistent with government policy, supported and informed by the results of the SDP public consultations. This approach is unique to the UK and minimises the nuclear liabilities that future generations will have to manage.

Low-level radioactive waste (LLW) has already been removed from Swiftsure, Resolution and Revenge, which have been used to prove that the dismantling processes and procedures being developed under the SDP are sufficiently robust to ensure the safe, secure, sustainable and environmentally responsible removal of LLW.

The next stage is to remove and dispose Intermediate Level Radioactive Waste (ILW); primarily the reactor pressure vessel and related items from the reactor compartment, which are above the LLW limit. ILW will be removed, transported to and stored at the Capenhurst Nuclear Licenced Site. This strategy will aim to develop a capability to dismantle the first ex-service nuclear submarine; the Demonstrator Submarine. The plan is to have the Demonstrator Submarine sent off-site to undergo final recycling by 2026 – we refer to this as Disposal26. The current assumption is that, following a period of storage, at a point in the future ILW components will be cut into smaller sections and packaged in containers ready for disposal to the Geological Disposal Facility (GDF).

We are committed to adopting a more circular economy and will re-use components which can be re-purposed in our operational fleet. Once all of the radioactive waste has been removed, around 90% of the materials on the submarines (mainly steel and other metals) can either be re-purposed or undergo conventional recycling at a licensed ship-breaking site which forms the final stage of the process.

Extensive information and documents including a strategic environmental assessment supporting the public consultations can be found at the SDP website. [1]

Submarines Strategy Development

Our strategy for submarines is reasonably mature, but there are unique challenges to develop a first of a kind dismantling capability. Therefore, we continue to challenge our assumptions to ensure we are employing the most appropriate methods and an optimised approach for dismantling and disposal of radioactive wastes.

Since the last strategy, the reactor pressure vessel removal options have been re-examined, to provide greater confidence on the method of removal.

The defueled submarines have been further characterised to determine the quantities of materials for recycling, reuse, disposal or storage. The characterisation informs opportunities for segregation at the point of size reduction with the aim to minimise waste value in accordance with the waste hierarchy.

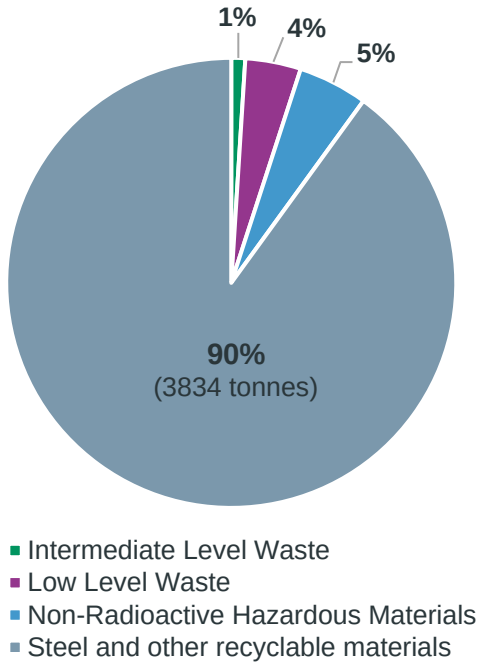
We continue to work with Radioactive Waste Management Limited (RWM) on the disposability assessment process for GDF disposal and we have a conceptual letter of compliance for the size-reduced, packaged, intermediate level radioactive waste.

Case Study 1: Low-level radioactive waste removal from submarines at Rosyth
Submarines that have left service with the Royal Navy and are stored at Rosyth and Devonport are amongst our most visible and prominent nuclear liabilities. Less obvious is the work that has been undertaken at Rosyth to progress submarine dismantling.

Swiftsure: In total 52 tonnes of Low-Level Waste (LLW) components were removed between December 2016 and August 2018.

Resolution: In total 77 tonnes of LLW components were removed. Approximately 50% more LLW was removed from Resolution in 75% of the time compared to Swiftsure.

Revenge: In total, 152 tonnes of LLW were removed with the work completed safely, on time and within budget.



The ongoing investment in LLW removal has continued to develop the essential knowledge and skills for long term submarine dismantling, leading to the removal of Intermediate Level Waste (ILW) and the eventual recycling of the non-radioactive components.

The vast majority (90%) of waste from dismantling submarines can be managed as controlled waste (non-radioactive). Once all the radioactive waste including the LLW and ILW has been removed, the submarine can then be moved off-site to undergo conventional recycling at a licensed ship-breaking site.

Consistent with this strategy and the Waste hierarchy, SDP has successfully diverted radioactive waste from near surface disposal by using specialist metal melting treatment for recycling. The characterisation and targeted size-reduction of submarine ILW components in future will minimise the volumes for storage and eventual disposal to the UK's Geological Disposal Facility.

Our approach to managing SDP wastes links with the United Nations' Sustainable Development Goal 12 'responsible consumption and production' which addresses the world's rapidly expanding extraction and consumption of materials, resulting in degradation of environmental resources.

Theme Two: Irradiated Fuel

Safe, secure storage and through life management

Description

UK submarines have pressurised water reactors where the nuclear fuel is contained within the reactor core. Submarine reactor development has steadily increased reactor core life and the reactor cores currently being manufactured are designed to power a submarine for its entire lifetime. This results in fewer irradiated fuel cores per submarine and minimises the associated nuclear liabilities.

Submarine fuel produces heat through the fission process; energy is released when U-235 atoms split into smaller atoms called fission products. The heat produces steam that is used to propel the submarine and to generate electricity. Fission products are radioactive and remain in the fuel, contained by a barrier called fuel cladding. At the end of its life, the irradiated fuel is removed from the reactor and currently stored under water. The water provides shielding and cooling whilst the residual fissile product decay heat, which is produced for several years after reactor shutdown, decays to low levels.

The first submarine cores were placed in the First-Generation Oxide Fuel Storage Pond (FGOFSP) at Sellafield nuclear licenced site. In 2003, we commissioned a dedicated fuel storage pond called the Wet Inlet Facility (WIF). The WIF is designed to support the continued safe and secure storage of irradiated fuel for several decades. Submarine cores stored in the FGOFSP have mostly been transferred to the WIF, and under the current planning assumptions all cores will have been transferred to the WIF by the next publication of this strategy. The FGOFSP and WIF are safe and secure storage facilities that are maintained and safely operated by Sellafield Ltd.

Scope

This theme includes all fuels that have been produced and irradiated for the purpose of nuclear submarine propulsion, the majority of which are at the Sellafield nuclear licenced site, with some fuel in submarines awaiting defuel at Devonport. This theme also includes a small quantity of research reactor fuel.

Fuels for future platforms that have not yet been commissioned, are outside the scope of this strategy, however, we are developing options for the management of nuclear fuel from future platforms and the infrastructure, transport and lifetime management requirements of each option.

Strategy

There are three elements to our strategy for managing irradiated fuel: consolidation; safe and secure interim storage; and disposition.

The irradiated fuel from VULCAN Naval Reactor Test Establishment (NRTE), Devonport and FGOFSP will be consolidated into the WIF prior to its disposition.

Irradiated fuel will remain in safe and secure interim storage to keep open future options for management including disposal or reuse.

While reuse cannot be discounted at this stage, development of a disposal concept for our irradiated fuel is being undertaken to provide a basis against which we can compare reuse options and decide on a disposition route.

Strategy Development

Disposal

We will continue to develop the arrangements for the disposal of irradiated fuel working with RWM as the concept for GDF disposal of civil spent fuel matures. We are working with the Nuclear Decommissioning Authority (NDA) and RWM to agree a packaging and conditioning arrangement for irradiated fuel that will meet the acceptance criteria for a GDF. Our irradiated fuel is considered in RWM's inventory for disposal. [2]

To deliver best value for money for the UK taxpayer, and dependant on the outcome of our disposability assessment we will collaborate with the NDA at the appropriate time in the future, to use UK civil legacy spent fuel conditioning and packaging infrastructure for our irradiated fuel.

Our irradiated fuel is dissimilar to other UK spent fuels and may require a bespoke disposal arrangement; however, the current civil spent fuel disposal container concepts will be considered as part of the disposability assessment, a bespoke disposal container for our irradiated fuel will only be used if there are significant benefits in doing so. We anticipate placing the irradiated fuel into international safeguards at the point of disposal.

Reuse

Reprocessing enables the unused part of the fuel to be recovered. It also extracts radioactive isotopes that would be immobilised and subsequently disposed of in a GDF as high-level waste. The uranium recovered through reprocessing could be reused in the manufacture of new nuclear fuel. As UK reprocessing facilities are not currently suitable or available for reprocessing our irradiated fuel, a new dedicated facility would be required. The scale of the technical and logistical challenge to make reprocessing of irradiated fuel a reality (including the subsequent

facility decommissioning and management of radioactive waste) is substantial. The costs and risks associated with reprocessing are currently considered to be disproportionate to the value in doing so. This option will be re-considered and value for money assessed if significant pre-conditioning of our irradiated fuel is required to meet the GDF acceptance criteria.

Research Fuels

In our previous strategy we stated that we would explore common solutions for the management of research reactor fuel, of which we have two types. Having done this, we have developed distinct strategies; for one of our fuel types, we are exploring the possibility of re-use into the fuel cycle, for the second type of fuel re-use is not possible, and so we are developing a disposal strategy. We are working closely with NDA to ensure our research fuels are managed coherently where there are similarities with NDA's exotic fuels. Where we are considering disposal, there is an aspiration to transfer title to the NDA to exploit benefits of managing similar materials collectively.

Additional Considerations

In developing a strategy for our irradiated fuel, we will ensure that UK and international security obligations are met, and that management of irradiated fuel adheres to the principles of the Non-Proliferation Treaty. We will also consult with the US Department of Defense on irradiated fuel strategy and management in accordance with the terms of the relevant US/UK agreements – e.g., the 1958 Mutual Defense Agreement, which applies to aspects of the naval propulsion system.

Security and safeguards requirements will be adhered to and considered throughout the irradiated fuel lifecycle.

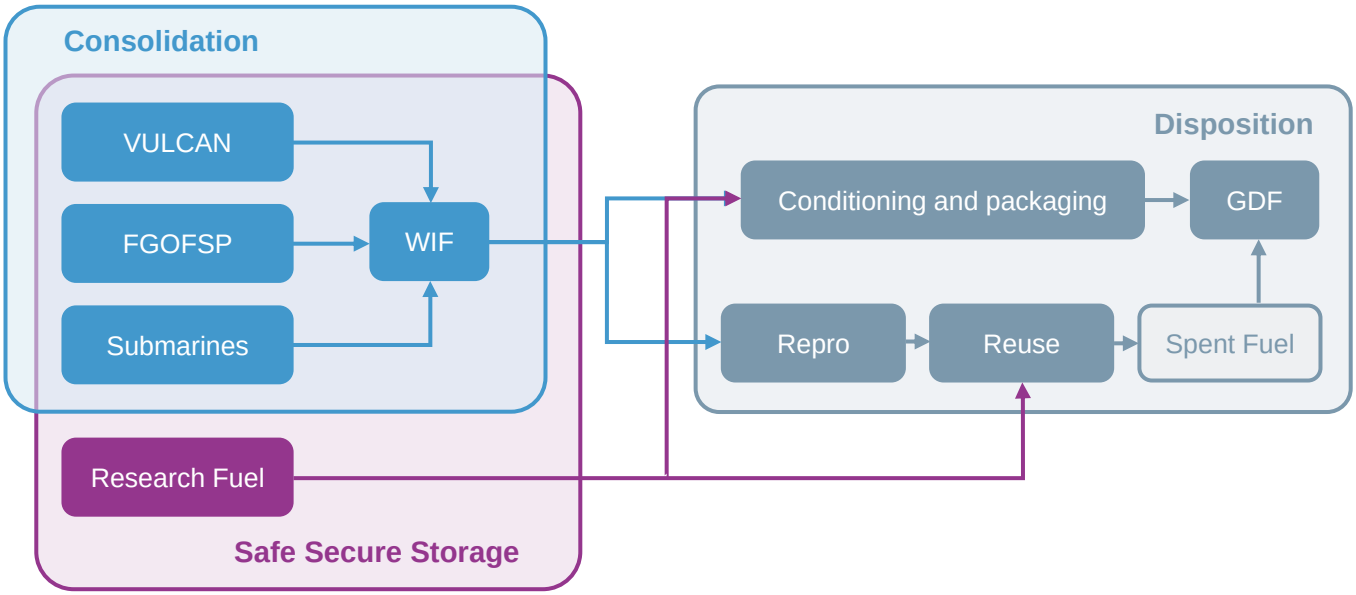


Figure T2-1: *The strategy for irradiated fuel*

Theme Three: Nuclear Material Liabilities

Safe and secure storage; management, consistent with similar UK nuclear liabilities

Description

This theme describes the generic strategy for nuclear material liabilities, and the specific strategies for plutonium and uranium liabilities.

Our uranium liabilities are predominantly from legacy enrichment activities and the plutonium liabilities are from reductions in our strategic reserve of nuclear material.

Our Uranium is also used as nuclear fuel in submarine reactors; the resulting 'Irradiated Fuel' from nuclear submarines is described in Theme Two.

Nuclear Safeguards

Nuclear safeguards are measures to verify that civil nuclear materials and activities are only used for their intended peaceful purposes. The International Atomic Energy Agency (IAEA) is an independent science and technology based intergovernmental organisation within the United Nations family. Part of the IAEA's role is to conduct independent verification to ensure that states comply with their non-proliferation agreements, including nuclear safeguards.

Our material that is surplus to requirements can be placed into safeguards, under the UKs voluntary offer safeguards agreement, and can be inspected by the IAEA.

Scope

The scope of this theme is our uranium and plutonium liabilities which are currently considered to be of no use to the programme, stored away from defence sites, most of which has been voluntarily placed into safeguards.

The UK is a recognised Nuclear Weapon State; we own a strategic reserve of nuclear materials for defence purposes, held outside International Safeguards. Our strategic reserve of nuclear materials is maintained at the minimum practicable level to meet our requirements. The strategic reserve material is outside the scope of this strategy.

Our nuclear material liabilities are subject to stringent controls and accountancy in accordance with relevant legislation. Our nuclear material liabilities are managed to the same high standards as similar civil material on the sites at which they are stored.

Nuclear Material Liabilities: Strategy

Our nuclear material liabilities will continue to be stored safely and securely on non-defence nuclear programme licenced sites under contractual arrangements. We continue to explore and realise opportunities for the coherent long-term management of materials with similar characteristics in line with UK government policy. Where appropriate, it is our intention to transfer ownership of some of our nuclear material liabilities to the NDA at a time when all relevant authorities agree, and specific criteria have been met demonstrating transfer is in the best interests of the UK. These materials would then be managed by NDA in line with its strategies for nuclear materials, consistent with government policy.

We will ensure that UK and international security obligations are met, the management of our nuclear liabilities adhere to the principles of the Non-Proliferation Treaty and we will collaborate and consult with international partners in accordance with the terms of the relevant treaties and agreements – e.g. the 1958 Mutual Defense Agreement.

Nuclear Material Liabilities: Strategy Development

We will continue to work with the NDA, the department for Business Energy and Industrial Strategy (BEIS) and regulators to develop the strategy for nuclear materials management. Clear and consistent strategies for the management of nuclear liabilities across responsible defence and civil authorities will ensure we realise opportunities and mitigate risks across the enterprise and deliver greater value to the taxpayer. We will do this by simplifying contractual arrangements, optimising the use of existing facilities and ensuring each organisations' skills are focussed on their respective missions.

Plutonium Liabilities

We own less than two tonnes of plutonium liabilities, which equates to less than 2% of the national total; the NDA manages around 140 tonnes[1] of civil separated plutonium that has arisen from reprocessing of spent fuel and overseas energy utilities under historical commercial agreements. Plutonium is fissile, radioactive and hazardous, it is stored in specialist facilities that provide a very high degree of safety and security.

Plutonium Liability: Strategy

The safe and secure management of civil separated plutonium is a UK government priority. Continued, indefinite, long-term storage leaves a burden of security risks and proliferation sensitivities for future generations to manage. The UK government, working with the NDA, aims to identify a solution that puts the UK's civil plutonium beyond reach. This could be reuse as mixed oxide fuel in nuclear reactors or as an immobilised product for disposal. This would put the material in a form which both reduces the long-term security burden during storage and ensures it is suitable for disposal in a GDF. In the meantime, the material will remain in safe and secure indefinite long-term storage pending decisions on the disposition route.

Our plutonium liability will continue to be kept in safe and secure storage until a UK solution to put it beyond reach is agreed. It will be managed in the same way as the NDA plutonium [3] to get the best value solution for the UK; we will not pursue an independent through life management and disposal solution.

We will transfer our plutonium liability to the NDA at a time when all relevant authorities agree and specific criteria have been met, demonstrating transfer is in the best interests of the UK.

[1] This quantity includes our plutonium.

Plutonium Liability: Strategy Development

The NDA and BEIS continue to make progress towards the solution for the long-term management of UK plutonium.

In 2011, informed by a public consultation and advice from the NDA, the UK government concluded that its preferred policy would be to reuse civil separated plutonium as a mixed oxide fuel in civil nuclear reactors, with any material unsuitable for reuse immobilised and treated as waste for disposal. Both approaches would put the plutonium in a form which reduces the long-term security and safety burdens during storage and ensures its suitability for GDF disposal. It was emphasised at the time that, while UK government believed it had enough information to set a direction, it did not have sufficient confidence to progress into implementation.

Since then, the UK government has been working closely with the NDA to develop reuse and immobilisation options that could be credibly deployed and is considering these options against critical success factors and interdependencies. As part of this, the NDA has undertaken targeted research and published a summary of their plutonium management work to date in 2019. [3] Further technical work is needed on the options before any decision can be made, and the NDA is working with the government on an agreed multi-year programme of work which covers both reuse and immobilisation options.

Due to the size of the UK plutonium inventory, any long-term disposition solution will take many decades to implement. While work to assess options for long-term disposition is ongoing, the material will continue to be stored in a suite of custom-built facilities that ensure its safety and security in line with regulatory requirements.

We continually assess the quantity of material that we need to maintain our strategic defence capability. Proactive management of the plutonium stockpile will ensure that any material that is no longer required will be identified as a liability as will put beyond reach in timescales commensurate with the UK plutonium management programme.

The UK’s civil plutonium will eventually end up in the GDF either as an immobilised waste form or used mixed oxide fuel, this will be a UK activity and will include a provision for our liability plutonium, which will not require separate acceptance criteria or waste package design.

Diagram NM-1 illustrates the strategy for the management of our plutonium through to disposal.

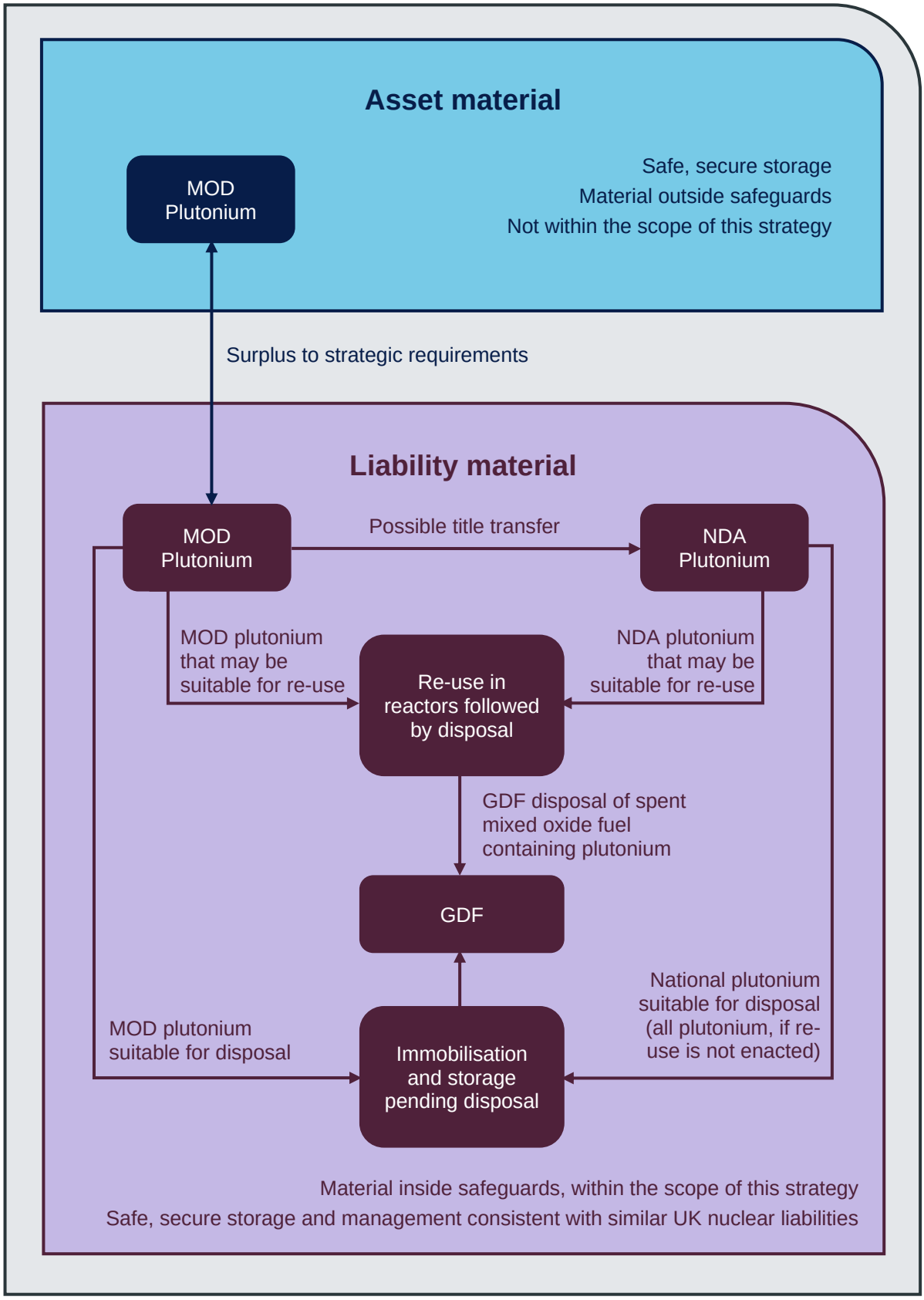


Diagram NM-1: *Illustration of our liability plutonium strategy*

Uranium Liabilities

We own an inventory of uranium in several forms, each require different management and disposal arrangements. Most of our liability inventory is held in International Safeguards.

Our uranium liabilities accounted for around 15% of the total on NDA sites and most of this is similar to the NDA's uranium.

The largest component of our uranium liabilities was in the form of uranium hexafluoride. We have recently transferred ownership of this to the NDA. We also hold smaller quantities of uranium oxide and metal at NDA sites. Our liabilities are held safely and securely under the stewardship of the relevant nuclear site licensee at nuclear licenced sites at Springfields and Capenhurst.

Uranium Liability: Strategy

Our uranium will continue to be safely and securely stored and any opportunities for reuse will be explored.

Where possible our uranium will be managed in the same way as the NDA uranium to get the best value solution for the UK; we will not pursue independent through life management and disposal solutions if a common approach can be adopted.

We will transfer our uranium to the NDA on a case-by-case basis at a time when all relevant authorities agree and specific criteria have been met, demonstrating transfer is in the best interests of the UK.

Uranium Liability: Strategy Development

Where possible our liability uranium strategy will be aligned with the NDA uranium strategy. [4] We will collaborate with the NDA now and in the future to ensure a cost-effective solution for the UK is realised wherever possible. This includes commercial opportunities that the NDA may be pursuing to realise any potential value of uranium and capabilities to convert uranium compounds into more passively safe forms suitable for interim storage and disposal.

Diagram MN-2 illustrates the strategy for the management of our uranium through to disposal.

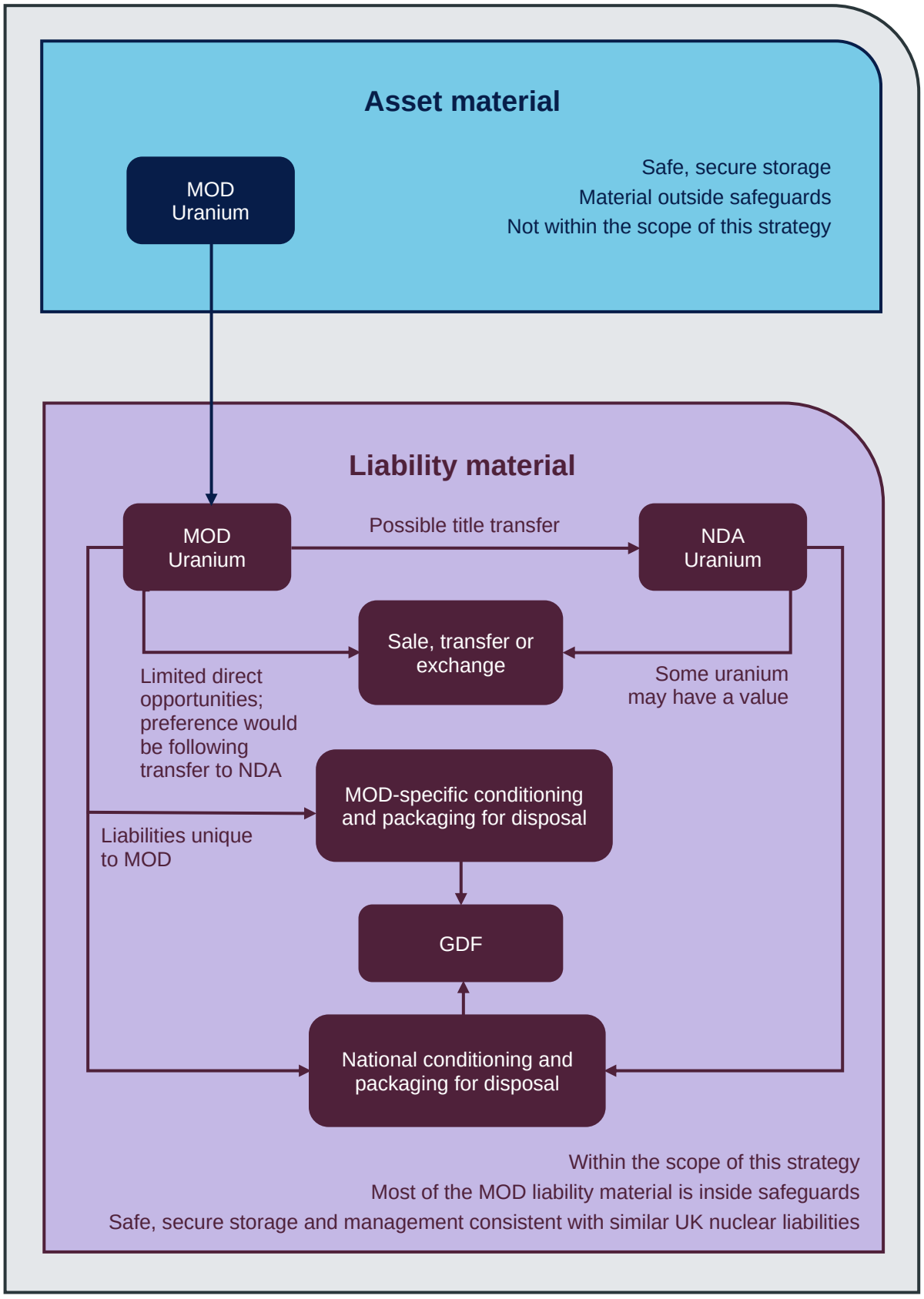


Diagram NM-2: *Illustration of our liability uranium strategy*

Case Study 2: Transfer agreement and candidate materials

Since publication of the last strategy, we have been working with NDA and BEIS on strategy implementation; one of the activities has been to explore the opportunity of transferring some of our nuclear liability material to the NDA. Working together we identified several candidates for transfer and, based on several factors, prioritised our uranium hexafluoride.

In 2020, we signed an agreement with BEIS and NDA describing the generic process for title transfer of our nuclear liability materials and radioactive waste to NDA and setting out the conditions that would have to be met.

We share similar objectives with NDA and BEIS, to manage nuclear materials and radioactive waste safely, securely and in the most cost-effective way for the UK taxpayer while minimising the impact on the environment. Furthermore, we have nuclear materials and radioactive wastes that are indistinguishable in nature to those for which NDA is responsible under the Energy Act.

All parties recognise there may be synergies between civil and defence liabilities which offer opportunities for potential cost reduction and improved government efficiency.

Title transfer offers a route for managing our nuclear materials and radioactive waste more effectively and efficiently within NDA, delivering safety, security and value for money.

Any transfer of our nuclear material and radioactive waste to NDA will be considered on a case-by-case basis and subject to specific NDA and BEIS approvals, and subject to the following conditions:

- The nuclear materials/radioactive waste is similar.
- We have no future strategic interest in the nuclear materials/radioactive waste.
- We all confirm NDA is best placed to provide the through-life management
- We all confirm there is an adequate understanding of the liability management, security and information security requirements, scope, financial, commercial and logistic considerations and risk.
- We have no concerns about placing the nuclear materials/radioactive waste into safeguards.
- The Defence Nuclear Safety Regulator and the Defence Nuclear Security Regulator have confirmed they are content for the material to leave their regulatory regime.
- The Office for Nuclear Regulation has confirmed that it is content for the material to enter its regulatory regime.
- BEIS confirms it agrees that it is in the UK taxpayer interest to the nuclear materials or radioactive waste to be both managed by NDA and be in NDA's ownership including consideration of the future liabilities and the funding.

Following the agreement, we have successfully completed the transfer of our uranium hexafluoride tails to NDA, along with the funding allocated in our spending review.

Theme Four: Sites and Facilities

Safe and secure storage; management, consistent with similar UK nuclear liabilities

Description

‘Sites’ refers to nuclear licensed or authorised sites that support the defence nuclear programme.

‘Facilities’ are buildings on sites (production and maintenance facilities etc.) and machinery, tools, equipment and ancillary items.

There is an enduring requirement for the defence nuclear programme which differs from the legacy civil site decommissioning mission. The management of defence nuclear programme sites and facilities is outlined in the facilities’ management plans.

The first two defence nuclear programme sites that will require site decommissioning and remediation are:

- VULCAN NRTE in Caithness, once it reaches the end of operations supporting in service submarines.
- Rosyth Royal Dockyard at the end of its submarine dismantling mission. Rosyth Royal Dockyard has already met the ‘no danger’ criterion for large parts of the site that have already been decommissioned and remediated.

At the rest of the defence nuclear programme sites there is a varying amount of decommissioning of facilities as part of site rationalisation and the provision of new and replacement facilities.

Not all sites and facilities that support the defence nuclear programme are owned and operated by us; there are several ownership and operator arrangements. This document lays out the generic top-level decommissioning strategy to provide a coherent approach whilst not preventing site specific opportunities to be realised. The strategy recognises the varied nature of the sites and facilities and the different ownership models.

Decommissioning[2] within the defence nuclear programme is required to replace aging facilities with new facilities built to modern standards; and to release sites from nuclear use that are no longer required to support defence. Decommissioning is considered throughout the lifetime of facilities and there are no defence nuclear programme sites and facilities that present the types of hazard that are present in some of the legacy civil reactor sites and facilities.

[2] Decommissioning refers to the administrative and technical actions taken to remove all or some of the regulatory controls from an authorised facility so the facility and its site can be reused.

Scope

The key sites and their associated facilities considered by this theme are listed below and are described further in Annex A. Below in Figure SF-1 the locations of the sites mentioned below are shown.

- Atomic Weapons Establishment (AWE), Aldermaston and Burghfield, Berkshire (strategic weapons research and manufacturing, decommissioning and dismantling facilities).
- BAE Systems Maritime - Submarines, Barrow-in-Furness (submarine production and naval reactor plant initial fuelling, commissioning, and critical operations).
- Her Majesty's Naval Base Clyde, North West of Glasgow (submarine and strategic weapons maintenance and operations).
- Her Majesty's Naval Base Devonport, Plymouth (submarine maintenance and operations, and submarine storage).
- Devonport Royal Dockyard, Plymouth (submarine repair, refit, and defueling).
- Rosyth Royal Dockyard, North of Edinburgh (storage of ion exchange resin, submarine storage and dismantling).
- Rolls-Royce Submarines Limited, Derby (naval reactor core production).
- VULCAN NRTE, Dounreay (naval reactor plant evaluation).

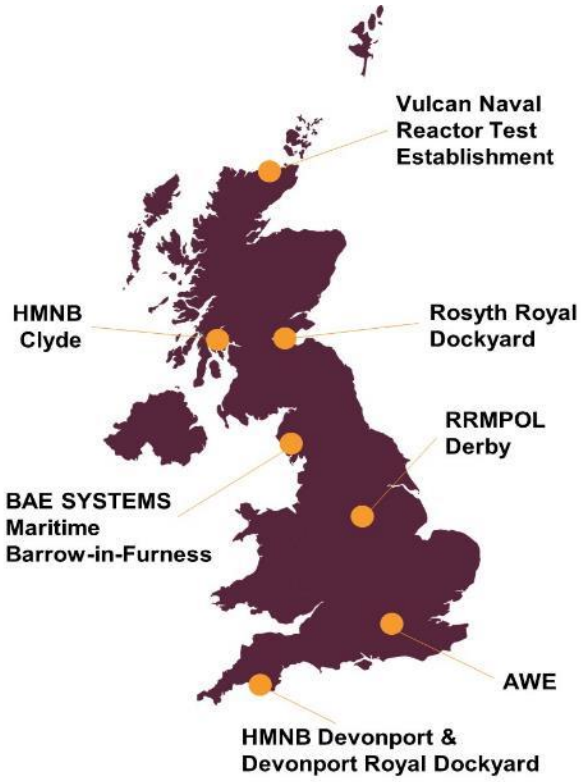


Figure SF-1: Map of the UK identifying the locations of the sites mentioned

In addition to the sites listed here, we own nuclear materials which are held and managed on our behalf at nuclear licensed sites at Capenhurst, Sellafield, and Springfields; and irradiated fuel that is managed at our 'Wet Inlet Facility' at Sellafield. We fund the cost of managing our liabilities at these sites, but the sites themselves are not our liabilities.

The out of service submarines stored at Rosyth and Devonport are in the scope of the 'submarines' section of this strategy.

Sites and Facilities Strategy

Sites

Site decommissioning will be driven by the principles of optimisation and proportionality. Our decisions will be based on safety, policy and the effective and efficient use of resources. In addition, our decommissioning strategies will be coherent with the lifetime plans of adjacent nuclear or industrial facilities.

Hazards are reduced in a progressive, systematic, and timely manner consistent with decommissioning as soon as reasonably practicable. It may be necessary to commission new facilities to support site wide decommissioning objectives as part of an optimised defence nuclear estate. In some instances, we will need to consider decommissioning timescales in conjunction with other nuclear operators. For example, we are coordinating decommissioning activities at VULCAN NRTE with the neighbouring Dounreay site designated to the NDA, through working closely with BEIS and NDA.

End state is the term used to describe the condition of the site following decommissioning activities. End states for sites will be based on site characterisation; contractual arrangements; the requirements of relevant organisations; policy and guidance. We will consider the full lifecycle impacts on people and the environment to ensure the chosen strategy does not compromise the needs or the welfare of current or future generations. A staged progression to the end state will often be the optimum approach, and we will keep options under review given the enduring mission at most of our sites.

End states will be commensurate with the next planned use.

Alternative uses will be considered, for example: facilities may be temporarily converted to a waste store or decontamination facility before demolition, in this way, the use of resources during decommissioning will be minimised. An example of this is the possible re- use of the Active Waste Accumulation Facility at Rosyth for the Submarine Dismantling Programme (SDP). Decommissioning will be subject to relevant planning procedures.

Sites are subject to land quality management [5] so that the range and extent of radioactive and conventional contamination is understood. Where beneficial, the remediation of sites may take place in stages, some of which may be completed a considerable time in advance of the site reaching its end state. In some cases, decommissioning can commence before cessation of operations, the Rosyth site has already undertaken remediation and has met the no danger criteria for most of the site with the exception of a few areas and facilities that are still in use.

Radioactive waste from sites will be covered under the radioactive waste theme, but the nature of the radioactive waste generated will inform how and when the decommissioning is done to optimise implementation of the waste hierarchy.

The environment agencies'[3] expectations for optimisation are described in their Guidance on Requirements for Release from Radioactive Substances Regulation (GRR). [6] This guidance brings together in a transparent way the various radioactive waste management options permissible under environmental legislation and explains how a site may eventually be released from associated regulatory control. We will continue to work closely with the environment agencies and safety regulators to optimise our site decommissioning.

Facilities

Facilities provide specific operations and services for us. These facilities are updated as appropriate to sustain our capabilities, sometimes this requires the facility to be replaced or modified to meet requirements. When a facility is to be replaced or it becomes redundant, it is dismantled and decommissioned (including remediation of land and ground water if required) as soon as reasonably practicable. There are on-going upgrades to facilities and the associated decommissioning at defence nuclear programme sites. New facilities are designed and constructed with due consideration to the eventual decontamination and decommissioning; proportionate decommissioning strategies will be maintained for our facilities.

Radioactive waste from facility decommissioning will be covered under the Radioactive Waste theme, but the nature of the radioactive waste generated will inform how and when the decommissioning is done, to optimise the implementation of the waste hierarchy.

Strategy Development

We will continue to characterise and catalogue nuclear site and facility liabilities. The early characterisation of nuclear liabilities enables us to plan effectively and collaborate with the NDA and other nuclear operators to explore and realise opportunities, share best practices and techniques and align programmes where practicable. We will work closely with site operators and the NDA to ensure the approach to decommissioning and disposal leads to a reduction in overall radiological and environmental risk at the best value for money for the UK taxpayer. [4] Site plans have the potential to affect local communities and we understand the importance of engagement with local authorities and communities.

We will continue to participate in UK forums to share experience in decommissioning of sites and facilities and develop UK policy. We will continue to support the UK government's proposal to amend the legislative framework that applies to nuclear sites [7] and enable more streamlined regulation during the final stages of decommissioning and clean-up.

[3] Environment Agency (EA) in England and Wales, Scottish Environment Protection Agency (SEPA) in Scotland and the Defence Nuclear Safety Regulator (DNSR).

Case Study 3: VULCAN NRTE

For over 50 years VULCAN Naval Reactor Test Establishment (NRTE) has been the cornerstone of the Royal Navy's nuclear propulsion programme, testing and proving the operation of five generations of reactor core. Located on the Caithness coast in the north of Scotland, the site is on land owned by the Nuclear Decommissioning Authority (NDA) and leased to the MOD. The site is currently managed by Rolls-Royce Submarines Limited under contract to the MOD.

On 2nd November 2011 the Secretary of State for Defence announced that no further prototype testing of naval nuclear propulsion plant would be required. In July 2015, on completion of its mission, the Shore Test Facility reactor was shut down for the final time. The anticipated programme is for the site to enter formal decommissioning in the mid-2020s and complete by the mid-2030s. This will be in line with the programme for the decommissioning of the Dounreay site and will allow Vulcan to maintain use of shared services such as waste vaults and low-level liquid waste plant.

All fuel will be removed from site by the end of 2025, removing one of the significant nuclear hazards and marking a step change in the site risk. Over the next 2-3 years the focus will be on the removal of assets and redundant equipment to pave the way for plant decommissioning. Characterisation of land, facilities and plant will continue to develop a baseline for future decommissioning activity.

Waste characterisation and the planning and development of appropriate waste routes for decommissioning waste will be key to successful decommissioning. We will continue to work closely with our regulators, BEIS, NDA and Scottish government throughout this planning activity. We will also continue to work with our colleagues in the Submarine Dismantling Programme to share knowledge and learning as we progress through our work.

Theme Five: Radioactive Waste

Protecting people and the environment

Description

Radioactive waste is material that is either radioactive itself, or is contaminated by radioactivity, for which no further use is envisaged.[4]

We hold legacy waste, and we continue to produce a range of radioactive wastes both from operations and decommissioning. Wastes include soft and hard wastes, filters, activated metal components and ion exchange resins from operations; and various metal, plant, building rubble and equipment from decommissioning.

Our wastes range in classification from Very Low-Level Waste (VLLW) and Low-Level Waste (LLW) to Intermediate Level Waste (ILW); we have no High-Level Waste (HLW). The majority of our ILW is currently stored at the site where it was generated. Waste classification is illustrated below in Figure RW-1.

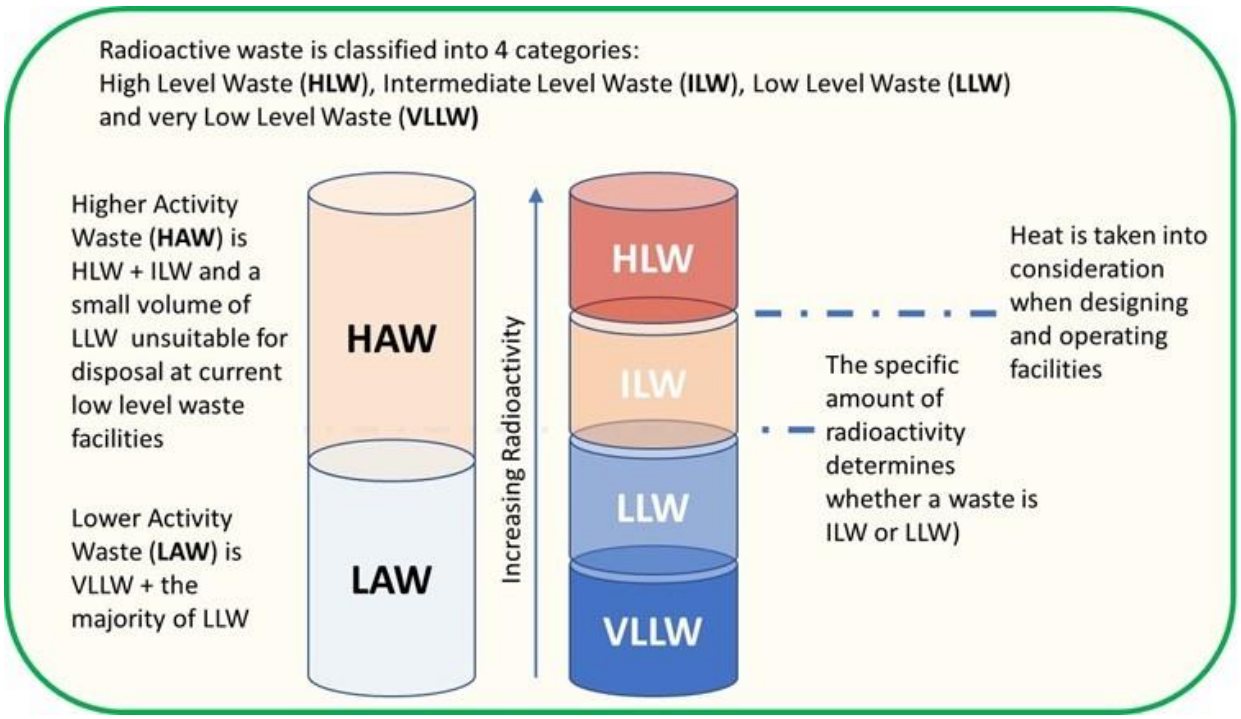


Figure RW-1: Illustration of waste classification

[4] Government policy means that certain nuclear materials such as uranium, plutonium and spent nuclear fuel have not been declared as wastes by their owners.

We have a relatively small proportion of the UK's legacy waste and anticipated future arisings. The charts below in Figure RW-2 from the 2019 UK Radioactive Waste Inventory illustrate this effectively.

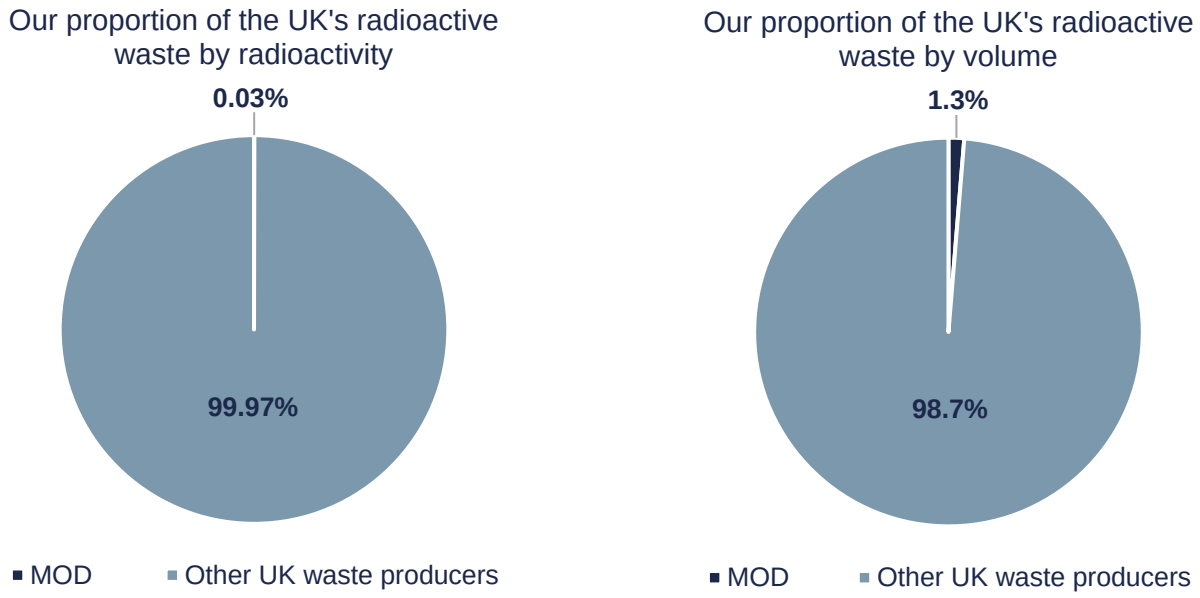


Figure RW-2: Charts illustrating the percentage (volume and activity) of defence radioactive waste

Discharges

We generate liquid and gaseous discharges during operations and decommissioning. Our discharges are kept as low as is reasonably achievable and within the limits set by the Environment Agency (EA) in England and Scottish Environment Protection Agency (SEPA) in Scotland.

The charts below in Figure RW-3 illustrate data from the latest UK strategy for radioactive discharges (2015).

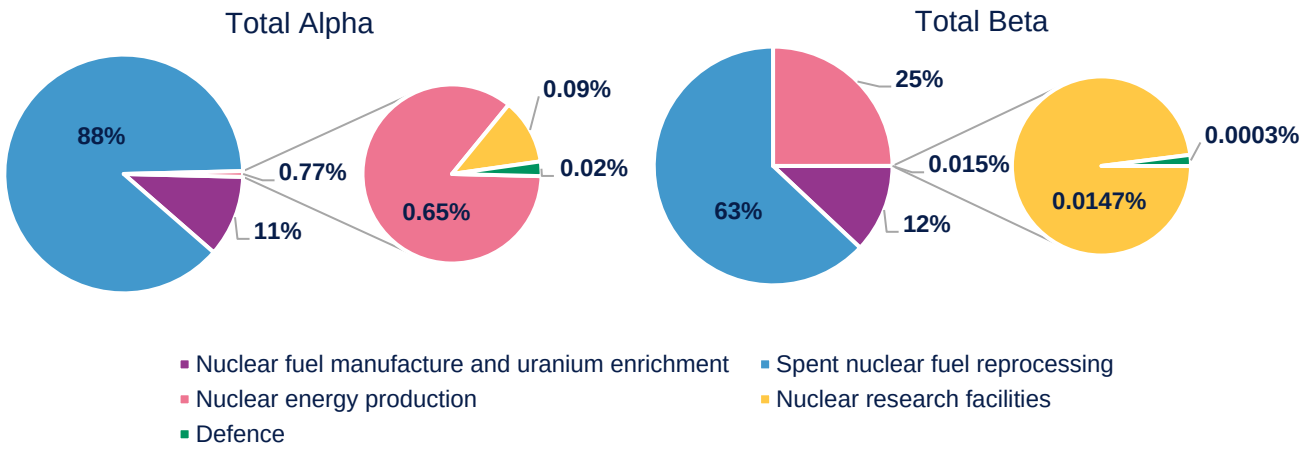


Figure RW-3: Liquid discharges by sector 2015

Scope

This strategy covers all aspects of managing our current and predicted future radioactive wastes and our radioactive discharges to the environment. As a responsible and proactive nuclear operator this is more than simply storage and disposal, it covers a spectrum of activity to understand the wastes and identify the options available for managing them from generation to disposal. It includes demonstrable application of the Waste Hierarchy (see Figure RW-4) and the selection of best available techniques to manage wastes and discharges considering a range of factors.

Strategy

The majority of our wastes are LLW and lower activity ILW, however, safety, security and environmental protection remain key factors to be considered when developing waste management plans. Disposals are only made to facilities which have been suitably permitted by the EA and SEPA.

Underpinned strategies will continue to be developed for all our waste streams so that similar wastes can, where possible, be managed coherently both within defence and with the wider nuclear industry. We will provide leadership to realise opportunities for sharing treatment capabilities, interim storage and transport capabilities, and disposal solutions across the individual projects.

For wastes that require the development of new treatment methods to enable disposal, we will work with regulators, the NDA and the nuclear industry supply chain on the development of processes and techniques.

We will continue to apply the Waste Hierarchy as a framework for waste management decision-making, along with other criteria, to enable an effective balance of priorities including protection of health, safety, security and the environment; value for money; affordability; and technical maturity. Applying the Waste Hierarchy will ensure that:

Figure RW-4: The Waste Hierarchy

- Where practicable the generation of waste will be prevented or reduced by design or at source.
- We will minimise waste by the appropriate design and operation of processes, equipment, and techniques. Decommissioning and disposal aspects are already being considered for future submarines currently in the design stage.
- We will reuse materials where appropriate to reduce disposal volumes. Processing used materials into new products reduces the consumption of raw materials, energy, and the need for ‘conventional’ waste treatment and disposal methods.
- Some submarine components are refurbished and recycled, reducing waste volumes.

We will ensure that our radioactive wastes are characterised to allow identification of waste management routes and then determine the most appropriate for implementation. The ability to manage radioactive waste effectively is critical to our continued operations. A range of treatment and disposal techniques will be adopted, which depend on the physical, chemical, and radiological properties of the waste.

Waste is only consigned for permanent disposal if reuse or recovery is not reasonably practicable. Waste characterisation, sorting and segregation, volume reduction, decay storage and surface decontamination are all methods that will be used to effectively manage wastes for disposal.

Disposal routes for our radioactive wastes (following application of the Waste Hierarchy) are shown in Figure RW-5.

The Low-Level Waste Repository (LLWR), waste service providers, and a GDF (when built) are recognised as UK assets to be used efficiently; capacity at LLWR and GDF is to be preserved by the use of other routes where appropriate. We contribute to sustaining the waste infrastructure and waste service providers by diverting waste (traditionally consigned to the LLWR), to suitably permitted treatment, recycling or landfill facilities where appropriate.

After the application of the Waste Hierarchy, waste is disposed in accordance with its classification and the availability of an appropriate waste route. Where routes are available, disposal of waste will be prompt, unless there is a necessity for accumulation to achieve a consignment quantity, or in allowing the waste to transition from ILW to LLW through radioactive decay. To avoid double handling, and where appropriate, waste will be packaged for disposal at outset, provided this does not affect future transport and handling or foreclose alternative options.

Where waste routes are not currently available, we will ensure that all waste is packaged appropriately and stored in a safe and secure manner until waste management routes become available.

Where a case can be made, taking into consideration safety, security, availability and cost, we will seek to use existing UK facilities for the treatment and packaging of waste to avoid duplication of capability and capital expenditure. Similarly, if we commission facilities for treatment and packaging of waste, consideration will be given to the possibility of making facilities available to the NDA and wider nuclear industry within security and safeguards limitations. We continue to work with the NDA and the supply chain to share good practice and to forecast the wastes we will be producing in the future to inform the supply chain.

Higher Activity Waste (HAW) and LLW are described in the following sections.

HAW

Our HAW includes ILW and a small volume of LLW that is unsuitable for disposal at LLW facilities.

Examples of our HAW:

Legacy wastes: These are packaged and stored in suitable facilities. Most legacy HAW will need some form of processing and packaging before final disposal. Examples include 200l drums of legacy waste at AWE.

Operational waste: These have established waste management routes in place for packaging and storage pending the availability of a geological disposal facility or decay to LLW. Examples include operational wastes from submarine maintenance.

Decommissioning waste: Examples include plutonium and uranium contaminated material from facility decommissioning and the large steel submarine reactor pressure vessels that are expected to require size reduction and packaging.

Full details of our radioactive wastes are available in the 2019 UK Radioactive Waste Inventory. [8]

HAW Strategy

HAW is safely and securely stored, awaiting decay to LLW, or the availability of a geological disposal facility. Storage of HAW will take into account the long-term storage recommendations from the Committee On Radioactive Waste Management. [9]

We will work with RWM using the Letter of Compliance process to develop and agree the processing and packaging requirements necessary for our HAW to meet the waste acceptance criteria for disposal. This involves us producing disposability assessments for each of our HAW waste streams.

For legacy HAW, we may reassess the waste using current equipment to determine whether the wastes are still HAW; reassessment of some legacy HAW has already led to reclassification as LLW. There may also be advantages in sorting and segregating some legacy HAW into HAW and LLW where it is safe to do so. We will manage our HAW in accordance with the principles of the NDA Radioactive Waste Strategy. [9]

Solid LLW

We generate solid LLW both from operations and decommissioning. Operational waste is typically from maintenance and monitoring and includes protective clothing, paper and plastics; decommissioning waste includes building rubble and metals.

Solid LLW Strategy

The implementation of successive UK strategies for LLW has proved successful, resulting in the development of several alternative waste management routes and the diversion of significant volumes of our waste away from the LLWR. Prior to consignment to the LLWR (or to Dounreay for co-management with NDA LLW in the case of LLW from VULCAN NRTE), our wastes will continue to be assessed to determine whether there are other more suitable alternatives available, for example, surface decontamination or thermal treatment. We will continue to manage our LLW in accordance with the principles of the 2019 NDA Radioactive Waste Strategy. [10]

LLW is consigned for disposal at the earliest opportunity. Wastes with very low levels of activity that can be classified either as VLLW or ‘out of scope’ are consigned to the appropriate treatment or disposal facility. The successful delivery of this approach will provide capability and capacity to manage LLW for many decades provided the current focus on implementation is maintained.

Where the security classification of wastes may prevent diversion from LLWR to other routes, we will challenge whether the classification is still appropriate (in the case of legacy equipment) or whether appropriate controls can be introduced to resolve security concerns.

Operational and decommissioning activities produce radioactive and non-radioactive wastes. For reasons including practicality and value for money, radioactive and non-radioactive wastes will be segregated and managed in a manner consistent with the Waste Hierarchy. Figure RW-5 below illustrates our strategy to managing radioactive waste.

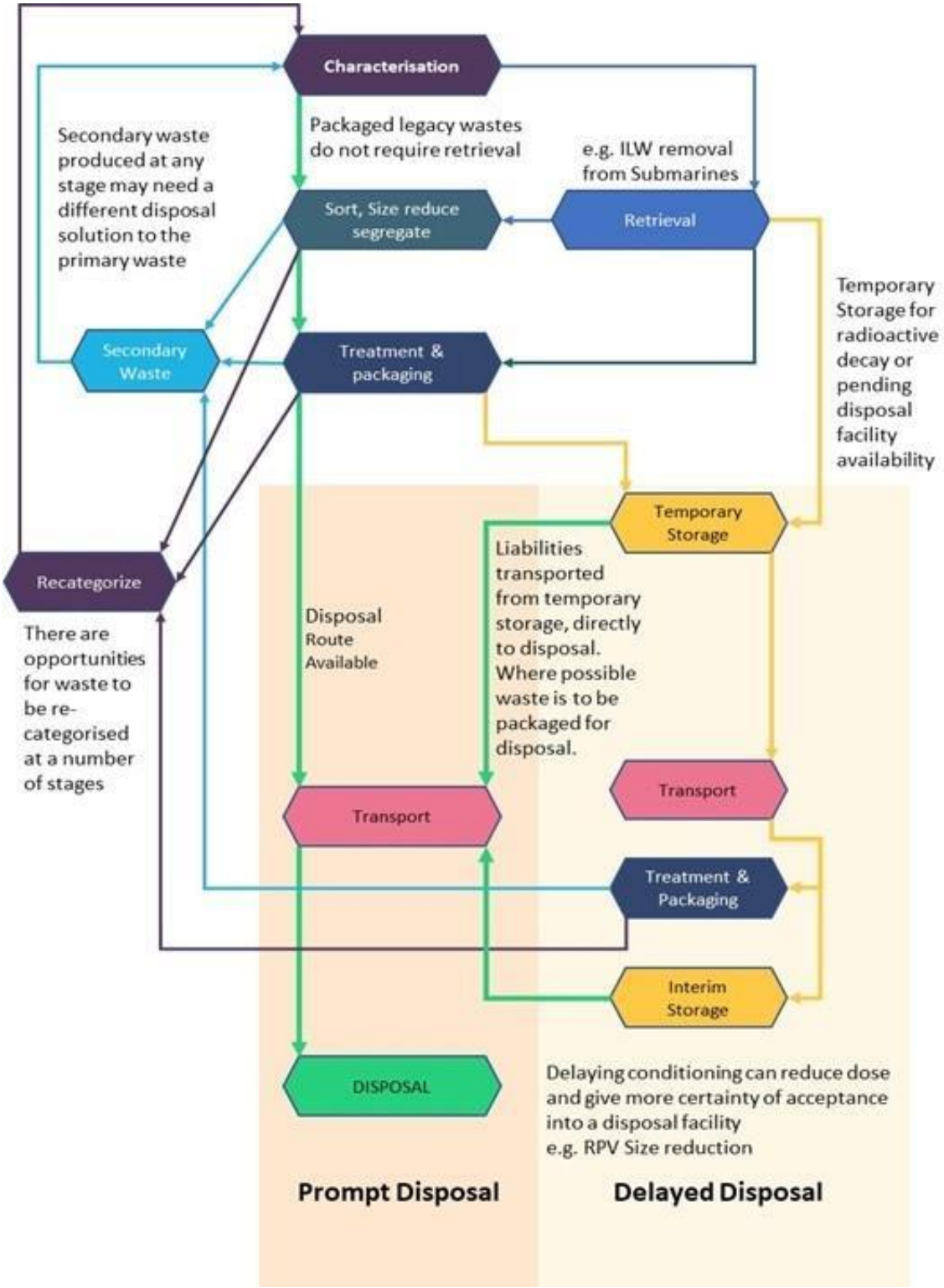


Figure RW-5: *Our generic approach to managing radioactive waste*

Strategy Development

- We will continue to participate in the development and implementation of UK radioactive waste policy.
- We will seek the optimum solution for the storage of HAW that protects people and the environment in a safe and cost-effective manner.
- We will work with our sites, the NDA and waste producers to share best practice on all aspects of waste treatment solutions, for example thermal treatment.
- We will explore opportunities for working together more effectively; for example, consolidated or shared storage, transport, shared use of assets.

The enduring nature of our programme will produce liabilities that will require management and disposal facilities beyond the lifetime of the current and planned future facilities. Recognising the NDA own current, and will own future waste facilities, we will work with them, their subsidiaries and waste service providers to plan our current and future disposals.

We will seek to implement the principles of the NDA's radioactive waste strategy to develop appropriate through life plans for the management of our radioactive waste.

We will ensure our strategy for managing liabilities evolves in line with applicable UK policy and strategy, and that our through life management plans can adapt to changes and take advantage of opportunities that may enable us to manage our liabilities more effectively.

Wastes at the boundary between each of the waste categories need careful management. [10] Some boundary LLW may be more suitable for geological disposal and similarly HAW at the boundary may be more suitable for disposal in a near surface environment. We will work with regulators the Office for Nuclear Regulation (ONR), EA, SEPA, the Defence Nuclear Safety Regulator (DNSR) and the nuclear community as a policy for boundary waste is developed and will determine appropriate management strategies for the appropriate waste streams. As possible alternative options to GDF for some of the UK HAW inventory are explored, we will identify our liabilities that may be candidates for alternative disposal options.

Since the last NLMS there has been progress attaining confidence in the disposability of our liabilities through the RWM disposability assessment process. Some legacy HAW packages are being re-analysed with current equipment to determine the radioactivity of the contents more accurately as some packages have now been proved to be LLW.

A significant amount of material has been diverted from LLWR and managed using more appropriate routes. Work is underway with LLWR Ltd and waste producers to identify further operational wastes that could be diverted from LLWR.

Liquid and Gaseous Discharges

We generate liquid and gaseous discharges during ongoing operations and decommissioning. The levels can vary over time due to the nature of operations, for example, gaseous discharges can vary due to the periodic nature of submarine refit operations.

We support the UK Strategy for Radioactive Discharges and the aims of the OSPAR North East Atlantic Environment Strategy 2010 - 2020 (reviewed 2018). [11] [12]

Our radioactive discharges are within the limits set by the EA; SEPA; and DNSR. We apply Best Applicable Techniques (Best Practicable Means and Best Practicable Environmental Option in

Scotland) to keep discharges to the environment as low as is practicable whilst meeting our business requirements.

We provide information on our discharges to water and air to the environment agencies and the Food Standards Agency for inclusion in the Radioactivity in Food and the Environment report (RIFE). [13] These reports provide visibility of the quantities discharged and the effect on the environment. We produce relatively small discharges, comparable to the medical and bioscience, research and waste management sectors. In addition to RIFE, we conduct an annual monitoring programme for discharges to the marine environment on a voluntary basis and taking a wider range of samples. This is conducted independently by Defence Science and Technology Laboratories and confirms that defence nuclear programme discharges have no discernible effect on the environment or health.

Radioactive Waste in Scotland

Scottish government policy on HAW [14] is that long-term management of higher activity radioactive waste should be in near-surface facilities. Facilities should be located as near as possible to the site where the waste is produced. The Scottish government does not support deep geological disposal. In England and Wales, the current policy for HAW is geological disposal. In 2016 the Scottish government published the implementation strategy [15] to expand on the framework provided in 2011 to allow waste management decisions to be taken to ensure the policy is implemented in a safe, environmentally acceptable, and cost-effective manner.

The Scottish government policy does not apply to radioactive waste from those defence premises which are not subject to regulation under the Environmental Authorisations (Scotland) Regulations 2018 (EA(S)R) (which replaced the Radioactive Substances Act 1993). [16] This means the majority of our HAW arising in Scotland is not subject to the Scottish government policy, including radioactive waste produced from the operational nuclear submarine bases on the Clyde, from the VULCAN Naval Reactor Test Establishment (NRTE) in Caithness, and from the decommissioning and dismantling of redundant nuclear submarines now in afloat storage at Rosyth Dockyard.

All long-term waste management options will be subject to robust regulatory requirements and we will work with the Scottish Environment Protection Agency to secure approved disposal routes for all our radioactive waste.

The HAW from submarine dismantling at Rosyth will be transported to Capenhurst where it will be stored. The conditions for acceptance into the appropriate disposal facility will determine the final treatment and packaging requirements. We are in the process of determining the treatment, storage and disposal options for HAW from VULCAN NRTE.

Our LLW from Rosyth will be managed in accordance with the UK strategy for solid LLW [10]. Solid LLW from VULCAN NRTE will continue to be consigned to the Dounreay Site for processing and disposal under permitted arrangements.

Our irradiated fuel in Scotland will be consolidated at the WIF at Sellafield and managed in accordance with the irradiated fuel approach described in this strategy.

We will determine the long-term management strategy for HAW generated in Scotland, and will comply with Scottish government policies and strategies where applicable. We will engage with the Scottish government on decommissioning at our sites in Scotland and with local communities through local liaison committees.

Case Study 4: LLW resins

In common with civil industry, we have used ion-exchange resins (IXR). IXR act like a filter, removing radioactive particles from the submarine reactor plant, reducing the dose to crew during operations and to workers during maintenance.

Most IXR can be cemented within a waste package and disposed to LLWR. In the past we have added compounds to some of our IXR (which have become LLW during operations) to make them more effective as a filter, however, the presence of these compounds has meant that the radioactive waste IXR would not be accepted at LLWR. An additional conditioning step is required ahead of cementation, to remove the compounds, meet LLWR's waste acceptance criteria and allow LLWR disposal.

We have been leading an innovative project with the supply chain, which has culminated in an integrated conditioning technique to both remove the prohibited compounds and produce a final cemented waste package, suitable for disposal to LLWR. We have considered a range of thermal treatment technologies and have selected our preferred technology to enable the earliest disposal of the IXR. Inactive and active trials have been successful and the processing of our IXR is planned between 2023 and 2030.

Environmental and safety regulators and the NDA have been kept informed throughout the evolution of the project and we continue to work with the NDA to share our knowledge and experience gained from the thermal treatment of our IXR.

Case Study 5: HAW at AWE

Our nuclear weapons capability has generated Higher Activity Waste (HAW) that now requires treatment and disposal. The packaged HAW requires treatment and packaging to produce a passively safe waste form suitable for long term storage and eventual GDF disposal.

Both our own, and NDA strategies emphasise the importance of government collaboration in the best interests of the UK and we have both made commitments to work together to manage nuclear liabilities.

These strategies have been implemented through the planned treatment and management of a quantity of HAW from the Atomic Weapons Establishment (AWE). As part of the Best Available Techniques assessment for the management of our HAW, the NDA agreed to include the use of its own facilities as one of the credible options. Following a joint (NDA, MOD and AWE) assessment of the options, and taking into account many factors including safety, value for taxpayer money, and environmental protection, the preferred option was to use existing waste treatment facilities at the Sellafield site.

The preferred option has several advantages:

- It represents significant cost avoidance for the UK taxpayer. AWE's initial investment appraisal estimated the cumulative lifetime cost of an option sited at AWE was £600-720 million, the preferred option will have a lifetime cost which is lower and has other benefits.
- Existing plant and skilled resource would be sustained at the Sellafield site and would not need to be duplicated at AWE.
- The environmental cost, capital investment, risk and additional liability for decommissioning associated with a new construction at AWE would be avoided.
- Hazard reduction at the Aldermaston site could be accelerated without adding to the risk burden at Sellafield.
- AWE investment at Sellafield has increased the HAW processing capacity so that there is no delay or detriment to the decommissioning mission at Sellafield. Furthermore, the retention of safely packaged HAW at Sellafield avoids operational, logistical and environmental issues associated with returning the waste to AWE.

Case Study 5 continued

This programme of work is being delivered through our effective collaboration with, BEIS, AWE, NDA, Sellafield Limited and LLWR, overcoming challenges due to differences in departmental processes.

There has been sustained regulatory and stakeholder engagement throughout. A monthly programme board and working group oversees delivery of the necessary interventions to ensure that the collaboration is successful and continues to be in the best interest of the UK.

Shipments of HAW from AWE began in Spring 2021.

Effective collaboration has supported the resolution of several commercial, operational and logistical challenges, including:

- cross-sector commercial policy approaches;
- title transfer of material at the appropriate point in time, to satisfy obligations under international safeguards; and
- enabling the transportation of HAW by sharing good practice.

Theme Six: Enablers

Description

Successful delivery of this strategy is supported by enablers which are critical to all areas of our business and not specific to managing nuclear liabilities.

The enablers underpin the key themes (submarines; irradiated fuel; nuclear materials; sites and facilities; and radioactive waste). This strategy can only be implemented if the enablers are effectively delivered. The strategy for enablers is to rely upon our organisational processes and policy for the provision and development of the enablers and not to develop them specifically for managing nuclear liabilities. The enablers described are as follows:

- Health and Safety, Security and Quality
- Environmental Protection and Sustainability
- People, Skills and Capability
- Funding
- Investment Appraisal
- Contracting and Incentivisation, Competition and the Supply Chain
- Knowledge and Information Management (KIM)
- Stakeholder Engagement and Communications

Health and Safety, Security and Quality

Health and safety, security and quality are all important factors in managing nuclear liabilities. The development and implementation of this strategy will be consistent with our policies, UK legislation and wider government strategies. We will comply with all applicable health and safety and security legislation. On the occasions where we need to be exempt from legislation to allow us to effectively carry out our business, we will put arrangements in place that ‘produce outcomes that are, as far as reasonably practicable, at least as good as those required by UK legislation’ as established in the Secretary of State’s policy statement. [17]

The Secretary of State’s policy statement is amplified in the’ Defence policy for health, safety and environmental protection’ DSA01.1. [18] Further details on our implementation of the policy can be found in DSA01.2 ‘Implementation of defence policy for health, safety and environmental protection’ [19] and Joint Service Publication (JSP) 375 ‘Management of health and safety in defence’. [20]

We are committed to supporting the workforce in managing stress and improving wellbeing. The Defence People Mental Health and Wellbeing Strategy 2017-2022 [21] sets out the direction to achieve this; in addition, there are many resources available to ensure we create a safe working environment that is conducive to developing people’s health and wellbeing.

The Defence Safety Authority (DSA) provides scrutiny and assurance that activities within defence are conducted safely and in accordance with policy and legislation. The DNSR) and the Defence Nuclear Security Regulator (DNSyR) are independent organisations within the DSA:

- DNSR regulates the defence nuclear programme authorised sites with regulation policy covered by DSA02 – DNSR Defence Nuclear Safety Regulations of the Defence Nuclear Enterprise and the guidance document DSA03; [22] [23] and
- DNSyR is the independent regulator of nuclear security across the defence nuclear programme. The relevant JSPs contain the policy and direction on nuclear security regulation, to develop, deliver and sustain security arrangements to protect nuclear material, nuclear information and nuclear assets across the defence nuclear programme.

Regulation of our licenced sites is carried out by the ONR against licence conditions in the same way that ONR regulates civil nuclear sites. DNSR works closely with the ONR, EA and SEPA and will continue this relationship to provide a consistent approach to safety, security and environmental protection at defence nuclear programme sites.

Our approach to quality is set out in JSP 940. [24] Quality management is the process of ensuring that all the activities necessary to deliver organisational outputs meet customer and stakeholder requirements and are planned and carried out efficiently and effectively. By providing a systematic approach to governance, assurance, quality management and continuous improvement we can manage nuclear liabilities safely and securely. Quality is pivotal in safely managing our assets and liabilities through their entire lifecycle to an appropriate end state.

Environmental Protection and Sustainability

Our approach to environmental protection is established in the Secretary of States' policy statement (Ref. 17) with detailed policy laid out in DSA 01.1. [18] Further guidance is provided in JSP 418 'Management of Environmental Protection in Defence'. [25] At the submarine delivery level, we have adopted a consistent and coherent approach across the organisation for managing environmental issues through the use of an Environmental Management System compliant to the requirements of the ISO 14001 Environmental Management System standard.

The licensed sites within the defence nuclear programme are regulated by the EA in England under the Environmental Permitting Regulations 2016. [26] In Scotland, the regulator is SEPA with regulation covered under EA(S)R 2018. [16] Where there are exemptions or scenarios where the regulations are not appropriate, equivalent provisions are put in place and regulated by DNSR, for example using 'Letters of Agreement'. We will continue to work closely with the EA and SEPA to ensure consistent and appropriate environmental regulation is applied across the defence nuclear programme.

At a local level, all sites will maintain an Environmental Management System based on the ISO 14001 standard to ensure there is a formal, structured approach to managing the aspects of a site's activities, products or services that have, or could have an impact upon the environment.

We recognise the need to take a sustainable approach across our operation which involves balancing appropriate economic, social and environmental considerations. We recognise the tangible benefits and opportunities that sustainability provides, and it has been a long-standing component of defence strategy and policy. The National Security Strategy [27] includes a commitment to sustainability, and it is identified as one of our priorities in the Defence Strategic Direction [28] which is committed "To deliver Defence in the most effective, efficient and sustainable way".

In addition, in 2021 the UK government published the Integrated Review [29] the most comprehensive since the end of the Cold War, which set out the threats and challenges we face now and into the future. This highlighted the clear and present danger posed by climate change that afflicts all of us, every region of the world, every part of society. We appreciate its impact and how we must all work together to address it.

In March 2021 the MoD issued the Climate Change & Sustainability (CC&S) Strategic Approach [30] publication following a review spear-headed by Lt Gen Richard Nugee. This has set out an ambitious and coherent forward plan for the MoD in keeping with the UK government's commitments in Net Zero and its related work on sustainability, and it sets out the need for urgent action and proposes a coherent framework for embedding sustainability across the department.

At a global scale, the document highlights that, as one of five United Nations (UN) security council permanent members, we have an emphasised role and responsibility in meeting (and supporting others to meet) the 17 UN Sustainable Development Goals [31] which form the heart of the UN 2030 agenda for sustainable development. An impact assessment had been conducted at the submarine enterprise level to ascertain the level of work needed and the areas needing more attention. To deliver climate change and sustainability our attention is currently focussed on four key workstreams: Net Zero; Sustainable Procurement; Climate Resilience and Engagement; Behaviours & Culture. At an operational level, we interpret the strategies into guidance and best practice for all aspects of sustainable procurement so that we can ensure that we are working collaboratively with our Industry partners to respond to this collective challenge in a structured manner.

People, Skills and Capability

We have an on-going need to retain and manage the specialist capabilities that support the defence nuclear programme across the lifecycle from design and operation to decommissioning. To achieve this, we will recruit, retain, train and re-train people with the required skills and experience to manage our nuclear liabilities. Our guiding principle is “to have the right person, with the right skills, in the right post, for the right amount of time” [32] both internally, to act as an intelligent customer and within industry partners and the supply chain.

The nuclear industry continues to experience changes that are set to have a long-lasting impact upon both the nature and makeup of our workforce. The Nuclear Workforce Assessment 2019 projections show nuclear workforce demand is likely to require an inflow of between 3200 and 4800 new workers to the sector. [33] Civil Nuclear New Build and the ongoing NDA decommissioning programme both require significant resources. In defence, resources are required to support: the future submarine acquisition programmes; maintaining our current capabilities; and the effective management of our nuclear liabilities including materials, platforms and irradiated fuel. There are significant resourcing and engineering challenges ahead but there are also significant long-term benefits for the UK through expansion and the development and retention of an appropriately skilled workforce.

We are committed to creating a diverse and inclusive workforce. Meeting the Nuclear Sector Deal [34] target of a 40% female workforce by 2030 depends on both the balance in recruitment and the turnover of staff. Given an overall attrition rate of 8% (for example through retirement) and no net expansion, recruitment of at least 50% women is required, averaged over the next decade or so. The vision set out in the Defence Diversity and Inclusion Strategy 2018 – 2030 [35] is for defence outputs to be delivered by the right mix of capable and motivated people that appropriately represent the breadth of the society we exist to defend, now and in the future.

To meet these aims, we are working with industry partners to develop training opportunities, graduate development schemes and apprenticeships to enhance and diversify the nuclear workforce. Our highly skilled and experienced workforce will be retained and developed further to ensure that our people are equipped to deliver an evolving programme. Internal and external training programmes and mid-career training will enable our people to undertake a range of rewarding roles in the department.

Funding

We have the financial responsibility for the defence nuclear programme which is wholly funded by Her Majesty's Treasury (HMT). In common with the wider nuclear industry, we must be able to demonstrate, at the planning and approvals stage, that the future management of our nuclear liabilities has been fully considered.

Our provision for the management of nuclear liabilities is published in our Annual Report and Accounts, [36] an extract of which is shown below.

	Nuclear Decommissioning £M	Other Decommissioning and Restoration Costs £M	Early Retirement Commitments £M	Legal £M	Other* £M	Total** £M
Balance at 1 April 2018	18,831.2	41.6	87.6	596.6	516.0	20,073.0
Increase in provisions in-year	4,348.8	0.6	1.2	239.4	(44.5)	4,545.5
Provisions written back and reclassifications	(884.9)	-	(5.3)	(47.6)	(171.8)	(1,109.6)
Provisions utilised in-year	(146.7)	(1.7)	(6.0)	(117.6)	(109.1)	(380.9)
Unwinding of, and changes in, discount rate***	(10,733.9)	(1.1)	(0.6)	(31.5)	8.1	(10,759.0)
Balance at 31 March 2019	11,414.5	39.4	76.9	639.5	198.7	12,369.0
Increase in provisions in-year	882.7	15.9	1.9	222.6	96.0	1,219.1
Provisions written back and reclassifications	(695.2)	(22.7)	(8.2)	(139.4)	34.4	(831.1)
Provisions utilised in-year	(147.0)	(0.9)	(12.2)	(151.6)	(207.5)	(519.2)
Unwinding of, and changes in, discount rate	220.6	(1.1)	(5.3)	(7.0)	0.4	207.6
Balance at 31 March 2020	11,675.6	30.6	53.1	564.1	122.0	12,445.4

* Other includes provision, £93 million (2018-19: £154 million) for future payments under the Enhanced Learning Credit Scheme which helps qualifying Service Personnel or Service Leavers with the cost of learning.
** Movements in provisions pass through operating costs (see Note 4.4) or, for some changes in capitalised decommissioning liabilities, through Other Comprehensive Expenditure.
*** Provisions are discounted using HM Treasury's annually issued rates. In 2018-19 there was a significant change to the rates resulting in a large decrease in the value of the Nuclear Decommissioning provision.

To control near term funding requirements for the delivery of nuclear liabilities management activities, the Equipment Plan, as a subsidiary plan to the Defence Plan, sets out the funding profile for the next ten years. These plans are submitted to HMT for scrutiny and review alongside plans from all other government departments. HMT decides on the level of funding each department will receive. We allocate this funding across the Department to meet our business needs through the Annual Budget Cycle process. The funding is delegated to departments within the Ministry of Defence responsible for funding and delivering the defence nuclear programme, including nuclear liabilities.

A summary of the current financial liabilities for the defence nuclear programme are disclosed through the annual report and accounts, with the supplementary notes to these accounts setting out the methods and assumptions that form the basis of calculation on the current value of our nuclear liabilities. We are committed to adequately funding nuclear liabilities across a balanced and prioritised portfolio of activities to support defence.

Investment Appraisal

We strive to provide the best value for money for the UK taxpayer by selecting the most cost-effective option whilst maintaining high standards of safety and security. Value for money is achieved through the rigorous investment appraisal process described in JSP 507 [37] and the Central Government Guidance on Appraisal and Evaluation ("Green Book"). [38] Investment appraisal is a systematic process to clearly define the requirement, develop options to deliver it, and estimate and compare the costs and benefits of each option.

In pursuing our policy objectives, we will seek to achieve Value for Money, defined as optimising net social costs and benefits for delivering a given requirement, and achieved by selecting the optimal option against these criteria. Where there is only a single credible option for delivering a requirement, as may be the case for the delivery for certain complex nuclear liability requirements, contracts will be placed in accordance with the Single Source Contracting Regulations (SSCR), [39] as required by the Defence Reform Act 2014. [40] The SSCR and Single Source Regulations Office seeks to ensure that good value for money is obtained in government expenditure on qualifying defence contracts, and that persons who are parties to qualifying defence contracts are paid a fair and reasonable price under those contracts.

In developing an understanding of the costs and benefits of a given option, there are certain challenges presented by the timescales for the management of nuclear liabilities, which for certain liabilities will extend many decades into the future. In these cases, present-value provisions are developed using the discounting process described in the Green Book. This will be incorporated into a business case which describes the requirement and compares the options for delivery of the requirement on a cost and benefit basis. This business case will proceed through a staged approvals process. Upon completion of this process, decisions are subject to independent scrutiny by Defence Economics to ensure that decisions are affordable and present value for money to the department, in accordance with the process described in JSP 507.

Competition, Contracting and Incentivisation, and Supply Chain

The existence of a healthy and competitive defence industry and supply chain is vital to developing and sustaining key defence capabilities. The 2017 Defence Industrial Policy recognises the need to make it easier to do business with Defence, through improvements in transparency, early engagement, pace in contracting and good supply chain practice in industry.

The approach is detailed in the Commercial Toolkit which forms part of Knowledge in Defence. [41] Wherever possible, we will take a competitive approach to procuring services and will only use non-competitive approaches in specific, closely defined circumstances, as described in the Single Source Contracting Regulations. Where non-competitive approaches are utilised for contracts valued in excess of £5m, as a Qualifying Defence Contract this shall be governed by the Single Source Contracting Regulations 2014. We are working with our industry partners, the NDA, LLWR and RWM to ensure that our liabilities are considered and accounted for in UK programmes.

We will continue to build on and develop links with the supply chain to raise awareness of our current and future needs and to explore new initiatives and innovations which will assist in managing nuclear liabilities. Where appropriate and cost effective we will lead in developing solutions and technology with the possibility of sharing this across government. We will continue to work together with BEIS and the NDA to deliver effective and efficient management of our nuclear liabilities for the benefit of the UK.

Knowledge and Information Management (KIM)

Secure, effective management, storage and access to information is critical to successful and effective decision making, both now and in the future.

We are working with the LLWR, RWM, BEIS and the NDA in developing the long-term information requirements for disposal of LLW, future geological disposal, and the interim period of safe and secure storage. This will ensure that we can comply with information requirements and are engaged in the process of establishing waste records.

We will develop our nuclear liabilities knowledge and information management systems in line with the policy set out in JSP 441 – Information, Knowledge, Data and Digital in Defence. [42]

This policy states we should create, manage, organise, protect, value, share, review, dispose of and use all information assets through life. Ensuring this past and present information is preserved and shared effectively means that our resources can be maintained and used safely by the current and future personnel.

Stakeholder Engagement and Communications

Public and stakeholder engagement and communications are important to demonstrate openness and transparency, and to communicate our strategic direction. Effective communication establishes trust and builds support with stakeholders and communities to promote effective collaboration and enable outcomes which benefit everyone. Whilst we will aim to be open and transparent in our communications, maintaining the security and safety of our personnel, contractors, assets and information will be our guiding principle.

We recognise that the management of nuclear liabilities has the potential to be of concern to the communities around sites where our nuclear liabilities are managed. We understand these concerns and the importance of these activities to individuals, campaign groups and local communities and will consider public engagement on a case-by-case basis taking account of government policy and environmental and planning laws. We will continue to work with local authorities on the planning aspects of decommissioning and site remediation. Some examples of public engagement are the continued relationship with VULCAN NRTE and the Dounreay Stakeholder Group and the submarine dismantling programme public consultations.

The authority on defence communications is the Defence Directorate of Communications (DDC), which provides internal guidance to project teams. At project level, teams are required to plan, from the early stages of their projects, how and when they intend to engage with relevant people and organisations. All projects will have a communication strategy and plan to ensure that appropriate information is shared at the right time. Communication strategies and plans are living documents which should be reviewed at regular intervals to ensure that they are still relevant and up to date.

While the content of this strategy has not been subject to a public consultation, we have consulted safety and environmental regulators, devolved administrations and government departments. Our strategy is firmly based on UK Policies and strategies for managing nuclear liabilities and does not diverge from their principles.

International Relations

We are addressing nuclear liability management issues that are similar to those being considered by other nations. UK defence information has a substantial security aspect, but this does not preclude the potential for beneficial international collaborations provided it is possible within the constraints of the 1958 Mutual Defense Agreement and the Polaris Sales Agreement. We will develop international relations to explore possible opportunities for collaboration or sharing experiences and where we have existing relationships with international partners, these will be used to inform the effective management of nuclear liabilities.

The intent to strengthen defence relationships was reaffirmed in the 2021 Integrated Review, [29] which maintains a commitment to the defence nuclear programme. In general, the preference is for bilateral relationships as these offer the best balance of advantages and disadvantages. In particular, the Strategic Defence and Security Review [27] highlighted the need for deepened relationships with those that we can share capabilities with. However, where possible and there is clear benefit, we will also consider and engage multilateral relationships within the constraints of the 1958 Mutual Defense Agreement and the Polaris Sales Agreement.

Research and Development (R&D)

We account for around 30% [43] of the UK government spending on R&D, this is predominantly in support of military capability. We place great importance on maintaining knowledge and awareness of new technology and techniques available to assist in the effective management of all aspects of our business including managing nuclear liabilities.

Effective and directed R&D is at the heart of finding safe and cost-effective solutions for managing nuclear liabilities and achieving the best value for money for the taxpayer. To achieve this, we will work with industry partners, the NDA and the wider nuclear industry to ensure that we are fully involved in activities designed to direct and support R&D in the UK's decommissioning mission. We have shown how we can effectively collaborate, using programme boards and working groups, with industry partners for example managing problematic waste at AWE that was similar to civil legacy problematic waste and our development of thermal treatment techniques to deal with our problematic ion exchange resins (see the case study in the radioactive waste theme).

The NDA Strategy has laid out a series of "grand challenges for technical innovation". These have set a direction of travel and drive innovation and change. There are close synergies between these NDA challenge themes and the needs for R&D and technology development in the defence nuclear programme.

Where we have a unique liability (or a priority higher than other operators with similar liabilities) or there is a technology gap that cannot be met through a collaborative approach, we will fund R&D exclusively, (an example of this is the management of problematic ion exchange resins). Experience gained will be shared with the NDA and the wider nuclear community to benefit the UK. We will share and learn from industry best practice and exploit the opportunities offered by the supply chain for alternative disposal methods wherever it is possible to do so; whilst maintaining security and safety of information. We work with industry on R&D for managing nuclear liabilities through the Nuclear Waste and Decommissioning Research Forum and via the NDA's Research Board.

Transport

In common with other nuclear operators, we have a requirement to move nuclear materials, irradiated fuel and radioactive waste between locations. All transport movements related to defence nuclear programme activity are carried out safely and securely by specially trained personnel. These movements are kept to an appropriate level to allow us to meet our requirements. The transport of nuclear materials within the defence nuclear programme is regulated by DNSR. The approach is taken from the IAEA Safety Standard – 'Regulations for the Safe Transport of Radioactive Material' (Ref. 44). DNSR is the Competent Authority for transport packages in the defence nuclear programme and interfaces as necessary with ONR's Radioactive Materials Transport Team, the Department for Transport (DfT), and other government departments to provide an approach to regulation which is consistent with civil standards. Transport is conducted by road or rail using containers which meet the appropriate safety standards for the consignment, some containers are required to withstand high energy impact, mechanical stress and fire.

There is a very low probability of a radiological incident occurring during the transport of materials; however, we maintain a number of contingency plans to deal with such an event should it ever occur. [40] Our Transport and Nuclear Emergency Organisation conducts regular exercises to test its ability to respond to an emergency involving the participation of the emergency services, other government departments and local agencies to test the full co-operative response to an incident. Some exercises are assessed by the nuclear safety and transport regulators.

We will ensure that safety cases are planned or in place for all required movements of nuclear liabilities and uphold the responsibility to maintain the safety and compliance of its transport assets. We are currently defining the transport requirements for legacy, current and future nuclear liabilities. Where new transport and packaging assets are required, we will work with other parts of government to avoid unnecessary duplication. When designing new transport containers, we will consider the disposal requirements so that the transport container can either become the disposal container, or easily and safely separated and decontaminated for reuse or free release.

Defence Nuclear Liabilities Background

Why do we have Nuclear Liabilities?

Liabilities have arisen from building and operating nuclear submarines, and from the manufacture and management of nuclear weapons - collectively referred to as the defence nuclear programme.

The UK's nuclear weapons programme began in the 1940s, primarily based on an air launched system. Since 1963, the UK has operated nuclear-powered attack submarines that carry conventional but not nuclear weapons. The first of these Royal Navy attack submarines was HMS Dreadnought, followed by the Valiant, Churchill, and Swiftsure Classes - all of which have now left service. The latest attack submarine is the Astute Class which is replacing the Trafalgar Class.

From the late 1960s, four nuclear-powered Resolution Class submarines supported the strategic nuclear deterrent; these carried US-supplied Polaris missiles fitted with UK Chevaline nuclear warheads. The Resolution Class submarines have now left service, and the Chevaline warheads have been dismantled. Other historical UK nuclear warheads have also been dismantled.

Since 1994, four Vanguard Class submarines have been introduced into service and these carry the Trident missile system. A new class of submarines, the Dreadnought Class is currently being built to replace the Vanguard Class submarines.

Successive UK governments, including this government, have concluded that a credible, continuous and effective minimum nuclear deterrent will be maintained as part of the UK's defence strategy for as long as the global security situation makes it necessary. The UK, however, remains committed to the long-term goal of a world without nuclear weapons, in line with obligations under the Nuclear Non-Proliferation Treaty, and works with international partners to make progress on multilateral disarmament.

This strategy addresses the management, decommissioning and disposal of our legacy, current and future nuclear liabilities; it does not cover the UK's policies on nuclear deterrence or the future of that deterrent.

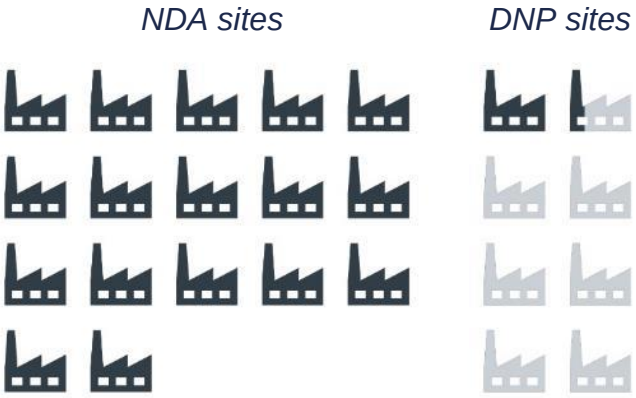
How do our Nuclear Liabilities compare with the rest of the UK?

Submarines

Submarines are unique to us, so there is no direct comparison, and the irradiated fuel is managed separately from submarine dismantling and disposal. Over 90% of the submarine will be recycled.

Irradiated Fuel

There are no direct comparisons. The legacy civil fuels have lower enrichment and are clad in different materials to the irradiated fuel from submarines. The NDA Theme is dominated by legacy civil fuels. There are similarities between some of our research fuels and some of the NDA's, that may allow these to be managed in the same way.



Sites and Facilities

The NDA is decommissioning and remediating 17 sites some of which contain plant in excess of 60 years old.

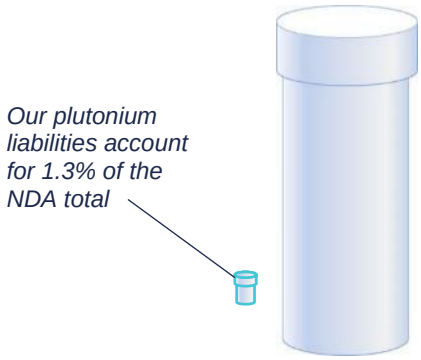
The Defence Nuclear Programme has eight sites. NRTE VULCAN is developing decommissioning plans for its site and facilities in Caithness Scotland.

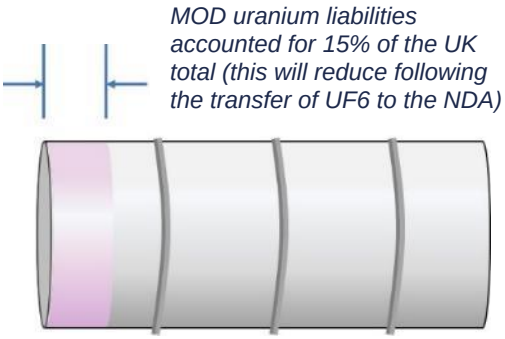
Rosyth has demonstrated the 'no danger' criteria for most of the site but continues to support submarine dismantling.

Nuclear Materials

Our plutonium liabilities are approximately 1.3% (by mass) of the NDA plutonium liabilities.

There are some differences in the isotopic content of our plutonium liabilities and the NDA's, but this will not prevent a common approach to the long-term storage and disposal.

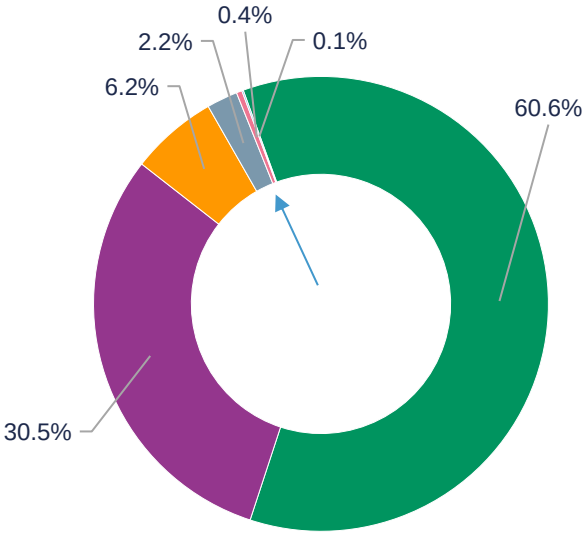




Most of our uranium liabilities are in similar chemical forms to NDA's e.g. Oxides and uranium hexafluoride tails and are physically indistinguishable.

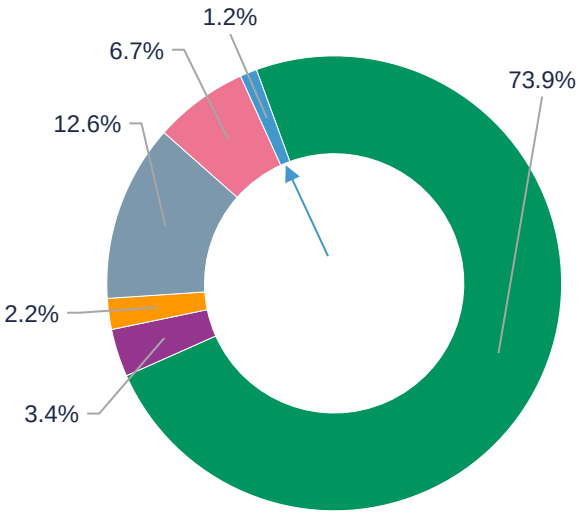
Radioactive Waste

Our radioactive waste, although substantial, constitutes a small percentage of the UK total; 0.03% by radioactivity (ILW); and 1.2 % by volume. [40] The diagram below (taken directly from the 2019 Radioactive Waste Inventory) shows the relative size of our nuclear liabilities compared with the UK total both in terms of total radioactivity, and total reported volume.



- Sellafield: 2,500,000 TBq
- AGR & PWR (operating stations): 1,300,000 TBq
- Dounreay: 260,000 TBq
- Magnox sites: 90,000 TBq
- Others: 17,000 TBq
- Defence sites: 1,100 TBq

Total radioactivity: 4,100,000 TBq



- Sellafield: 3,370,000 m³
- AGR & PWR (operating stations): 157,000 m³
- Dounreay: 101,000 m³
- Magnox sites: 576,000 m³
- Others: 303,000 m³
- Defence sites: 54,200 m³

Total reported volume: 4,560,000 m³

How are we dealing with our Nuclear Liabilities?

In October 2016, our policy for managing nuclear liabilities [44] was republished, stating the high-level policy, and re-enforcing the need for this strategy which builds upon the previous two strategies in 2011 and 2016.

At the most fundamental level we can deal with our nuclear liabilities either by conditioning and safely disposing of them, or by re-using and recycling them.

We are committed to embedding sustainability into everything we do, so many radioactive items do not become nuclear liabilities, instead they are re-used, refurbished, or recycled within the defence nuclear programme.

For all our liabilities we will adopt a safe and environmentally responsible strategy to bring them to an appropriate end point.

This document describes how are we dealing with our nuclear liabilities. The nuclear liabilities are described in sections called themes; these are summarised below.

Submarines

UK nuclear submarines have been leaving operational service periodically since HMS Dreadnought left service in 1980. They are disarmed immediately, defueled as soon as reasonably practicable, and de-equipped and prepared for being stored afloat, pending disposal by the SDP. The SDP was established to deliver a safe, environmentally responsible and cost-effective solution for dismantling 27 of the UK's defueled nuclear-powered submarines after they have left service with the Royal Navy.

The Submarine Delivery Agency is taking a staged approach to dismantling consistent with government policy and supported by the results of public consultation. This approach is unique and minimises the nuclear liabilities future generations will have to manage.

Low-Level waste has already been removed from Swiftsure, Resolution and Revenge which have been used as demonstrators to prove that the procedures being developed under the SDP are sufficiently robust to ensure the safe, secure and environmentally responsible LLW removal.

The next stage is initial dismantling, the reactor pressure vessel and related items from the reactor compartment which are above the LLW limit will be removed and stored at the Capenhurst Nuclear Licenced Site. The current assumption is that these items will be cut up and packaged in containers for disposal at a point in the future following interim storage.

We are committed to adopting a more circular economy and will re-use components which can be re-purposed in our operational fleet. Once all the radioactive waste has been removed around 90% of the materials on the submarines, mainly steel and other metals, can either be re-purposed or undergo conventional recycling at a licensed ship-breaking site which forms the final stage of the process.

Extensive information and documents including a strategic environmental assessment supporting the public consultations can be found at the SDP website. [1]

Irradiated Fuel

There are three elements to our strategy for managing irradiated fuel: consolidation; safe and secure interim storage; and disposition. The irradiated fuel from VULCAN NRTE, Devonport and legacy facilities will be consolidated to a single location prior to its disposition. Irradiated fuel will remain in safe and secure interim storage to keep open future options for management including disposal or reuse. Whilst reuse cannot be discounted at this stage, development of a disposal concept for our irradiated fuel is being undertaken to provide a basis against which we can compare reuse options and decide on a disposition route.

Nuclear Material Liabilities

Our nuclear material liabilities will continue to be stored safely and securely on nuclear licensed sites (outside the defence nuclear programme) under contractual arrangements. We continue to explore and realise opportunities for the coherent long-term management of materials with similar characteristics in line with UK government policy. Where appropriate, it is our intention to transfer ownership of some of our nuclear material liabilities to the NDA at a time when all relevant authorities agree, and specific criteria have been met demonstrating transfer is in the best interests of the UK.

Sites and Facilities

The majority of the defence nuclear programme sites (Annex A) will continue to be required to support us for the foreseeable future. Defence nuclear programme sites and facilities will continue to be managed responsibly; when there is no longer a requirement for them, they will be decommissioned.

Facilities will be dismantled and removed as soon as practicable, and sites will be returned to a state commensurate with their next planned use. Decommissioning activities will produce radioactive and non-radioactive wastes; the wastes anticipated will influence the decommissioning activity so that they can be segregated and managed in line with the Waste Hierarchy and applicable polices as discussed in Theme Four. We will consider the benefits of adopting an integrated multi-site, UK-wide approach to managing these liabilities.

Radioactive Wastes

Solid LLW

We will continue to manage our LLW in accordance with the principles of the 2019 NDA Radioactive Waste Strategy. [10] Prior to consignment to the LLWR (or to Dounreay for co-management with NDA LLW in the case of LLW from VULCAN NRTE), our wastes will continue to be assessed to determine whether there are more suitable alternatives available for example, surface decontamination or thermal treatment. The implementation of successive UK strategies for LLW has proved successful, resulting in the development of several alternative waste management routes and the diversion of significant volumes of our waste away from the LLWR.

LLW is consigned for disposal at the earliest opportunity. Wastes with very low levels of activity that can be classified either as VLLW or ‘out of scope’ are consigned to the appropriate treatment or disposal facility.

Operational and decommissioning activities produce radioactive and non-radioactive wastes. For reasons including practicality and value for money, radioactive and non-radioactive wastes will be segregated and managed in a manner consistent with the Waste Hierarchy.

Higher Activity Waste

Higher Activity Waste is safely and securely stored, awaiting decay to LLW, or the availability of a geological disposal facility. Storage of HAW will take into account the long-term storage recommendations from the Committee On Radioactive Waste Management. [8]

We will work with RWM using the 'Letter of Compliance' process to develop and agree the processing and packaging requirements necessary for our HAW to meet the waste acceptance criteria for disposal. This involves us producing disposability assessments for each of our HAW waste streams.

For legacy HAW, we may reassess the waste using current equipment to determine whether the wastes are still HAW; reassessment of some legacy HAW has already led to reclassification as LLW. There may also be advantages in sorting and segregating some legacy HAW into HAW and LLW where it is safe to do so. We will manage our HAW in accordance with the principles of the 2019 NDA Radioactive Waste Strategy. [10]

What is the NDA's approach to our Nuclear Liabilities?

The NDA, RWM and BEIS are important partners for the management of our nuclear liabilities and we continue to work together.

The NDA's fourth strategy was published in April 2021 [4] under the terms of the Energy Act (2004), which requires the NDA to produce a strategy every five years. The NDA strategy for Non-NDA liabilities such as ours and other liability owners are clearly articulated.

We will continue to work with BEIS and the NDA in the best interests of the UK. The Energy Act (2004) makes provision for a 'nuclear transfer scheme' whereby liabilities not covered by the Act may be transferred to or from the NDA.

Nuclear Decommissioning Authority

The Energy Act (2004) [45] [46] outlines the NDA's responsibilities for the ownership and management of the UK's nuclear legacy sites and provides the NDA with a clear mandate. The NDA was established in 2005 as a non-departmental public body to ensure that the UK's nuclear legacy sites are decommissioned and cleaned up safely, securely, cost effectively and in ways that help protect people and the environment. The NDA's sponsoring department is the Department for Business Energy and Industrial Strategy (BEIS). The NDA has an annual budget of around £3billion and 15,000 employees across the estate. The NDA owns the LLWR, a key asset for the management of LLW in the UK. BEIS are responsible for establishing the programme to implement a GDF for disposal of HAW. RWM, which is a wholly owned subsidiary of the NDA, will be the site licensee for a GDF. The NDA is working with the Scottish government to implement its policy for the long-term management of HAW in Scotland, and for some aspects of its work in Scotland, NDA is responsible to Scottish Ministers.

Are our Nuclear Liabilities safe and secure?

The safety and security of our current and future nuclear liabilities through all stages of management to final disposal is, and will continue to be, of paramount importance.

We acknowledge that for some of our liabilities, storage is an interim necessity before an appropriate end point is available. Storage is designed to accommodate uncertainties in the availability of disposal facilities and the storage, conditioning and disposal of all our liabilities will meet regulatory requirements.

We comply with all applicable legislation. In addition, and in accordance with our Safety, Health, Environmental Protection, and Sustainable Development Policy [16] [17] where defence has exemptions and derogations from either domestic or international law, we will introduce standards and management arrangements that produce outcomes that are, so far as reasonably practicable, at least as good as those required by legislation.

The storage, dismantling, decommissioning, and disposal of our nuclear liabilities is regulated by the statutory and defence, nuclear safety and environmental protection regulators.[5] Before any decommissioning, dismantling, and disposal activities can commence, the regulators must be satisfied that these activities are necessary and safe, and that the risk to the public, workers and the environment arising from these activities is acceptable and As Low As Reasonably Practicable (ALARP) and that Best Available Techniques are used (or Best Practicable Means and Best Practicable Environmental Option in Scotland).

Our sustainable development and sustainable procurement strategies [28] [30] influence our decommissioning and disposal approach. These strategies identify the issues that need appropriate consideration including sustainable consumption and production, climate change and energy, and natural resource protection and environmental enhancement.

The ONR, EA and SEPA, regulate the nuclear safety and environmental aspects of the defence nuclear programme. Where defence exemptions exist, DNSR regulate environmental protection in the defence nuclear programme. The ONR regulates matters relating to civil nuclear transport and DNSR regulate matters relating to defence nuclear transport.

[5] ONR - Sites/Facilities that we regulate

What will managing our Nuclear Liabilities cost and how will it be funded?

Our Annual Report and Accounts [36] contains details of the provision held to manage our nuclear Liabilities. The figure is subject to variation due to changes in strategic assumptions and Her Majesty's Treasury (HMT) accounting factors. Some of our nuclear liabilities are already being managed through funded projects. As the management of nuclear liabilities is funded from the defence vote; future nuclear liabilities projects and future phases of current nuclear liabilities projects will have to compete with capability projects for funding. Approvals are only given when a case can be made that demonstrates the solution is both affordable and value for money. Given the range of possible options to manage some of our nuclear liabilities, the developing UK policy in some areas, and the timing of disposal facilities for HAW, there are some cost, funding and timing uncertainties. Once the strategy for a particular liability reaches a suitable level of maturity, cost estimates can be given a higher degree of confidence. We will appropriately fund our use of any UK facilities. We are making a funding contribution to GDF development and have planned for ongoing contributions.

Why don't we have defined solutions for all our Nuclear Liabilities?

Some of our nuclear liabilities can be managed in the short term; sites and facilities have been, and continue to be decommissioned, waste is being consigned to LLWR and diverted to other routes in accordance with the 2019 UK radioactive waste strategy [10] and discussed further in the radioactive waste theme). However, some elements of strategy development are long term activities that cannot predict the outcome of decisions yet to be taken on future nuclear policy and infrastructure in the UK. The design parameters and timing of disposal facilities for HAW will determine the long-term management of our nuclear liabilities, including storage, processing and packaging requirements. We will continue to develop plans for options that will inform decisions and strategic direction.

How are we developing and implementing our strategy?

This strategy continues to develop as we consider the disposal options for each of our liabilities in line with applicable policy, the development of techniques and the availability of facilities. Some liabilities require us to develop bespoke techniques to produce a stable waste form that meets waste acceptance criteria, for example, developing a thermal treatment process for ion exchange resins. We work with the NDA, industry partners, other government departments and regulators to help in development and implementation of our strategy. Since the last strategy we have strengthened our collaboration with NDA and BEIS. We will also work with other waste producers and learn from international civil and defence developments. We will consider public engagement on a case-by-case basis, taking account of government policy and environmental and planning law. Sites within the defence nuclear programme, as part of their Licence and/or Authorisation Conditions, make and implement adequate arrangements for the decommissioning of any plant or process that may affect safety. Implementation will be on a local basis in accordance with the site strategy and our project approval process. As the decommissioning of some facilities has already been successfully carried out across our estate we will continue to collaborate and share best practice with current and future nuclear liabilities management projects and new capability acquisitions.

What is our strategy for Nuclear Liabilities in Scotland?

This strategy applies to our management of nuclear liabilities throughout the UK, Scottish government policy on HAW [14] is that long-term management of higher activity radioactive waste should be in near-surface facilities. Facilities should be located as near as possible to the site where the waste is produced. The Scottish government does not support deep geological disposal. In England and Wales, the current policy for HAW is geological disposal. In 2016 the Scottish government published the implementation strategy [15] to expand on the framework provided in 2011 to allow waste management decisions to be taken to ensure the policy is implemented in a safe, environmentally acceptable, and cost-effective manner.

The Scottish government policy does not apply to radioactive waste from those defence premises which are not subject to regulation under the Environmental Authorisations (Scotland) Regulations 2018 (EA(S)R) (which replaced the Radioactive Substances Act 1993. [16] This means the majority of our HAW arising in Scotland is not subject to the Scottish government policy, including radioactive waste produced from the operational nuclear submarine bases on the Clyde, from VULCAN NRTE, and from the decommissioning and dismantling of redundant nuclear submarines now in afloat storage at Rosyth Dockyard.

All long-term waste management options will be subject to robust regulatory requirements and we will work with the Scottish Environment Protection Agency to secure approved disposal routes for all our radioactive waste.

The HAW from submarine dismantling at Rosyth will be transported to Capenhurst where it will be stored. The conditions for acceptance into the appropriate disposal facility will determine the final treatment and packaging requirements. We are in the process of determining the treatment, storage and disposal options for HAW from VULCAN NRTE.

Our LLW from Rosyth will be managed in accordance with the UK Radioactive Waste Strategy. [10] VULCAN NRTE solid LLW will continue to be consigned to the Dounreay Site for processing and disposal under permitted arrangements.

Our irradiated fuel in Scotland will be consolidated at the WIF at Sellafield and managed in accordance with the irradiated fuel approach described in this strategy.

We will determine the long-term management strategy for HAW generated in Scotland and will comply with Scottish government Policies and Strategies where applicable. We will engage with the Scottish government on decommissioning at our sites in Scotland and with local communities through local liaison committees.

What are the relevant US/UK agreements?

From the early stages of the defence nuclear programme, the UK has worked with the Unites States, exchanging technology and expertise within the confines of international treaties and legal obligations. These exchanges are governed by the 1958 US/UK Mutual Defense Agreement (1958 MDA). The UK's first nuclear propulsion plant was provided by the US under the 1958 MDA. Subsequently, the UK has manufactured its own nuclear propulsion plant, but continues to work closely with the US. The terms of the agreement particularly those relating to security requirements, will be a key consideration when deciding how to dismantle and dispose of our nuclear propulsion plant.

The foundations of the UK's submarine based nuclear deterrent are vested in the Polaris Sales Agreement (PSA), a government-to-government treaty established in 1963 between the US and the UK. This agreement was subsequently amended in 1982 to enable the UK to purchase the Trident missile system. The PSA now includes a collaborative US/UK agreement to design and build the missile compartment of the UK's Dreadnought Class nuclear submarines, which will have a high degree of commonality between US and UK systems. Dismantling and disposal are important considerations at the early stages of design. US/UK exchanges related to the nuclear weapon programme are governed by both the PSA and the 1958 MDA.

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Abbreviations

Abbreviation	Meaning
ALARP	As Low As Reasonably Practicable
AWAF	Active Waste Accumulation Facility
AWE	Atomic Weapons Establishment
BEIS	Business Energy and Industrial Strategy
CASD	Continuous At-Sea Deterrent
CC&S	Climate Change & Sustainability
DDC	Defence Directorate of Communications
DNO	Defence Nuclear Organisation
DNSR	Defence Nuclear Safety Regulator
DNSyR	Defence Nuclear Security Regulator
DRD	Devonport Royal Dockyard
DRDL	Devonport Royal Dockyard Ltd
DSA	Defence Safety Authority
EA	Environment Agency
EA(S)R	Environmental Authorisation (Scotland) Regulations
FGOFSP	First Generation Oxide Storage Pond
GDF	Geological Disposal Facility
HAW	Higher Activity Waste
HLW	High Level Waste
HMNB	Her Majesty’s Naval Base
HMT	Her Majesty’s Treasury
IAEA	International Atomic Energy Agency
ILW	Intermediate Level Waste
IXR	Ion Exchange Resin
JSP	Joint Service Publication
KiD	Knowledge in Defence
KIM	Knowledge and Information Management
LAW	Low Activity Waste

LLW	Low-Level Waste
LLWR	Low-Level Waste Repository
LMUKSS	Lockheed Martin UK Strategic Systems
MDA	Mutual Defence Agreement
MOD	Ministry of Defence
NDA	Nuclear Decommissioning Authority
NRTE	Naval Reactor Test Establishment
ONR	Office For Nuclear Regulation
PSA	Polaris Sales Agreement
R&D	Research and Development
RIFE	Radiation In Food and the Environment
RNAD	Royal Naval Armament Depot
RWM	Radioactive Waste Management Limited
SDP	Submarine Dismantling Programme
SEPA	Scottish Environmental Protection Agency
SSCR	Single Source Contracting Regulations
UK	United Kingdom
UN	United Nations
VDAD	Vulcan Defuel and Decommissioning
VLLW	Very Low-Level Waste
WIF	Wet Inlet Facility

Annex A: Our Sites

Atomic Weapons Establishment Aldermaston and Burghfield

Introduction

The Atomic Weapons Establishment (AWE) in Berkshire conducts research, design, and manufacturing activities in support of the UK's nuclear warhead stockpile. AWE works across the entire life cycle of warheads - from initial concept and design, to manufacture and assembly, in-service support, and finally decommissioning and disposal.

AWE provides safe and secure storage for plutonium and enriched uranium and retains the capability for the design and implementation of potential replacement warheads. AWE provides intelligence and support to the UK government by developing innovative solutions to combat nuclear threat, terrorism and nuclear proliferation.

The Aldermaston site (formerly a wartime airfield) was established in 1950 as the principal research, design, and manufacturing facility supporting the UK's nuclear weapons programme. It is now a sophisticated centre providing advanced research, design, and manufacturing facilities.

The Burghfield site was a royal ordnance (munitions) factory that was redeveloped in 1954 to support the nuclear weapons programme. It formally became part of AWE in 1987. The Burghfield site is responsible for the complex final assembly and maintenance of the UK's nuclear warheads while in service, as well as their decommissioning.

AWE Aldermaston and Burghfield are licensed by the Office for Nuclear Regulation under the Nuclear Installations Act 1965 through nuclear site licences issued to AWE plc. Both the Office for Nuclear Regulation and the Environment Agency regulate AWE in accordance with applicable legislation e.g., Ionising Radiations Regulations (2017) and Environmental Permitting Regulations (2016). Defence Nuclear Safety Regulator authorises and regulates specific nuclear activities, primarily those exempt from the licensing requirement of the Nuclear Installations Act 1965 under the AWE Act 1993.

Decommissioning Related Activities

AWE is undertaking a major refurbishment programme to replace obsolete facilities and supporting equipment. As a result, a number of the radioactive processes have been modernised and moved to new facilities. This has allowed the decommissioning and demolition of several redundant processing buildings. Decommissioning activities and the management of decommissioning waste at AWE are being managed as a coherent programme.

As part of our undertaking to work with the Nuclear Decommissioning Authority in the national interest, AWE is sending a substantial amount of Higher Activity Waste to Sellafield for safe treatment packaging and storage over the next decade. The combined approach ensures the timely processing of Higher Activity Waste into a passively safe form and safe long-term storage prior to future treatment and eventual disposal to a Geological Disposal Facility when this becomes available in the UK. AWE actively shares best practice and participates in the investigation of opportunities with the wider nuclear industry to improve safety, reduce costs and find solutions for problematic wastes.

Ownership and Operator

On 1 July 2021, AWE plc, the company operating the Atomic Weapons Establishments (AWE), became a Non-Departmental Public Body, wholly owned by the Ministry of Defence.

We own the AWE sites, including the assets and liabilities. AWE is responsible under a contract with us for operating the sites safely and securely as well as delivering a safe, effective and efficient nuclear warhead programme, including the management of nuclear liabilities, decommissioning of facilities and the management or radioactive waste. AWE plc employs the workforce, holds the nuclear site licences, environmental permits and other regulatory permissions.

AWE plc is governed by a Ministry of Defence -appointed Board consisting of a Chairperson, two Ministry of Defence representatives, six Non-Executive Directors, AWE’s Chief Financial Officer and AWE’s CEO.

End State

An outline programme to achieve deregulation from the Nuclear Installations Act 1965 and Environmental Permitting Regulations 2016 is maintained, however AWE will continue to support the defence nuclear programme for the foreseeable future.

Barrow-In-Furness

Introduction

The BAE Systems Maritime - Submarines facility at Barrow-in-Furness, Cumbria provides shipbuilding facilities for both the submarine and the surface fleet. The Vanguard Class of submarine was built at Barrow. The Astute Class is currently being built at Barrow, and work is progressing building the Dreadnought Class.

The site has a shipbuilding heritage dating from 1871. Britain's first nuclear powered submarine HMS Dreadnought (commissioned in 1963) and Britain's first Polaris-armed ballistic nuclear powered submarine HMS Resolution (commissioned in 1967) were both built in Barrow.

The submarine facilities are centred on the Devonshire Dock Hall that provides covered facilities (the largest in Europe) for the construction and assembly of submarines. A number of Nuclear Build Facilities are now being constructed as part of the Barrow Shipyard Site Redevelopment Programme. The Primary Build Capability will support the manufacture and assembly of the Dreadnought Primary Plant and the Devonshire Dock Quay and Nuclear Berth Support will deliver the in-water commissioning capability.

The Barrow site is licensed by the Office for Nuclear Regulation under the Nuclear Installations Act 1965 for nuclear fuel storage and handling. Both the Office for Nuclear Regulation and the EA regulate BAE Systems Maritime - Submarines, Barrow, in accordance with applicable legislation e.g., Ionising Radiations Regulations (2017) and Environmental Permitting Regulations (2016). Defence Nuclear Safety Regulator authorises and regulates specific nuclear activities, primarily those exempt from the licensing requirement of the Nuclear Installations Act 1965; these include initial testing of the nuclear reactor.

Decommissioning Related Activities

The Barrow site contains only a small number of facilities that constitute nuclear liabilities and the radioactive inventory at the time of decommissioning is expected to be extremely low. These facilities support the production of nuclear submarines and no decommissioning is expected to be required at the site.

Ownership and Operator

The site is commercially owned; BAE Systems Maritime - Submarines is the site operator.

End State

The Barrow site will continue to support of the defence nuclear programme for the foreseeable future. The end state will be at the owner's discretion (subject to contracts) but is likely to be continued defence, industrial, or maritime use.

Clyde

Introduction

Her Majesty's Naval Base (HMNB) Clyde, north west of Glasgow, Scotland, is the operational base for the UK's strategic nuclear deterrent and provides facilities for the operation and maintenance of all classes of UK submarine.

The Naval Base comprises separate sites at Faslane and Royal Naval Armament Depot (RNAD) Coulport.

The Faslane site provides a range of nuclear submarine support capabilities including facilities for the maintenance and docking of submarines. The RNAD Coulport site undertakes the storage, processing, maintenance and issue of the Trident Weapon System and the ammunitioning of all submarine embarked weapons.

HMNB Clyde is the base port for the Vanguard and Astute Class submarine, and the remaining Trafalgar Class submarines. Nuclear activities on HMNB Clyde are authorised and regulated by the Defence Nuclear Safety Regulator.

The Office for Nuclear Regulation regulate the Naval Base in accordance with applicable legislation e.g., Ionising Radiations Regulations (2017). Scottish Environmental Protection Agency regulate the Naval Base by agreement in accordance with the Environmental Authorisations (Scotland) Regulations 2018 (EA(S)R).

Decommissioning Related Activities

The majority of facilities will remain in operation beyond 2030 to support both Astute Class and Dreadnought Class submarine operations. The Radioactive Effluent Disposal Facility and Active Processing Facility are due to be decommissioned following construction of the replacement radioactive waste handling and treatment facility.

Ownership and Operator

We own and operate HMNB Clyde. The Naval Base is supported by the principal Clyde operating contractor, Babcock International Group Plc and by the ABL Alliance which is a joint venture between AWE, Babcock and Lockheed Martin UK Strategic Systems (LMUKSS).

End State

HMNB Clyde will continue to support the defence nuclear programme for the foreseeable future.

HMNB Devonport

Introduction

Her Majesty's Naval Base (HMNB) Devonport in Plymouth, Devon can be used by any of the Royal Navy's submarines for visits, replenishment of stores, planned maintenance operations, and for defect repair. The Naval Base (along with Devonport Royal Dockyard) is part of the Devonport site, and has been providing support to the Royal Navy since the 1690s. The site is jointly shared with Babcock International Group.

Nuclear activities on the Naval Base are conducted on the tidal submarine berths, supporting facilities, and the basin facilities are used for berthing out-of-service nuclear submarines. Fourteen[6] out-of-service submarines are currently stored afloat at HMNB Devonport. Nuclear activities on HMNB Devonport are authorised and regulated by the Defence Nuclear Safety Regulator.

Both the Office for Nuclear Regulation and the Environment Agency regulate the Naval Base in accordance with applicable legislation e.g., Ionising Radiations Regulations (2017) and Environmental Permitting Regulations (2016).[7]

Decommissioning Related Activities

Our decommissioning liabilities at the tidal berths is small and limited to the supporting radioactive effluent handling facility. The potential for consolidation and optimisation of nuclear and radiological facilities on the Naval Base and dockyard sites is being examined. Decommissioning activities at the Naval Base and the dockyard will be coordinated and prioritised to optimise the reduction of risk across both sites. Initial dismantling of submarines is planned to take place at the licensed Devonport dockyard site. Initial dismantling is the process whereby the radioactive materials are removed from the submarine, leaving the rest of the submarine free to be dismantled using conventional ship recycling at a separate ship recycling facility. Intermediate level waste from submarine dismantling activities will be removed from site and stored pending the availability of a UK disposal facility.

Ownership and Operator

We own and operate HMNB Devonport and we are supported by Babcock International Group plc.

End State

HMNB Devonport will continue to support the defence nuclear programme for the foreseeable future.

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[6] At the time of writing fourteen submarines are at HMNB, however this may increase before next publication, and submarines are transferred between the Naval Base and Dockyard for specific activities.

[7] HMNB(D) is not legally bound by the radioactive substances part of the Environmental Permitting Regulations 2016 (EPR16), but agree to apply 'the spirit' of the legislation through the Environment Agency issued 'Approval' to dispose of radioactive wastes.

Devonport Royal Dockyard

Introduction

Devonport Royal Dockyard (DRD) in Plymouth, Devon provides the Royal Navy's repair and refitting facilities for the UK's nuclear submarines, and is the only site in the UK equipped to conduct nuclear submarine refits including those for the Vanguard Class. The nuclear site at DRD is licensed to Devonport Royal Dockyard Ltd (DRDL) by the Office for Nuclear Regulation under the Nuclear Installations Act 1965.

Both the Office for Nuclear Regulation and the EA regulate DRDL in accordance with applicable legislation e.g., Ionising Radiations Regulations (2017) and Environmental Permitting Regulations (2016).

Decommissioning Related Activities

There are a number of operational nuclear facilities on site that are maintained as part of DRDL's on-going support to the defence nuclear programme. New facilities are being constructed to enable the management of nuclear liabilities to progress, for example, a new Reactor Access Housing for defueling. In addition, there are redundant facilities for older submarine classes and activities that are no longer undertaken, that have been decontaminated and are in care and maintenance. Some facilities have already been decommissioned for example, two obsolete Alternative Core Reactor Cooling units for decay heat removal and chemistry control and fuel storage facility. New facilities are being constructed to enable the management of nuclear liabilities to progress, for example, a new Reactor Access Housing for defueling. Submarines are stored at HMNB, but the preparations for storage are undertaken at DRD.

The potential for consolidation and optimisation of nuclear and radiological facilities on the Naval Base and dockyard sites is being examined. Decommissioning activities at the Naval Base and the dockyard will be coordinated and prioritised to optimise the reduction of risk across both sites. Initial dismantling of submarines currently berthed at HMNB Devonport is planned to take place at Devonport dockyard. Initial dismantling is the process whereby the radioactive materials are removed from the defueled submarine, leaving the rest of the submarine free to be dismantled using conventional ship recycling at a separate ship recycling facility. ILW from submarine dismantling activities will be removed from site and stored pending the availability of a UK disposal facility.

Ownership and Operator

Devonport Dockyard is owned and operated by DRDL (a subsidiary of Babcock International Group plc).

End State

The site will continue to support the defence nuclear programme for the foreseeable future. The site end state will be at the owner's discretion (subject to contracts) but is likely to support ongoing non-nuclear maritime defence and industrial activities.

Rosyth Royal Dockyard

Introduction

Rosyth Royal Dockyard to the north west of Edinburgh in Fife formerly undertook refitting of Royal Navy submarines and surface vessels, and was the site for the recent assembly of UK's two Queen Elizabeth Class aircraft carriers. The dockyard started construction in 1909 and has fulfilled various roles in support of defence including submarine maintenance, refuelling and decommissioning.

In-service submarine maintenance activities completed in 2003, but seven out-of-service defueled nuclear submarines are stored safely here.

Two areas of the site remain licensed by the Office for Nuclear Regulation under Nuclear Installations Act 1965, with Rosyth Royal Dockyard Ltd as the site licensee. Nuclear work on the licensed site now comprises activities related to the Submarine Dismantling Programme (SDP), which commenced in No. 2 Dock in late 2016; and waste storage and processing in the separate Active Waste Accumulation Facility (AWAF). This facility was purpose built for the safe and secure storage of legacy ion exchange resin from submarine operation and maintenance activities. Resins storage continues, and the facility is also used to process and manage radioactive wastes arising from SDP and from on-going decommissioning and clean-up of the dockyard. Both the Office for Nuclear Regulation and Scottish Environmental Protection Agency regulate Rosyth Royal Dockyard Ltd (as the site licensee) in accordance with applicable legislation e.g., Ionising Radiations Regulations (2017) and Environmental Authorisations (Scotland) Regulations 2018 (EA(S)R). DNSR Authorises and regulates specific nuclear activities that are located off the licensed site, primarily those exempt from the licensing requirement of the Nuclear Installations Act 1965.

Decommissioning Related Activities

The main programme to decommission and remove the legacy submarine refit facilities completed in 2010. Key operational facilities remain, to support remaining activities, and new infrastructure has been provided to support SDP. MOD is now on contract with Trabebe Inutec to process the legacy resins to a condition where they can be disposed of as LLW. Initial dismantling of submarines is taking take place at Rosyth Dockyard, this is the process whereby the radioactive components are removed, leaving the rest of the submarine free to be dismantled via conventional ship recycling at a separate ship recycling facility. ILW from submarine dismantling activities will be removed from site and stored pending the availability of a UK disposal facility.

Ownership and Operator

Rosyth nuclear site is owned and operated by Babcock International Group plc. Radioactive waste from SDP operations remains under MOD ownership and our liability.

End State

The site will continue to support the defence nuclear programme for the foreseeable future. Once submarine dismantling operations are complete, decommissioning of the remaining nuclear infrastructure and radioactive waste processing facilities will enable the site to be delicensed and all extant SEPA permits to be revoked. When all the MOD-owned nuclear legacy has been removed, the Rosyth dockyard site will continue to support on-going non-nuclear maritime defence and industrial activities.

Rolls-Royce Submarines Limited

Introduction

Rolls-Royce Submarines Limited, a subsidiary of Rolls-Royce plc., operates two nuclear licensed sites in Derby. The sites are used for manufacture and testing of nuclear reactor fuel, reactor cores, and other associated nuclear propulsion components for the Royal Navy's submarines. The Derby manufacturing site was licensed in 1960 and undertakes the processing of uranium fuel and the fabrication of submarine nuclear reactor cores.

The Neptune site accommodates a zero-power reactor used to test materials to support the design of future submarine reactors. The nuclear sites are licensed and regulated by the Office for Nuclear Regulation under the Nuclear Installations Act 1965. Both the Office for Nuclear Regulation and the EA regulate the site in accordance with applicable legislation e.g., Ionising Radiations Regulations (2017) and Environmental Permitting Regulations (2016).

Decommissioning Related Activities

The current submarine reactor manufacturing capability is being regenerated to sustain the UK capability to manufacture submarine reactors. The regenerated capability will occupy a similar area and is currently planned to be within the established nuclear licensed site.

Ownership and Operator

The site is commercially owned, Rolls-Royce Submarines Limited is the site operator.

End State

Rolls-Royce Submarines Limited will continue to support the defence nuclear programme for the foreseeable future and will continue to supply nuclear reactor cores for the Astute Class and Dreadnought Class submarines.

VULCAN Naval Reactor Test Establishment

Introduction

The VULCAN NRTE site at Dounreay in Caithness, Scotland has been responsible for the prototyping of naval nuclear reactors for UK submarines. The first prototype reactor (the Dounreay Submarine Prototype 1) was commissioned in 1963 and the second (the Shore Test Facility) was commissioned in 1987.

The decision not to prototype the next generation of reactor cores was announced in 2011 and VULCAN NRTE ceased critical operations in 2015. The VULCAN NRTE site is adjacent to the NDA's civil nuclear site at Dounreay that is currently undergoing decommissioning. Nuclear activities at VULCAN NRTE are authorised and regulated by DNSR in conjunction with Office for Nuclear Regulation and Scottish Environmental Protection Agency as appropriate.

Decommissioning Related Activities

The Vulcan Defuel and Decommissioning (VDAD) project is responsible for defueling of the second prototype reactor, the removal of fuel from site and developing the plans for decommissioning the site. The VDAD project team are working in close co-operation with the NDA who are responsible for decommissioning of the adjacent Dounreay site.

Ownership and Operator

The VULCAN NRTE site is owned by the Nuclear Decommissioning Authority on behalf of the government and is leased to and operated by us. The site is supported by an operations and maintenance contract with Rolls-Royce Submarines Limited under a 'Government Owned Contractor Operated' arrangement.

End State

The end state of VULCAN NRTE will be commensurate with the next planned use and decided in agreement with the Nuclear Decommissioning Authority, taking full account of the end state for the adjacent civil nuclear site at Dounreay.